ARMSTRONG
FLOW CONTROL

Steam Traps

Installation and Testing of Armstrong Steam Traps

Strainers. Install strainers ahead of traps if specified or when dirt conditions warrant their use. Some types of traps are more susceptible to dirt problems than others—see Recommendation Chart on page CG-2.

Some traps have built-in strainers. When a strainer blowdown valve is used, shut off steam supply valve before opening strainer blowdown valve. Condensate in trap body will flash back through strainer screen for thorough cleaning. Open steam valve slowly.

Dirt Pockets are excellent for stopping scale and core sand, and eliminating erosion that can occur in elbows when dirt pockets are not provided. Clean periodically.

Syphon Installations require a water seal and, with the exception of the DC, a check valve in or before the trap. Syphon pipe should be one size smaller than nominal size of trap used but not less than 1/2" pipe size.

Elevating Condensate. Do not oversize the vertical riser. In fact, one pipe size smaller than normal for the job will give excellent results.

Check Valves are frequently needed. They are a must if no discharge line shutoff valve is used. Fig. CG-63 shows three possible locations for external check valves—Armstrong inverted bucket traps are available with internal check valves, while disc traps act as their own check valve. Recommended locations are given in Fig. CG-63.

Discharge Line Check Valves prevent backflow and isolate trap when test valve is opened. Normally installed at location B, Fig. CG-63. When return line is elevated and trap is exposed to freezing conditions, install check valve at location A.

Inlet Line Check Valves prevent loss of seal if pressure should drop suddenly or if trap is above drip point in IB traps. Armstrong Stainless Steel Check Valve in trap body, location D, Fig. CG-63, is recommended. If swing check is used, install at location C.

Figure CG-62.
Typical IB Bottom Inlet—Side Outlet Hookup

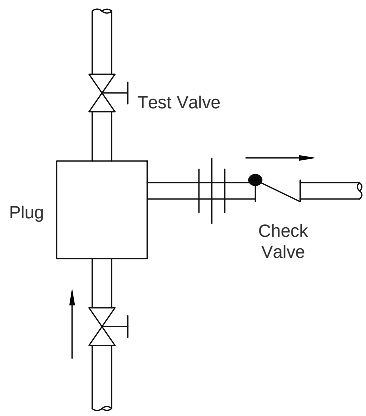


Figure CG-63.
Possible Check Valve Locations

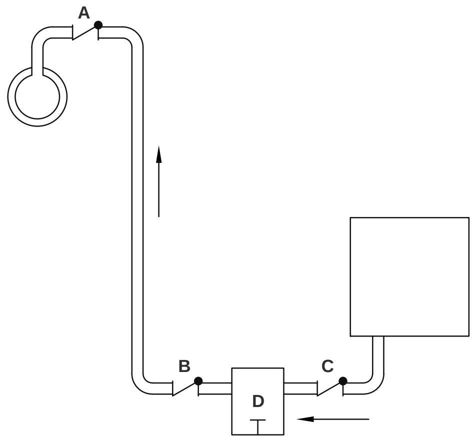


Figure CG-64.
Typical IB By-pass Hookup

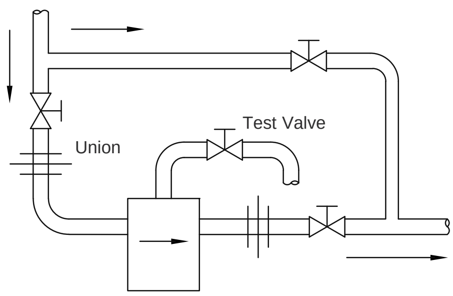
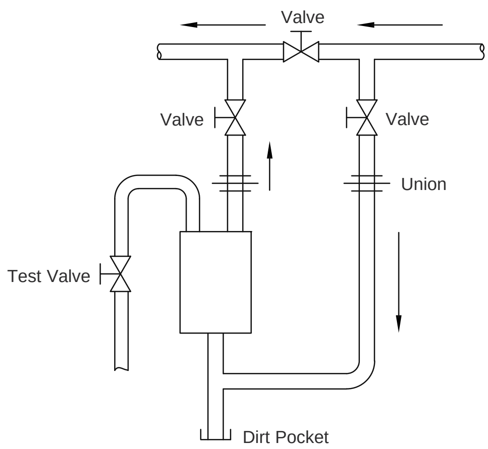


Figure CG-65.
Typical IB By-pass Hookup, Bottom Inlet—Top Outlet



Installation and Testing of Armstrong Steam Traps

A Safety Drain Trap should be used whenever there is a likelihood that the inlet pressure will fall below the outlet pressure of a primary steam trap, especially in the presence of freezing air. One such application would be on a modulated pressure heating coil that must be drained with an elevated return line. In the event of insufficient drainage from the primary trap, condensate rises into the safety drain and is discharged before it can enter the heat exchanger. An F&T trap makes a good safety drain because of its ability to handle large amounts of air and its simplicity of operation. Safety drain trap should be same size (capacity) as primary trap.

The proper application of a safety drain is shown in Fig. CG-66. The inlet to the safety drain must be located on the heat exchanger drip leg, above the inlet to the primary trap. It must discharge to an open sewer. The drain plug of the safety drain is piped to the inlet of the primary trap. This prevents the discharge of condensate formed in the safety drain by body radiation when the primary trap is active. The safety drain has an integral vacuum breaker to maintain operation when pressure in the heat exchanger falls below atmospheric. The inlet of the vacuum breaker should be fitted with a gooseneck to prevent dirt from being sucked in when it operates. The vacuum breaker inlet should be provided with a riser equal in elevation to the bottom of the heat exchanger to prevent water leakage when the vacuum breaker is operating, but the drip leg and trap body are flooded.

Protection Against Freezing

A properly selected and installed trap will not freeze as long as steam is coming to the trap. If the steam supply should be shut off, the steam condenses, forming a vacuum in the heat exchanger or tracer line. This prevents free drainage of the condensate from the system before freezing can occur. Therefore, install a vacuum breaker between the equipment being drained and the trap. If there is not gravity drainage through the trap to the return line, the trap and discharge line should be drained manually or automatically by means of a freeze protection drain. Also, when multiple traps are installed in a trap station, insulating the traps can provide freeze protection.

Anti-Freeze Precautions.

1. Do not oversize trap.
2. Keep trap discharge lines very short.
3. Pitch trap discharge lines down for fast gravity discharge.
4. Insulate trap discharge lines and condensate return lines.
5. Where condensate return lines are exposed to ambient weather conditions, tracer lines should be considered.
6. If the return line is overhead, run vertical discharge line adjacent to drain line to top of return header and insulate drain line and trap discharge line together. See Fig. CG-67.

NOTE: A long horizontal discharge line invites trouble. Ice can form at the far end, eventually sealing off the pipe. This prevents the trap from operating. No more steam can enter the trap, and the water in the trap body freezes.

Figure CG-66. Typical Safety Drain Trap Hookup

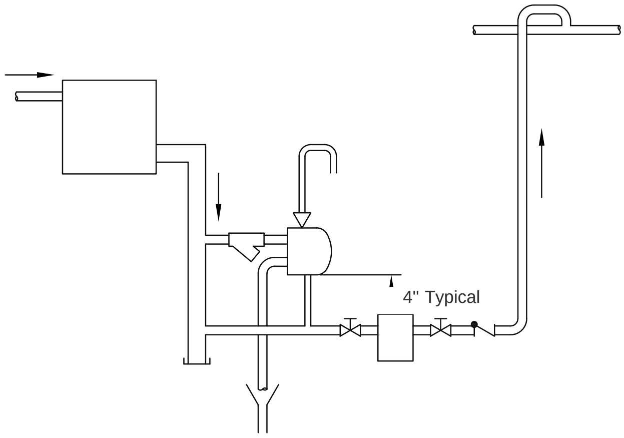
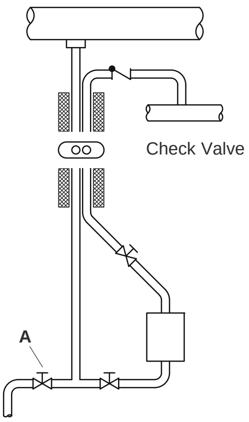
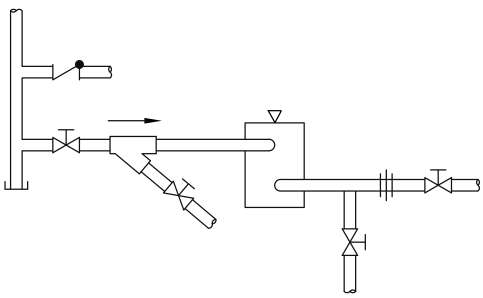


Figure CG-67.



Outdoor installation to permit ground level trap testing and maintenance when steam supply and return lines are high overhead. Drain line and trap discharge line are insulated together to prevent freezing. Note location of check valve in discharge line and blowdown valve **A** that drains the steam main when trap is opened for cleaning or repair.

Figure CG-68.
Typical F&T Hookup



Installation and Testing of Armstrong Steam Traps

Testing Armstrong Steam Traps

Testing Schedule.
For maximum trap life and steam economy, a regular schedule should be set up for trap testing and preventive maintenance. Trap size, operating pressure and importance determine how frequently traps should be checked.

Table CG-28. Suggested Yearly Trap Testing Frequency

Operating Pressure (psig)	Application			
	Drip	Tracer	Coil	Process
0-100	1	1	2	3
101-250	2	2	2	3
251-450	2	2	3	4
451 and above	3	3	4	12

How to Test

The test valve method is best. Fig. CG-60 (page CG-45) shows correct hookup, with shutoff valve in return line to isolate trap from return header. Here is what to look for when test valve is opened:

1. **Condensate Discharge**—Inverted bucket and disc traps should have an intermittent condensate discharge. F&T traps should have a continuous condensate discharge, while thermostatic traps can be either continuous or intermittent, depending on the load. When an IB trap has an extremely small load it will have a continuous condensate discharge which causes a dribbling effect. This mode of operation is normal under this condition.
2. **Flash Steam**—Do not mistake this for a steam leak through the trap valve. Condensate under pressure holds more heat units-Btu-per pound than condensate at atmospheric pressure. When condensate is discharged, these extra heat units re-evaporate some of the condensate. See description of flash steam on page CG-4.
   How to Identify Flash: Trap users sometimes confuse flash steam with leaking steam. Here's how to tell the difference: If steam blows out continuously, in a "blue" stream, it's leaking steam. If steam "floats" out intermittently (each time the trap discharges) in a whitish cloud, it's flash steam.
3. Continuous Steam Blow—Trouble. Refer to page CG-49.
4. No Flow—Possible trouble. Refer to page CG-49.

Listening Device Test. Use a listening device or hold one end of a steel rod against the trap cap and the other end against your ear. You should be able to hear the difference between the intermittent discharge of some traps and the continuous discharge of others. This correct operating condition can be distinguished from the higher velocity sound of a trap blowing through. Considerable experience is required for this method of testing, as other noises are telegraphed along the pipe lines.

Pyrometer Method of Testing. This method may not give accurate results, depending on the return line design and the diameter of the trap orifice. Also, when discharging into a common return, another trap may be blowing through, causing a high temperature at the outlet of the trap being tested. Better results can be obtained with a listening device. Request Armstrong Bulletin 310.

Figure CG-69.
Typical DC Hookup

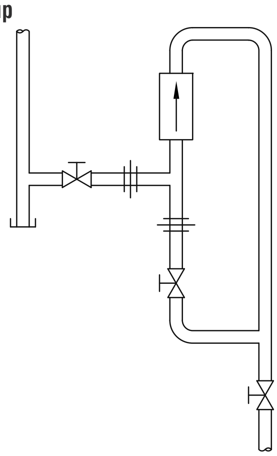


Figure CG-70.
Typical Disc Trap Hookup

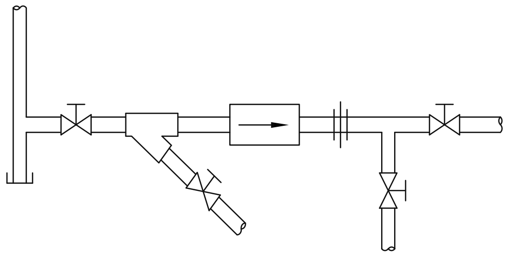
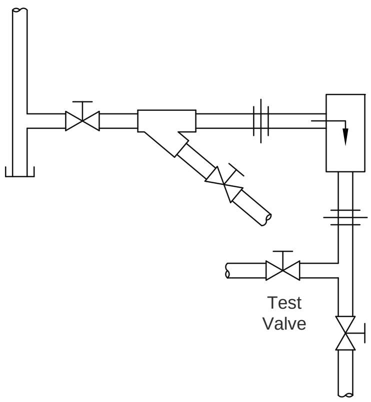


Figure CG-71.
Typical Thermostatic Hookup



Troubleshooting Armstrong Steam Traps

The following summary will prove helpful in locating and correcting nearly all steam trap troubles. Many of these are actually system problems rather than trap troubles.

More detailed troubleshooting literature is available for specific products and applications—consult factory.

Whenever a trap fails to operate and the reason is not readily apparent, the discharge from the trap should be observed. If the trap is installed with a test outlet, this will be a simple matter—otherwise, it will be necessary to break the discharge connection.

Cold Trap—No Discharge
If the trap fails to discharge condensate, then:

A. Pressure may be too high.
1. Wrong pressure originally specified.
2. Pressure raised without installing smaller orifice.
3. PRV out of order.
4. Pressure gauge in boiler reads low.
5. Orifice enlarged by normal wear.
6. High vacuum in return line increases pressure differential beyond which trap may operate.

B. No condensate or steam coming to trap.
1. Stopped by plugged strainer ahead of trap.
2. Broken valve in line to trap.
3. Pipe line or elbows plugged.

C. Worn or defective mechanism.
Repair or replace as required.

D. Trap body filled with dirt.
Install strainer or remove dirt at source.

E. For IB, bucket vent filled with dirt. Prevent by:
1. Installing strainer.
2. Enlarging vent slightly.
3. Using bucket vent scrubbing wire.

F. For F&T traps, if air vent is not functioning properly, trap will likely air bind.

G. For thermostatic traps, the bellows element may rupture from hydraulic shock, causing the trap to fail closed.

H. For disc traps, trap may be installed backward.

Hot Trap—No Discharge
A. No condensate coming to trap.
1. Trap installed above leaky by-pass valve.
2. Broken or damaged syphon pipe in syphon drained cylinder.
3. Vacuum in water heater coils may prevent drainage. Install a vacuum breaker between the heat exchanger and the trap.

Steam Loss
If the trap blows live steam, the trouble may be due to any of the following causes:

A. Valve may fail to seat.
1. Piece of scale lodged in orifice.
2. Worn parts.

B. IB trap may lose its prime.
1. If the trap is blowing live steam, close the inlet valve for a few minutes. Then gradually open. If the trap catches its prime, chances are the trap is all right.
2. Prime loss is usually due to sudden or frequent drops in steam pressure. On such jobs, the installation of a check valve is called for—location D or C in Fig. CG-63 (page CG-46). If possible, locate trap well below drip point.

C. For F&T and thermostatic traps, thermostatic elements may fail to close.

Continuous Flow
If an IB or disc trap discharges continuously, or an F&T or thermostatic trap discharges at full capacity, check the following:

A. Trap too small.
1. A larger trap, or additional traps, should be installed in parallel.
2. High pressure traps may have been used for a low pressure job. Install right size of internal mechanism.

B. Abnormal water conditions. Boiler may foam or prime, throwing large quantities of water into steam lines. A separator should be installed or else the feed water conditions should be remedied.

Sluggish Heating
When trap operates satisfactorily, but unit fails to heat properly:

A. One or more units may be short-circuiting. The remedy is to install a trap on each unit. See page CG-15.

B. Traps may be too small for job even though they may appear to be handling the condensate efficiently. Try next larger size trap.

C. Trap may have insufficient air-handling capacity, or the air may not be reaching trap. In either case, use auxiliary air vents.

Mysterious Trouble
If trap operates satisfactorily when discharging to atmosphere, but trouble is encountered when connected with return line, check the following:

A. Back pressure may reduce capacity of trap.
1. Return line too small—trap hot.
2. Other traps may be blowing steam—trap hot.
3. Atmospheric vent in condensate receiver may be plugged—trap hot or cold.
4. Obstruction in return line—trap hot.
5. Excess vacuum in return line—trap cold.

Imaginary Troubles
If it appears that steam escapes every time trap discharges, remember: Hot condensate forms flash steam when released to lower pressure, but it usually condenses quickly in the return line. See Chart CG-4 on page CG-4.

Trap Selection and Safety Factors

This table provides recommendations for traps likely to be most effective in various applications. The recommended safety factors ensure proper operation under varying conditions. For more specific information on recommended traps and safety factors, contact your Armstrong Representative.

Table CG-27.

Application	1st Choice	2nd Choice	Safety Factor
Boiler Header	IBLV	F&T	1.5:1
(Superheat)	IBCV Burnished	Wafer	Start-Up Load
Steam Mains & Branch Lines			
(Non-Freezing)	IB (CV if pressure varies)	F&T	2:1, 3:1 if @ end of main, ahead of valve, or on branch
(Freezing)	IB	Thermostatic or Disc	Same as above
Steam Separator	IBLV	DC	3:1
Steam quality 90% or less	DC	—	
Tracer Lines	IB	Thermostatic or Disc	2:1
Unit Heaters and Air Handlers			
(Constant Pressure)	IBLV	F&T	3:1
(0-15 Variable Pressure)	F&T	IBLV	2:1 @ 1/2 psi Differential
(16-30 Variable Pressure)			2:1 @ 2 psi Differential
(>30 Variable Pressure)			3:1 @ 1/2 Max. Pressure Differential
Finned Radiation & Pipe Coils			
(Constant Pressure)	IB	Thermostatic	3:1 for quick heating 2:1 normally
(Variable Pressure)	F&T	IB	
Process Air Heaters			
(Constant Pressure)	IB	F&T	2:1
(Variable Pressure)	F&T	IBLV	3:1 @ 1/2 Max. Pressure Differential
Steam Absorption Machine (Chiller)	F&T	IB Ext. Air Vent	2:1 @ 1/2 psi Differential
Shell & Tube Heat Exchangers, Pipe & Embossed Coils			
(Constant Pressure)	IB	DC or F&T	2:1
(Variable Pressure)	F&T	DC or IBT (If >30 psi IBLV)	<15 psi 2:1 @ 1/2 psi 16-30 psi 2:1 @ 2 psi >30 psi 3:1 @ 1/2 Max. Pressure Differential
Evaporator Single Effect & Multiple Effect	DC	IBLV or F&T	2:1, If load 50,000 lbs/hr use 3:1
Jacketed Kettles			
(Gravity Drain)	IBLV	F&T or Thermostatic	3:1
(Syphon Drain)	DC	IBLV	
Rotating Dryers	DC	IBLV	3:1 for DC, 8:1 for IB variable pressure, 10:1 for IB variable pressure
Flash Tanks	IBLV	DC or F&T	3:1

IBLV = Inverted Bucket Large Vent
IBCV = Inverted Bucket Internal Check Valve
IBT = Inverted Bucket Thermic Vent
F&T = Float & Thermostatic
DC = Differential Condensate Controller

Use an IB with external air vent above the F&T pressure limitations or if the steam is dirty. All safety factors are at the operating pressure differential unless otherwise noted.

Installation and Testing of Armstrong Steam Traps

Before Installing

Run pipe to trap. Before installing the trap, clean the line by blowing down with steam or compressed air. (Clean any strainer screens after this blowdown.)

Trap Location ABCs

Accessible for inspection and repair.

Below drip point whenever possible.

Close to drip point.

Trap Hookups. For typical hookups, see Figs. CG-60 (below) through CG-71, pages CG-45 through CG-48.

Shutoff Valves ahead of traps are needed when traps drain steam mains, large water heaters, etc., where system cannot be shut down for trap maintenance. They are not needed for small steam-heated machines—a laundry press, for example. Shutoff valve in steam supply to machine is usually sufficient.

Shutoff Valves in trap discharge line are needed when trap has a by-pass. It is a good idea when there is high pressure in discharge header. See also Check Valves.

By-passes (Figs. CG-64 and CG-65) are discouraged, for if left open, they will defeat the function of the trap. If continuous service is absolutely required, use two traps in parallel, one as a primary, one as a standby.

Unions. If only one is used, it should be on discharge side of trap. With two unions, avoid horizontal or vertical in-line installations. The best practice is to install at right angles as in Figs. CG-60 and CG-64, or parallel as in Fig. CG-65.

Standard Connections. Servicing is simplified by keeping lengths of inlet and outlet nipples identical for traps of a given size and type. A spare trap with identical fittings and half unions can be kept in storeroom. In the event a trap needs repair, it is a simple matter to break the two unions, remove the trap, put in the spare and tighten the unions. Repairs can then be made in the shop and the repaired trap, with fittings and half unions, put back in stock.

Test Valves (Fig. CG-60) provide an excellent means of checking trap operation. Use a small plug valve. Provide a check valve or shutoff valve in the discharge line to isolate trap while testing.

Figure CG-60.
Typical IB Hookup

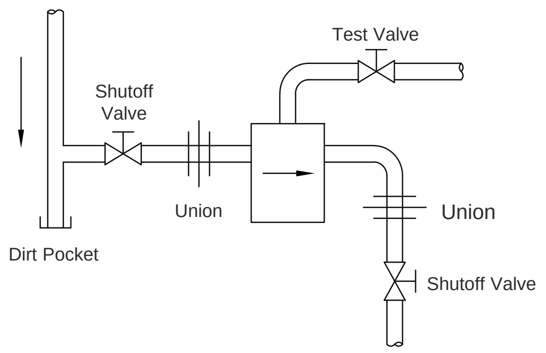
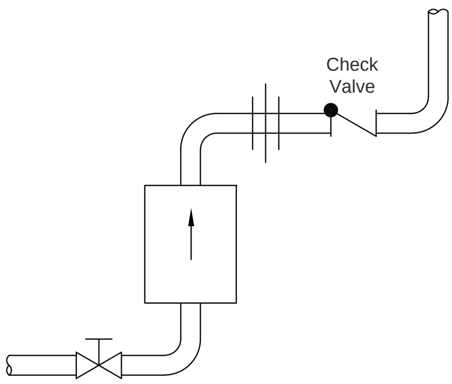


Figure CG-61.
Typical IB Bottom Inlet—Top Outlet Hookup



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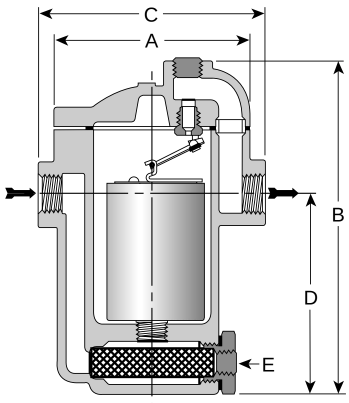
880 Series Inverted Bucket Steam Traps

Cast Iron for Horizontal Installation With Integral Strainer

For Pressures to 250 psig (17 bar)...Capacities to 4,400 lb/hr (2,000 kg/hr)



Description

The most reliable steam trap known—the inverted bucket—provides efficient condensate drainage of virtually all types of steam-using equipment. Put the inverted bucket to work in a tough cast iron package with an integral strainer, and you have the best of both worlds. Because they operate efficiently for longer periods of time, Armstrong cast iron inverted buckets add solid energy savings to lower replacement/labor costs. All Armstrong cast iron inverted bucket steam traps are repairable for even bigger maintenance savings.

A unique leverage system multiplies the force provided by the bucket to open the valve against system pressure. The mechanism is free-floating, and has no fixed pivots to create wear or friction.

Because the mechanism is located at the top of the trap, no dirt can collect on the orifice. Small particles of dirt are held in suspension until discharged by the full differential purging action when the bucket sinks, pulling the valve off the seat.

The discharge orifice is surrounded by a water seal, preventing live steam loss. Automatic air venting is provided by a small vent hole in the bucket, which provides continuous automatic air and CO_2 venting at steam temperature.

Inverted bucket traps drain continuously, although discharging intermittently, allowing no condensate backup. They are also resistant to water hammer.

Maximum Operating Conditions

Maximum allowable pressure (vessel design):	250 psig @ 450°F (17 bar @ 232°C)
Maximum operating pressure:	Model 880: 150 psig (10 bar) Model 881-883: 250 psig (17 bar)

Connections

Screwed NPT and BSPT

Materials

Body:	ASTM A48 Class 30
Internals:	All stainless steel—304
Valve and seat:	Hardened chrome steel—17-4PH
Test plug:	Carbon steel
Strainer:	Stainless steel—304

Options

- Stainless steel internal check valve
- Thermic vent bucket
- Scrub wire

Specification

Inverted bucket steam trap, type ... in cast iron with integral strainer, with continuous air venting at steam temperature, with free-floating stainless steel mechanism, and discharge orifice at the top of the trap.

How to Order

Specify:
- Model number
- Size and type of pipe connection
- Maximum working pressure that will be encountered or orifice size
- Any options required

For a fully detailed certified drawing, refer to CD #1000.

880 Series Side Inlet, Side Outlet Traps With Integral Strainers. Add suffix "CV" to model number for internal check valve, "T" for thermic vent bucket.

Model No.	880*		881		882		883	
	in	mm	in	mm	in	mm	in	mm
Pipe Connections	1/2, 3/4	15, 20	1/2, 3/4, 1	15, 20, 25	1/2, 3/4	15, 20	3/4, 1, 1-1/4	20, 25, 32
Test Plug	1/4	6	1/4	6	1/2	15	3/4	20
"A" (Flange Diameter)	3-3/4	95.2	3-3/4	95.2	5-5/8	142.9	7	177.8
"B" (Height)	6-1/16	154	7-1/16	179	9-3/8	244	12-3/8	314
"C" (Face-to-Face)	5	127	5	127	6-1/2	165	7-7/8	200
"D" (Bottom to ℄ Inlet)	3-7/16	87.3	4-7/16	113	5-3/4	146	7-3/8	187
"E" (Blowdown Connection)	3/8	9	3/8	9	3/8	9	1/2	15
Number of Bolts	6							
Weight lb (kg)	5-1/2 (2.5)		6 (2.7)		15-1/2 (7.0)		31 (14.1)	

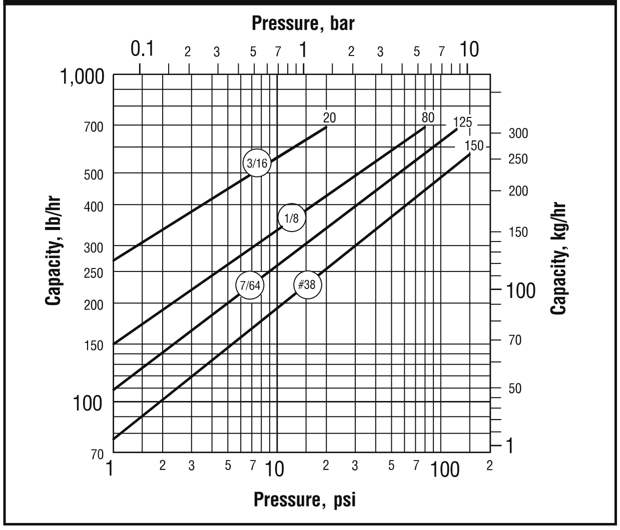
*Cannot be furnished with both thermic vent bucket and check valve.

880 Series Inverted Bucket Steam Traps

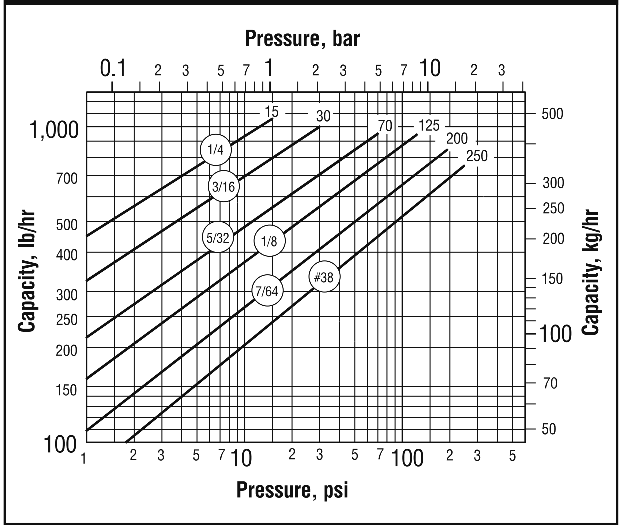
Cast Iron for Horizontal Installation With Integral Strainer

For Pressures to 250 psig (17 bar)...Capacities to 4,400 lb/hr (2,000 kg/hr)

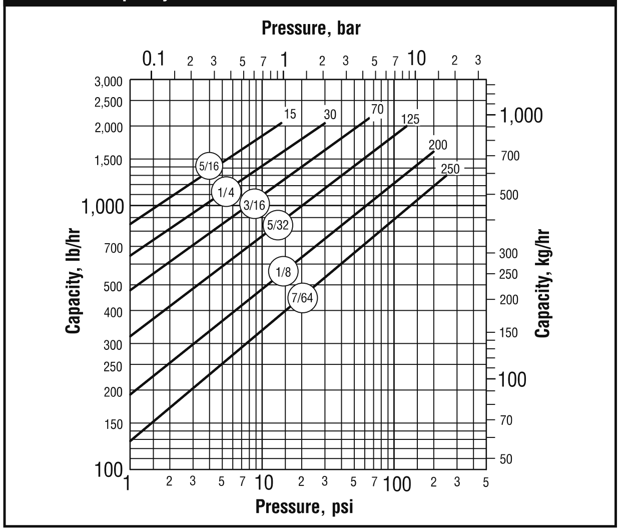
Model 880 Capacity



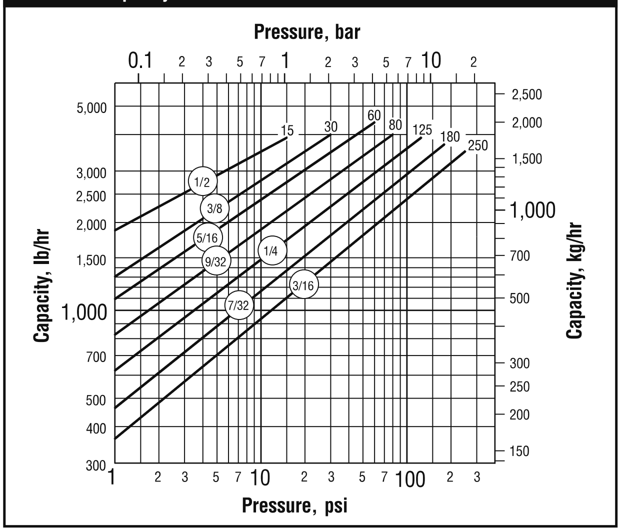
Model 881 Capacity



Model 882 Capacity



Model 883 Capacity



1000 Series Inverted Bucket Steam Trap

All Stainless Steel for Vertical Installation (Except U-1000 w/Strainer)

For Pressures to 650 psig (45 bar)...Capacities to 4,400 lb/hr (2,000 kg/hr)

Description

Armstrong 1000 Series stainless steel inverted bucket steam traps normally last three to four times longer than conventional traps used in identical services. Heat-treated stainless steel valves and seats are of the same design, material and workmanship as those used in traps for pressures up to 900 psig and temperatures to 900°F. More compact than cast iron or carbon steel equivalents, 1000 Series traps are ideal for trapping applications such as tracer lines, steam mains and heating/process applications.

The 1000 Series are guaranteed for three years.

Maximum Operating Conditions

Maximum allowable pressure (vessel design):

Model 1010, 1011:	400 psig @ 800°F (28 bar @ 427°C)
Model 1022:	650 psig @ 600°F (45 bar @ 316°C)
	627 psig @ 700°F (43 bar @ 371°C)
	604 psig @ 800°F (41.6 bar @ 427°C)
Model 1013:	450 psig @ 800°F (31 bar @ 427°C)

Maximum operating pressure:

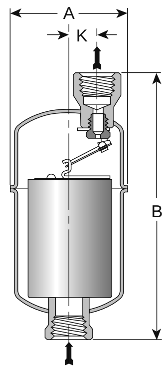
Model 1010:	150 psig (10 bar)
Model 1011:	400 psig (28 bar)
Model 1022:	650 psig (45 bar)
Model 1013:	450 psig (31 bar)

Connections

Screwed NPT and BSPT
Socketweld

Materials

Body:	ASTM A240 Grade 304L
Internals:	All stainless steel—304
Valve and seat:	Hardened chrome steel—17-4PH or Titanium



Model 1010 Trap

Options

- Stainless steel internal check valve
- Thermic vent bucket 250 psig (17 bar) maximum; for Model 1022 15 psig (1 bar) maximum
- Wiggle wire

Specification

Inverted bucket steam trap, type ... in all stainless steel, freeze resistant, without gaskets, with continuous air venting at steam temperature, free-floating stainless steel mechanism, and orifice at the top of the trap.

How to Order

Specify:
- Model number
- Size and type of pipe connection
- Maximum working pressure that will be encountered or orifice size
- Any options required

For a fully detailed certified drawing, refer to:

1010 and 1011	**CD #1006**
1022	**CD #1204**

1000 Series Traps

Model No.	1010		1011		1022		1013*	
Pipe Connections	in	mm	in	mm	in	mm	in	mm
	1/2, 3/4	15, 20	1/2, 3/4	15, 20	3/4	20	1	25
"A" (Diameter)	2-3/4	69.9	2-3/4	68.9	3-7/8	100	4-1/2	114
"B" (Height)	6-1/16	168	7-1/4	184	8-13/16	224	11-3/8	289
"K" (℄ Inlet to ℄ Outlet)	9/16	14.3	9/16	14.3	3/4	18	1-3/16	30.2
Weight lb (kg)	1-1/2 (0.7)		1-3/4 (0.8)		4 (2)		7-1/2 (3.4)	

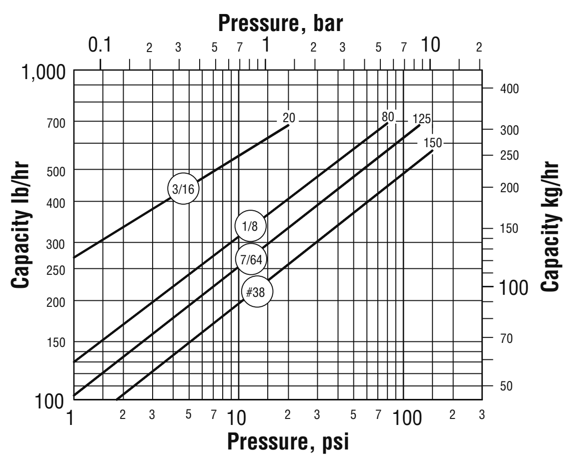
*Model 1013 only available with screwed connections.

1000 Series Inverted Bucket Steam Trap

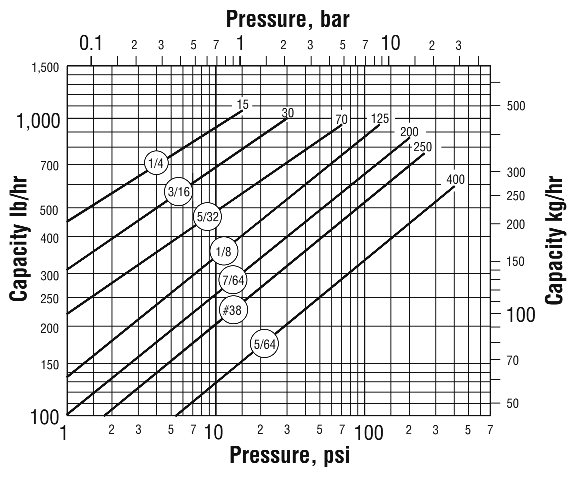
All Stainless Steel for Vertical Installation (Except U-1000 w/Strainer)

For Pressures to 650 psig (45 bar)...Capacities to 4,400 lb/hr (2,000 kg/hr)

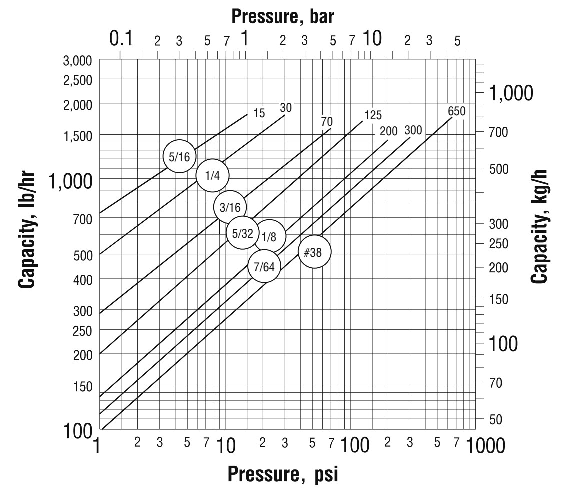
Model 1010 Capacity



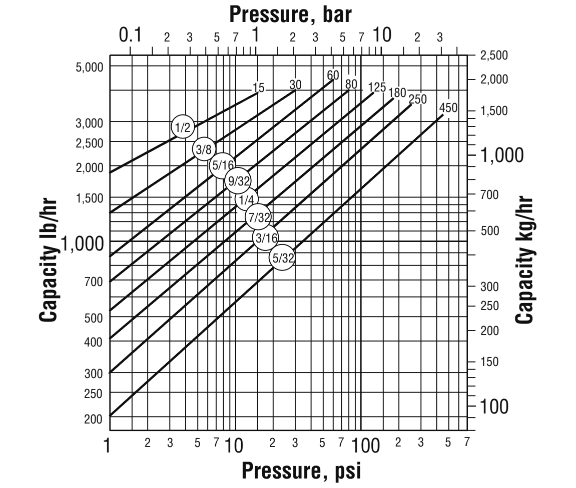
Model 1011 Capacity



Model 1022 Capacity



Model 1013 Capacity

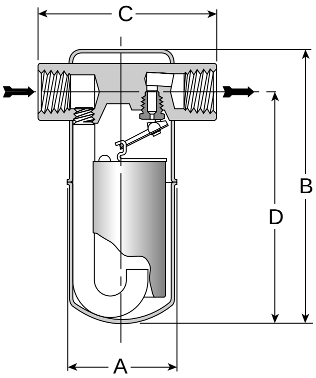


NOTE: #38 orifice in Model U-1022 is limited to 450 psi (31 bar).

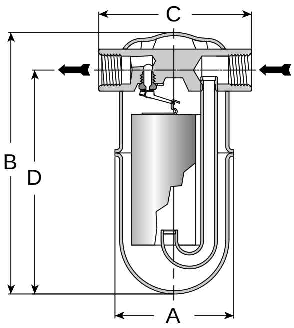
1800 Series Inverted Bucket Steam Trap

All Stainless Steel for Horizontal Installation

For Pressures to 650 psig (45 bar)...Capacities to 1,802 lb/hr (817 kg/hr)



Model 1811 Trap



Model 1822 Trap

Description

A quick and easy “in-line” replacement for other types of side inlet/side outlet traps, the Armstrong 1800 Series brings together all the benefits of energy-efficient inverted bucket operation. Side inlet/outlet all-welded construction means an inverted bucket trap that will operate efficiently on applications such as tracer lines, drips, heating, processing and similar applications.

With the 1800 Series you get freeze-resistant, all-stainless steel construction, with a three-year guarantee, plus all the benefits of inverted bucket operation:

Long, trouble-free service life
- Excellent purging action
- Continuous air venting
- Ease and flexibility of in-line installation

Maximum Operating Conditions

Maximum allowable pressure (vessel design):

Model 1810, 1811:	400 psig @ 800°F (28 bar @ 427°C)
Model 1822:	650 psig @ 600°F (45 bar @ 315°C) 627 psig @ 700°F (43 bar @ 371°C) 604 psig @ 800°F (41.6 bar @ 427°C)

Maximum operating pressure:

Model 1810:	200 psig (14 bar)
Model 1811:	400 psig (28 bar)
Model 1822:	650 psig (45 bar)

Connections

Screwed NPT and BSPT
Socketweld
Flanged (consult factory)

Materials

Body:	ASTM A240 Grade 304L
Internals:	All stainless steel—304
Valve and seat:	Hardened chrome steel—17-4PH or Titanium

Options

- Insu-Pak™ insulation for Models 1810/1811
- Stainless steel pop drain for Models 1811/1822
- Probe connection for Models 1811/1822
- Restricted orifice
- Wiggle wire

Specification

Inverted bucket steam trap, type ... in all stainless steel, freeze resistant, without gaskets, with continuous air venting at steam temperature, free-floating stainless steel mechanism, and orifice at the top of the trap.

How to Order

Specify:
- Model number
- Size and type of pipe connection
- Maximum working pressure that will be encountered or orifice size
- Any options required

For a fully detailed certified drawing, refer to CD #1005.

1800 Series Traps

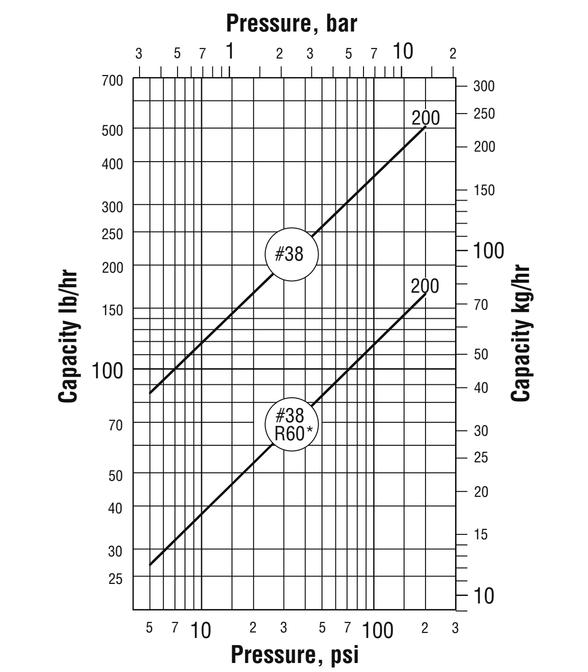
Model No.	1810		1811				1822			
Pipe Connections	in	mm	in	mm	in	mm	in	mm	in	mm
	3/8, 1/2	10, 15	1/2	15	3/4	20	1/2, 3/4	15, 20	1	25
“A” (Diameter)	2-11/16	68	2-11/16	68	2-11/16	68	3-7/8	99	3-7/8	99
“B” (Height)	5-5/16	135	6-5/16	160	6-9/16	167	8-1/2	218	8-1/2	218
“C” (Face to Face)	4-5/16	110	4-5/16	110	4-5/16	110	5	127	5	127
“D” (Bottom to ℄ Inlet)	4-7/16	113	5-7/16	138	5-9/16	141	7-3/8	187	7-1/8	181
Weight lb (kg)	1-3/4 (0.8)		2 (0.9)		2-3/8 (1.1)		7 (3)			

1800 Series Inverted Bucket Steam Trap

All Stainless Steel for Horizontal Installation

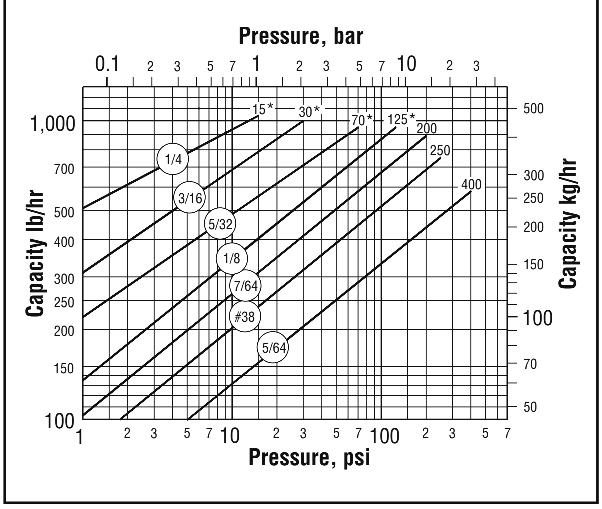
For Pressures to 650 psig (45 bar)...Capacities to 1,802 lb/hr (817 kg/hr)

Model 1810 Capacity



*NOTE: Because the orifice is located at the top, inverted bucket steam traps handle dirt and scale better than other types of traps. However, in applications where extremely dirty conditions exist, care should be exercised in the use of all types of restricted-orifice, reduced-capacity traps.

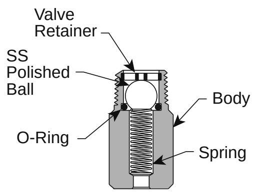
Model 1811 Capacity



*Orifices available only with 3/4" connections.

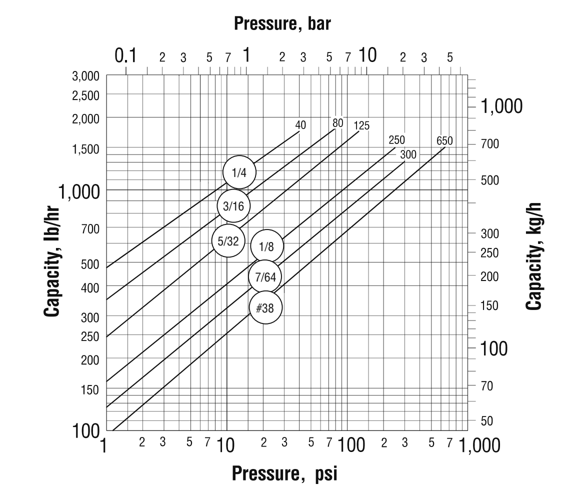
Options

Pop Drain for Freeze Protection
In general, a properly selected and installed Armstrong trap will not freeze as long as steam is coming to the trap. If the steam supply is shut off, a pop drain should be used to automatically drain the trap. Stainless steel pop drain available for Models 1811 and 1822.



Maximum Operating Conditions
Pressure: 600 psig (41 bar)
Temperature: 350°F (177°C)

Model 1822 Capacity



Insu-Pak™
Now you can insulate the in-line traps in your plant without complicating regular trap maintenance. Insu-Pak, a simple reusable insulation package, cuts the time and cost of in-field installation because it goes on in a snap. And it comes off just as easily. Insu-Pak can prevent trap freeze-up when used with a properly designed condensate manifold. Designed for use with Model 1810 and Model 1811 traps.

Probe connections are available for trap monitoring on Models 1811 and 1822.

Float & Thermostatic Steam Trap

The More Your Steam Pressure Varies, the More You Need Armstrong F&T Traps

When steam pressure may vary from maximum steam supply pressure to vacuum, Armstrong F&Ts are your most energy-efficient choice. Our line of F&Ts brings Armstrong performance, dependability and long life to trapping services requiring continuous drainage with high air venting capacity. Thanks to separate orifices for condensate and air, they provide continuous condensate drainage and air venting—even under conditions of zero pressure.

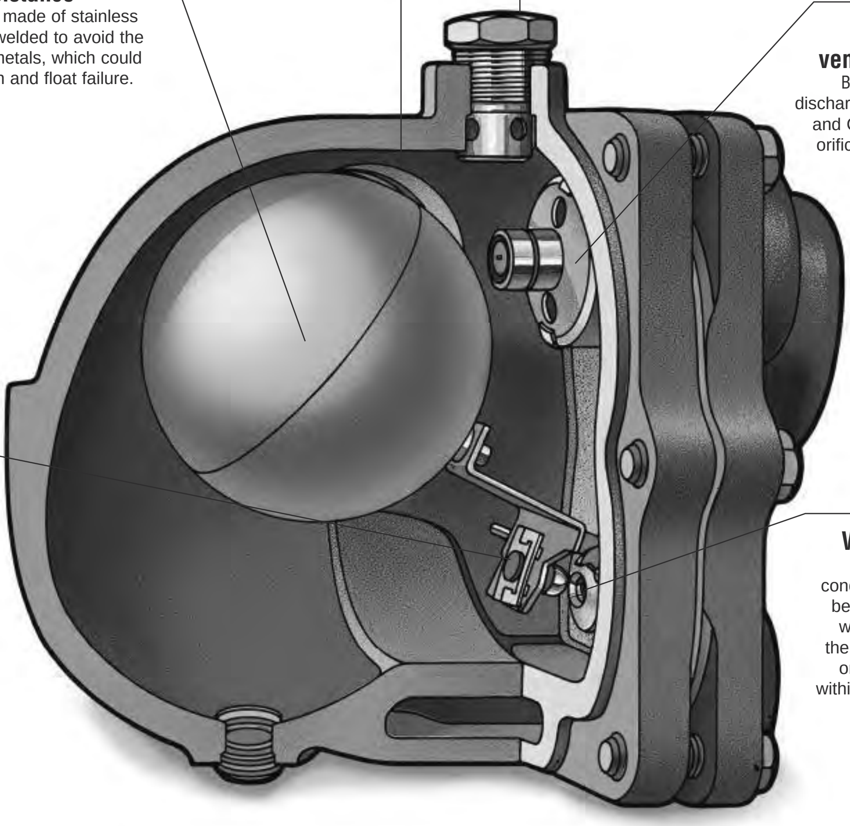
All the benefits detailed below have been designed into Armstrong F&Ts through long experience in the manufacture of pressure float-type drain traps. They assure you of optimum operating efficiency for long periods with minimum trouble.

No water seal at inlet
Inlet high on body and condensate discharge valve in the bottom of the body prevent formation of a water seal that could block flow of air to vent under very low pressure conditions.

Optional integral vacuum breakers
Provide maximum protection against freezing and water hammer in condensing equipment under modulated control. They also eliminate another fitting being installed in the line.

Corrosion resistance
Entire float mechanism is made of stainless steel. The float is Heliarc welded to avoid the introduction of dissimilar metals, which could lead to galvanic corrosion and float failure.

High-capacity venting of air and CO_2
Built-in thermostatic air vent discharges large volumes of air and CO_2 through its separate orifice—even under very low pressure conditions.



Long life and dependable service
Valve is stainless steel in all sizes. Seat is heat treated in 1-1/2" pipe size and larger. Rugged float mechanism is built to resist wear, and the stainless steel float provides exceptionally high collapsing pressure and resistance to hydraulic shock.

Water sealed valve
Steam cannot reach condensate discharge valve because it is always under water. Balanced pressure thermostatic air vent closes on steam at any pressure within the operating range of the trap.

Operation against back pressure
Trap operation is governed solely by the condensate level in the trap. Back pressure in the return line will not render the trap inoperative as long as there is any pressure differential to force condensate through the discharge valve.

Continuous drainage
No pressure fluctuations due to intermittent condensate drainage. Condensate is discharged at very close to steam temperature. No priming needed.

Float & Thermostatic Steam Trap

Built as Tough as the Jobs They Do

Armstrong float and thermostatic traps are unique in their super heavy duty construction. Armstrong uses high quality ASTM A48 Class 30 cast iron or ASTM A216 WCB cast steel—normally found in pressure vessels rated to 250 psi or 465 psi. Internal mechanisms are made from stainless steel and are heavily reinforced. No brass cotter pins here. Valves and seats are stainless steel, hardened, ground and lapped to withstand the erosive forces of flashing condensate.

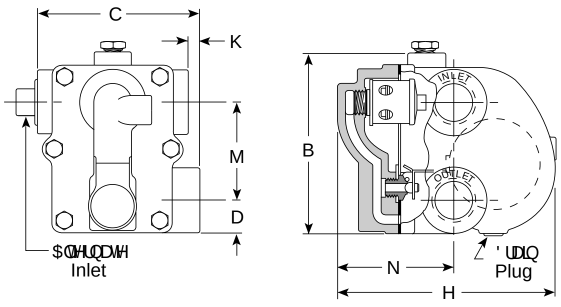
Why go to all this trouble on traps normally recommended for low-pressure, modulating service? The answer is in the word *modulating*. Modulating pressures mean widely varying loads, thermal cycling and high air and non-condensable gas loads. In other words, tough service. Inferior, lightweight construction is a mistake waiting to happen. Trap failures on modulating pressure may lead to water hammer, corrosion and even heat exchanger damage.

Armstrong's published capacities are based on actual measurements of traps handling hot, flashing condensate. Competitive F&Ts may utilize theoretical calculated capacities. Armstrong uses its own steam lab to give you actual capacity—especially important on high-capacity traps such as those in our ultra-capacity line. Not only does Armstrong offer super heavy duty construction for long life and reliability, but we also supply the data to back up performance. Here's a simple, easy-to-remember summary: The more your pressure varies, the more you need Armstrong F&Ts.

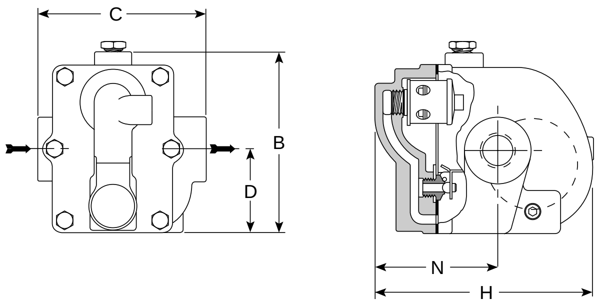
A & AI Series Float & Thermostatic Steam Trap

Cast Iron for Horizontal Installation, With Thermostatic Air Vent

For Pressures to 175 psig (12 bar)...Capacities to 8,600 lb/hr (3,900 kg/hr)



Model A Traps



Model AI Traps

Description

Armstrong A & AI Series F&T traps are for industrial service from 0 to 175 psig and feature a balanced pressure phosphor-bronze type bellows caged in stainless steel. Armstrong A & AI Series F&T traps are designed for service on heat exchange equipment where there is a need to vent air and non-condensable gases quickly.

The **AI Series F&T** traps feature the convenience of in-line connections with the same rugged internals found in the A Series.

Maximum Operating Conditions

Maximum allowable pressure (vessel design):
175 psig @ 377°F (12 bar @ 191°C)

Maximum operating pressure:

Model 30-A, AI:	30 psig (2 bar) saturated steam
Model 75-A, AI:	75 psig (5 bar) saturated steam
Model 125-A, AI:	125 psig (8.5 bar) saturated steam
Model 175-A, AI:	175 psig (12 bar) saturated steam

NOTE: Cast iron traps should not be used in systems where excessive hydraulic or thermal shock are present.

Connections

Screwed NPT and BSPT

Materials

Body and cap:	ASTM A48 Class 30
Internals:	All stainless steel—304
Valve:	Stainless steel—440
Seat:	Stainless steel—303 (ASTM A582) Stainless steel—440F in 1-1/2" and 2"
Thermostatic air vent:	Stainless steel and bronze with phosphor bronze bellows, caged in stainless steel

Options

Integral vacuum breaker. Add suffix VB to model number.

CAUTION: Do not use a conventional vacuum breaker open to the atmosphere in any system that incorporates a mechanical return system that carries pressure less than atmospheric pressure. This includes all return systems designated as vacuum returns, variable vacuum returns or subatmospheric returns. If a vacuum breaker must be installed in such a system, it should be of the type that is loaded to open only when the vacuum reaches a calibrated level well in excess of the design characteristics of the system.

Specification

Float and thermostatic steam trap, type ... in cast iron, with thermostatic air vent.

For a fully detailed certified drawing, refer to CD #1009.

How to Order

	Model		Option
75	AI	2	VB
30 75 125 175	A = Standard Connection	3 = 3/4" 4 = 1" 5 = 1-1/4" 6 = 1-1/2" 8 = 2"	VB = Vacuum Breaker
	AI = In-line Connection	2 = 1/2" 3 = 3/4" 4 = 1"	

A & AI Series Traps

Trap Series	Model A										Model AI	
Pipe Connections	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
	3/4	20	1	25	1-1/4	32	1-1/2	40	2	50	1/2, 3/4, 1	15, 20, 25
“B” (Height)	5-1/8	130	5-1/8	130	5-13/16	148	7-7/16	189	9-3/4	248	5-1/2	140
“C” (Face to Face)	4-7/8	124	4-7/8	124	4-5/8	117	5-3/4	146	7-5/8	194	5	127
“D” (Bottom to ℄)	1	25.4	1	25.4	1-7/32	31.0	1-13/32	35.7	1-11/16	42.9	2-9/16	65.1
“H” (Width)	6-7/16	164	6-7/8	164	8-1/8	206	8-7/16	214	11-5/8	295	6-1/2	165
“K” (Connection Offset)	3/8	95.2	3/8	95.2	—	—	—	—	—	—	—	—
“M” (℄ to ℄)	3	76.2	3	76.2	3	76.2	4-3/16	106	6	152	—	—
“N” (Top to ℄)	3-3/8	85.7	3-3/8	85.7	3-3/4	95.2	3-3/4	95.2	5	127	3-11/16	93.7
Weight lb (kg)	9-1/2 (4.3)		8-1/4 (3.7)		11 (5.0)		18-3/4 (8.5)		40 (18.1)		9-3/4 (4.4)	

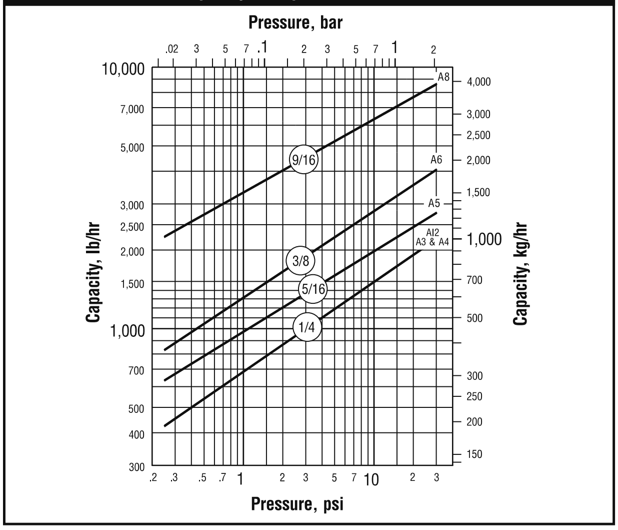
NOTE: Cast iron traps should not be used in systems where excessive hydraulic or thermal shock are present.

A & AI Series Float & Thermostatic Steam Trap

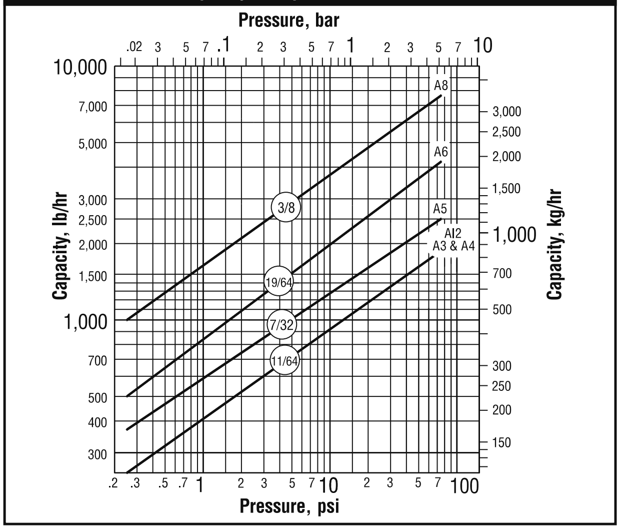
Cast Iron for Horizontal Installation, With Thermostatic Air Vent

For Pressures to 175 psig (12 bar)...Capacities to 8,600 lb/hr (3,900 kg/hr)

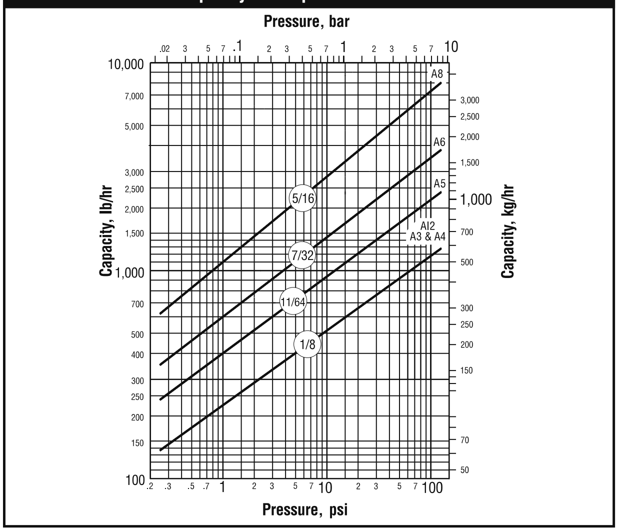
Model A & AI Series Capacity—30 psi



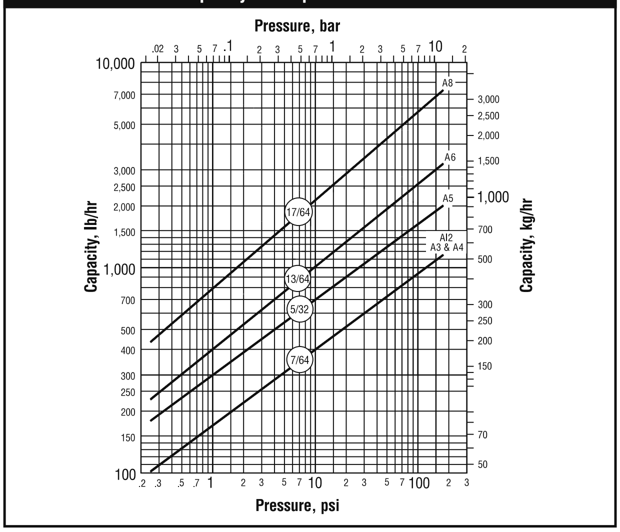
Model A & AI Series Capacity—75 psi



Model A & AI Series Capacity—125 psi



Model A & AI Series Capacity—175 psi



Options

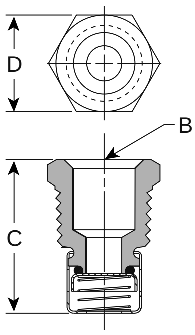
Vacuum Breaker—3/8" (10 mm) and 1/2" (15 mm) NPT

Many times, condensate will be retained ahead of steam traps because of the presence of a vacuum. To break a vacuum, air must be introduced into the system by means of a vacuum breaker.

For maximum protection against freezing and water hammer in condensing equipment under modulated control, vacuum breakers are recommended. Armstrong A and AI Series F&T Traps are available with integral vacuum breakers. Maximum service pressure is 150 psig (10 bar).

Vacuum Breaker

Size	in	mm	in	mm
	1/2 NPT	15	3/8 NPT	10
"B" Pipe Connections	3/8 NPT	10	1/4 NPT	6
"C" Height	1-1/4	32	1-3/32	28
"D" Width	7/8 Hex	22 Hex	11/16 Hex	17 Hex



FLOAT AND THERMOSTATIC STEAM TRAPS - FLT 17
(DN 1"HC – DN 25HC)

DESCRIPTION
FLT17 float and thermostatic (integral air vent) steam traps series are designed for all types of low and high pressure steam heating and process equipment.
Typical applications include unit heaters, heat exchangers, driers, jacketed vessels and all the applications where continuous drainage is essential.
Connections are female screwed or flanged for horizontal or vertical installation.

MAIN FEATURES
Modulating discharge.
Discharges condensate at steam temperature.
Unaffected by sudden or wide load and pressure changes.
Excellent air discharge (by thermostatic air vent).

OPTIONS: SLR – steam lock release
Equalizing plug or vent connection
Internal strainer
USE: Saturated and superheated steam.
AVAILABLE MODELS: FLT17-4,5 , 10 and 14
SIZES: DN 1"HC – DN25HC
CONNECTIONS: Female screwed ISO7/1 Rp (BS21)
Flanged EN 1092-2 PN16 or ANSI
INSTALLATION: Standard horizontal installation –
From left to right FLT17 (L-R)

Upon request:
-horizontal installation with the flow from right to left (R-L)
-vertical installation with the flow from top to bottom (V)

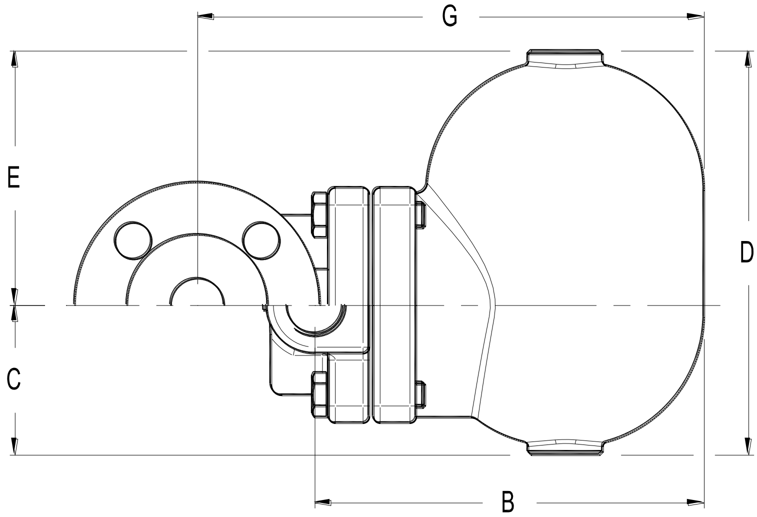
MAX. DIFFERENTIAL PRESSURE
FLT17HC-4,5 : 4,5 bar
FLT17HC-10 : 10 bar
FLT17HC-14: 14 bar

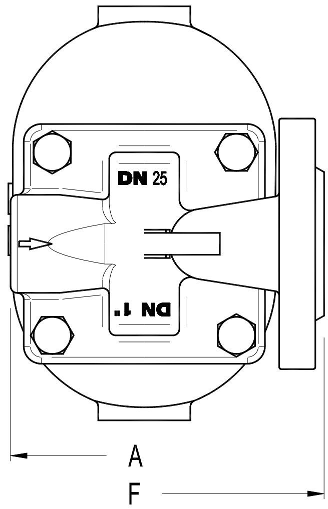
BODY LIMITING CONDITIONS		
FLANGED PN16*	FLANGED ANSI 150 **	RELATED TEMP.
ALLOW. PRES.	ALLOW. PRES.	
16 bar	15,4 bar	100 ºC
15,5 bar	14,6 bar	150 ºC
14,7 bar	13,8 bar	200 ºC
13,9 bar	12,1 bar	250 ºC

PMO - Max. operating pressure 14 bar
TMO - Max. operating temperature 198 ºC
* According to EN1092-2:2000 ; ** Acc. to EN1759-1:2004
Body limiting conditions PN16 or below, depending on the type of connection adopted. Rating PN16 for thread.

FLOW RATE CAPACITY IN Kgs/h														
MODEL	*SIZE*	*DIFFERENTIAL PRESSURE (bar)*												
		0,5	*1*	*1,5*	*2*	*3*	*4,5*	*6*	*7*	*8*	*9*	*10*	*12*	*14*
FLT17-4,5	**1"-25HC**	900	1250	1450	1700	2010	2400							
FLT17-10	**1"-25HC**	450	620	790	880	1100	1250	1500	1600	1700	1750	1800		
FLT17-14	**1"-25HC**	340	435	530	600	610	850	990	1100	1190	1240	1300	1350	1380

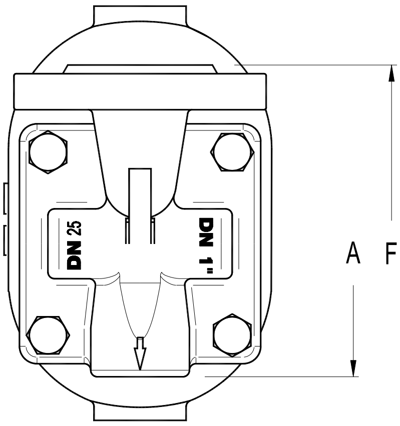
FLOAT AND THERMOSTATIC STEAM TRAPS - FLT 17
(DN 1"HC – DN 25HC)





DIMENSIONS (mm)												
Screwed							EN PN16			ANSI 150		
SIZE DN	*A*	*B*	*C*	*D*	*E*	*WGT. Kgs*	*F*	*G*	*WGT. Kgs*	*F*	*G*	*WGT. Kgs*
25-1"	120	195	80	190	110	9	160	248	11,3	160	248	10,9

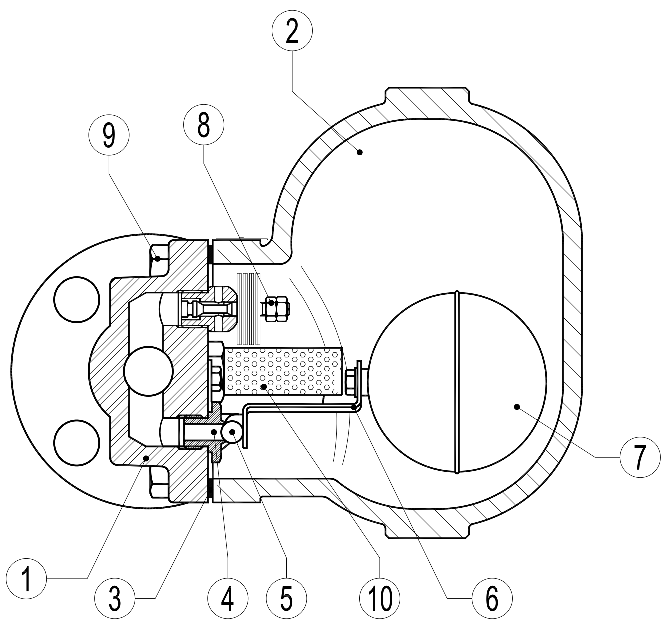
On request can be supplied an alternative version DN 32 - 11/4" with different lengths: A = 190 and F = 230 mm



Vertical Installation (V)

MATERIALS		
POS.Nr.	*DESIGNATION*	*MATERIAL*
1	Body	GJS-400-15 / 0.7040
2	Cover	GJS-400-15 / 0.7040
3	*Gasket	Stainless st. / Graphite
4	*Seat	AISI 410 / 1.4006
5	*Valve	AISI 440C / 1.4125
6	*Lever	AISI 304 / 1.4301
7	*Float	AISI 304 / 1.4301
8	*Air vent	Stainless st. (Bimetallic)
9	Bolts	Steel 8.8
10	**Strainer	AISI 304 / 1.4301

*Available spare parts ; ** Optional



FLOAT AND THERMOSTATIC STEAM TRAPS - FLT17

(DN 11/2" – 2"; DN 40 – 50)

DESCRIPTION

FLT17 float and thermostatic (integral air vent) steam traps series are designed for all types of low and high pressure steam heating and process equipment.

Typical applications include unit heaters, heat exchangers, driers, jacketed vessels and all the applications where continuous drainage is essential.

Connections are female screwed or flanged for horizontal or vertical installation.

MAIN FEATURES

Modulating discharge.

Discharges condensate at steam temperature.

Unaffected by sudden or wide load and pressure changes.

Excellent air discharge (by thermostatic air vent).

OPTIONS:	SLR – steam lock release Equalizing plug or vent connection
USE:	Saturated and superheated steam.
AVAILABLE MODELS:	FLT17-4,5 , 10 and 14
SIZES:	DN11/2" - DN2" ; DN40 – DN50
CONNECTIONS:	Female screwed ISO7/1 Rp (BS21) Flanged EN 1092-2 PN16 or ANSI
INSTALLATION:	Standard horizontal installation – From right to left FLT17 (R-L)

Upon request:

-horizontal installation with the flow from left to right (L-R)

-vertical installation with the flow from top to bottom (V)

MAX. DIFFERENTIAL PRESSURE

FLT17-4,5 : 4,5 bar

FLT17-10 : 10 bar

FLT17-14: 14 bar

BODY LIMITING CONDITIONS		
FLANGED PN16*	FLANGED ANSI 150 **	RELATED TEMP.
ALLOW. PRES.	ALLOW. PRES.	
16 bar	15,4 bar	100 ºC
15,5 bar	14,6 bar	150 ºC
14,7 bar	13,8 bar	200 ºC
13,9 bar	12,1 bar	250 ºC

PMO - Max. operating pressure 14 bar

TMO - Max. operating temperature 198 ºC

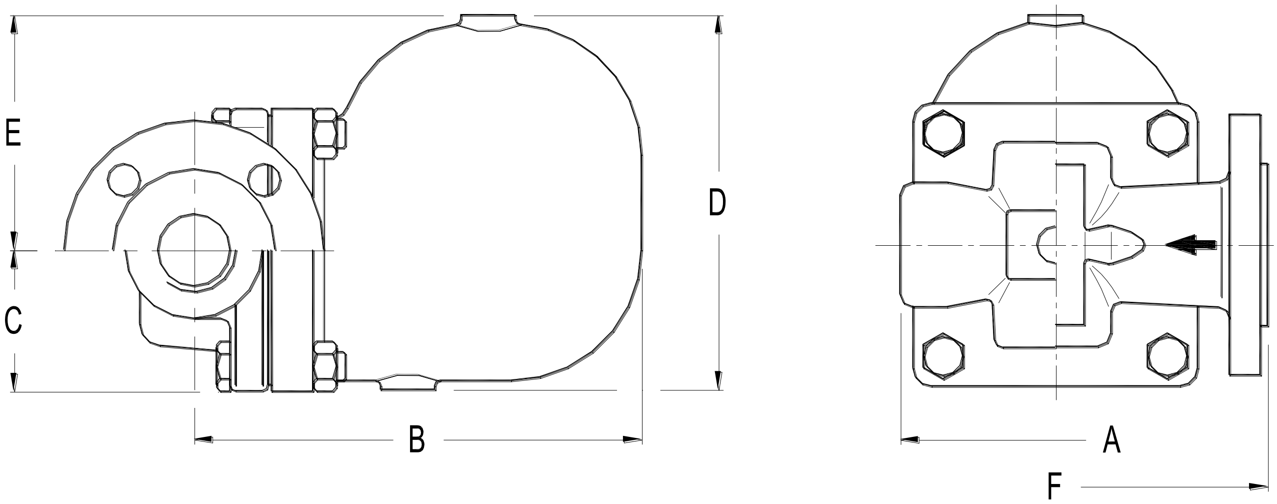
* According to EN1092-2:2000 ; ** Acc. to EN1759-1:2004

Body limiting conditions PN16 or below, depending on the type of connection adopted. Rating PN16 for thread.

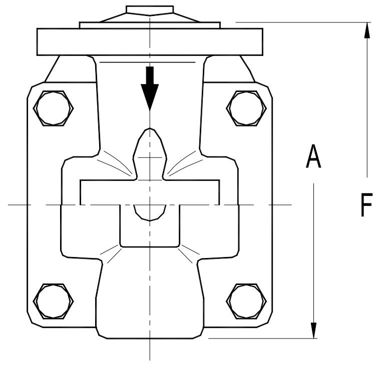
FLOW RATE CAPACITY IN Kgs/h										
MODEL	*SIZE*	*DIFFERENTIAL PRESSURE (bar)*								
		0,5	*1*	*1,5*	*2*	*4,5*	*7*	*10*	*12*	*14*
FLT17-4,5	**40-50**	2400	3400	3900	4500	7300				
FLT17-10	**40-50**	1500	2000	2600	3000	4000	5400	6200		
FLT17-14	**40-50**	950	1300	1600	1800	2600	3250	3900	4210	4950

FLOAT AND THERMOSTATIC STEAM TRAPS - FLT17

(DN 11/2" – 2"; DN 40 – 50)



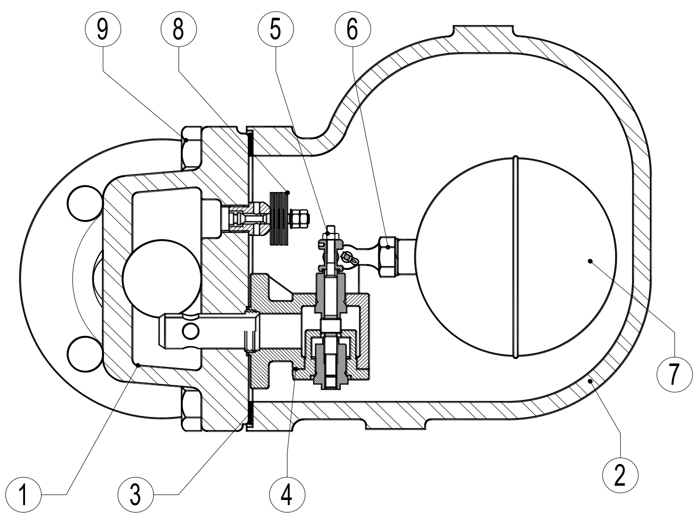
DIMENSIONS (mm)												
Screwed							EN PN16			ANSI 150		
SIZE DN	*A*	*B*	*C*	*D*	*E*	*WGT. Kgs*	*F*	*B*	*WGT. Kgs*	*F*	*B*	*WGT. Kgs*
40-11/2"	210	248	79	208	131	16,9	230	248	20,3	230	248	19,1
50-2"	210	248	79	208	131	17,5	230	248	20,7	230	248	20,5



Vertical Installation (V)

MATERIALS		
POS.Nr.	*DESIGNATION*	*MATERIAL*
1	Body	GJS-400-15 / 0.7040
2	Cover	GJS-400-15 / 0.7040
3	*Gasket	Stainless st. / Graphite
4	*Seat	CF8 / 1.4308
5	*Valve	AISI 420 / 1.4021
6	*Lever	AISI 304 / 1.4301
7	*Float	AISI 304 / 1.4301
8	*Air vent	Stainless st. (Bimetallic)
9	Bolts	Steel 8.8

*Available spare parts.



FLOAT AND THERMOSTATIC STEAM TRAPS - FLT17
(DN 2” HC; DN 50 HC)

DESCRIPTION
FLT17 float and thermostatic (integral air vent) steam traps series are designed for all types of low and high pressure steam heating and process equipment.
Typical applications include unit heaters, heat exchangers, driers, jacketed vessels and all the applications where continuous drainage is essential.
Connections are female screwed or flanged for horizontal or vertical installation.

MAIN FEATURES
Modulating discharge.
Discharges condensate at steam temperature.
Unaffected by sudden or wide load and pressure changes.
Excellent air discharge (by thermostatic air vent).

OPTIONS:	SLR – steam lock release Equalizing plug or vent connection
USE:	Saturated and superheated steam.
AVAILABLE MODELS:	FLT17-4,5 , 10 and 14
SIZES:	DN2” HC ; DN50 HC
CONNECTIONS:	Female screwed ISO7/1 Rp (BS21) Flanged EN 1092-2 PN16 or ANSI
INSTALLATION:	Standard horizontal installation – From right to left FLT17 (R-L)

Upon request:
-horizontal installation with the flow from left to right (L-R)
-vertical installation with the flow from top to bottom (V)

MAX. DIFFERENTIAL PRESSURE
FLT17HC-4,5 : 4,5 bar
FLT17HC-10 : 10 bar
FLT17HC-14: 14 bar

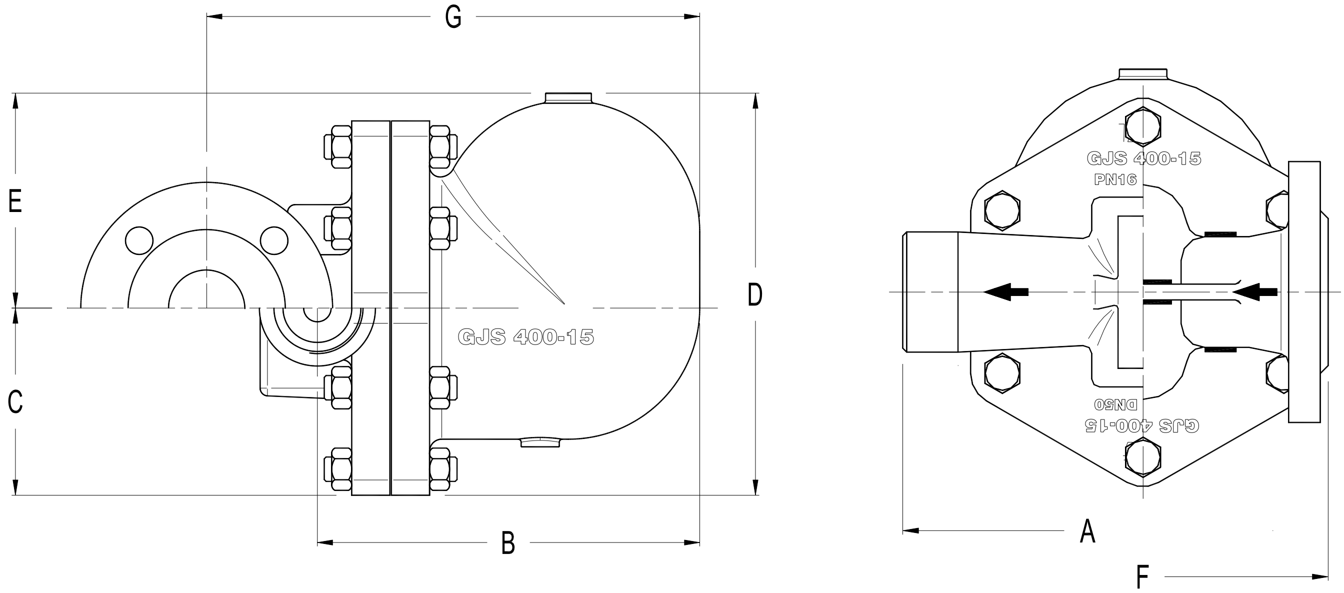
CE MARKING (PED - European Directive 97/23/EC)	
PN 16	Category
DN 50 HC	1 (CE Marked)

BODY LIMITING CONDITIONS		
FLANGED PN16*	FLANGED ANSI 150 **	RELATED TEMP.
ALLOW. PRES.	ALLOW. PRES.	
16 bar	15,4 bar	100 ºC
15,5 bar	14,6 bar	150 ºC
14,7 bar	13,8 bar	200 ºC
13,9 bar	12,1 bar	250 ºC

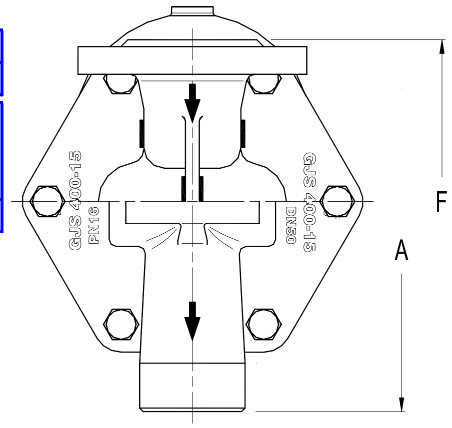
PMO - Max. operating pressure 14 bar
TMO - Max. operating temperature 198 ºC
* According to EN1092-2:2000 ; ** Acc. to EN1759-1:2004
Body limiting conditions PN16 or below, depending on the type of connection adopted. Rating PN16 for thread.

FLOW RATE CAPACITY IN Kgs/h													
MODEL	SIZE	DIFFERENTIAL PRESSURE (bar)											
		0,1	0,3	0,5	0,7	1	1,5	2	4,5	7	10	12	14
FLT17-4,5	50HC	2400	5900	7550	9050	11000	14000	15500	22500				
FLT17-10	50HC	1800	3000	3900	4450	5000	6100	7100	10000	13750	16000		
FLT17-14	50HC	900	1500	1900	2300	2700	3100	3600	5000	6900	8100	9000	9800

FLOAT AND THERMOSTATIC STEAM TRAPS - FLT17
(DN 2" HC; DN 50 HC)



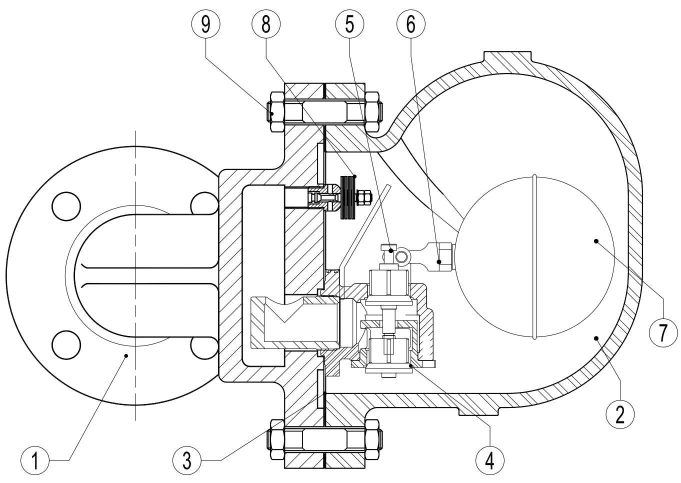
DIMENSIONS (mm)												
Screwed							EN PN16			ANSI 150		
SIZE DN	*A*	*B*	*C*	*D*	*E*	*WGT. Kgs*	*F*	*G*	*WGT. Kgs*	*F*	*G*	*WGT. Kgs*
50-2"	300	250	126	266	140	21,6	230	325	27,8	230	325	27,6



Vertical Installation (V)

MATERIALS		
POS.Nr.	*DESIGNATION*	*MATERIAL*
1	Body	GJS-400-15 / 0.7040
2	Cover	GJS-400-15 / 0.7040
3	*Gasket	Stainless st. / Graphite
4	*Seat	CF8 / 1.4308
5	*Valve	AISI 420 / 1.4021
6	*Lever	AISI 304 / 1.4301
7	*Float	AISI 304 / 1.4301
8	*Air vent	Stainless st. (Bimetallic)
9	Bolts	Steel 8.8

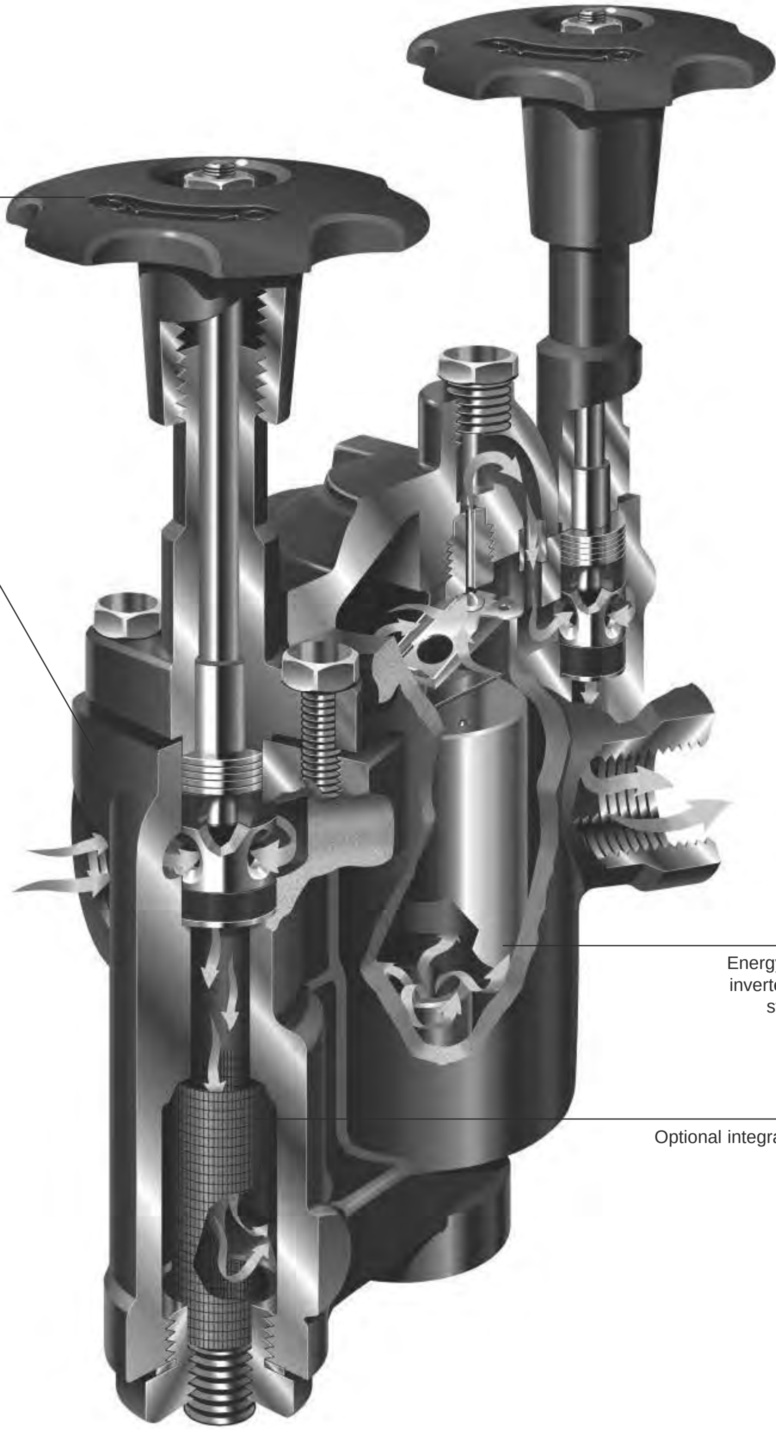
*Available spare parts.



TVS 800 Series Cast Iron Trap Valve Station

Put the principle of the inverted bucket to work in a tough cast iron package and you have the best of both worlds—energy efficiency and long-lasting reliability. Add the advantages of valves integrated into one compact trap/valve casting, and you extend the benefits into installation, trap testing and maintenance.

All the components are concentrated in a single, accessible package and can be dealt with in-line. And if you have existing Armstrong cast iron traps in-line, identical face-to-face dimensions will make retrofitting with the patented* Armstrong Trap Valve Station (TVS) a snap. You'll also reduce your inventory requirements. So you'll eliminate what you're paying just to keep parts on hand.



Reduced costs
TVS saves on these fronts: energy, installation and maintenance.

Integration of trap and valves
Inverted bucket long life and energy efficiency, plus the savings and convenience of components merged into one space-saving package.

A full range of options
TVS will accommodate a test valve, strainer, internal check valve, thermic vent bucket, TrapAlert™ and SteamEye®—remote steam trap monitoring system for steam traps.

Easy, in-line repairability

Elimination of potential leak points

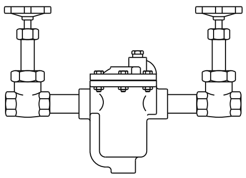
Reduced design time
Permits combining products with exact face-to-face dimensions.

*U.S. Patent 5,947,145

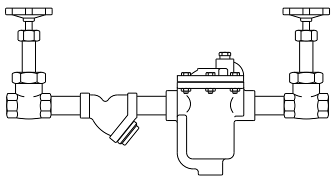
TVS 800 Series Cast Iron Trap Valve Station

TVS makes a long story…short.

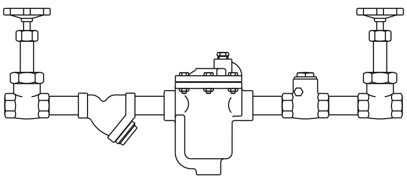
Typical Installation



Inverted bucket trap with two isolation valves



Inverted bucket trap with two isolation valves and strainer



Inverted bucket trap with two isolation valves, strainer and check valve

Trap Valve Station

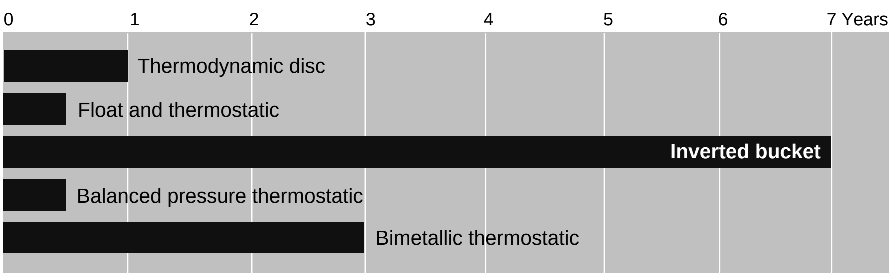
The Innovation Is Integration

The Armstrong TVS makes what used to be long, complicated steam installation stories simple and compact. It shortens installations by integrating components—specifically an inverted bucket steam trap with two or more valves.

For example, here's an old description for a typical installation: *valve-nipple-strainer-nipple-trap-nipple-valve*. It's a long tale, even for this simple piping arrangement. The Trap Valve Station rewrites this steam story: *pipe-TVS-pipe*. In other words, the TVS makes it all one, delivering the functions of multiple components in a dramatically smaller unit. It integrates two high-value products in a package of revolutionary versatility.

Look above to see how the Armstrong cast iron Trap Valve Station has rewritten these typical steam installations.

Average Service Life for Different Trap Types 200 psi (14 bar)

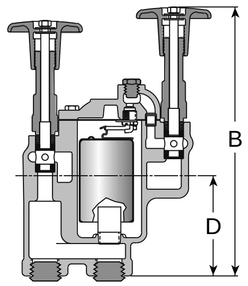


Above data from *ICI Engineer* January 1993 special issue with permission from ICI Engineering.

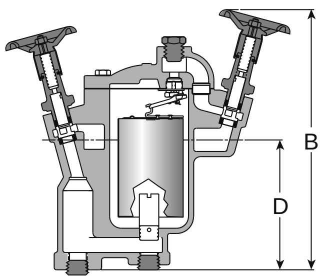
TVS 800 Series Trap Valve Station

Cast Iron for Horizontal Installation, With Integral Piston Valves

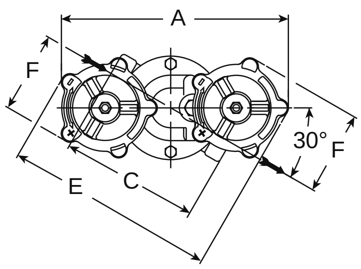
For Pressures to 250 psig (17 bar)...Capacities to 4,400 lb/hr (2,000 kg/hr)



Model TVS 811



Series TVS 812/813



Series TVS 811/812/813 - Top View

Same principle. Different package. Now the energy-saving performance and reliability of the inverted bucket steam trap are available in a versatile new package.

You'll still enjoy all the familiar benefits. And the same efficient condensate drainage from virtually every kind of steam-using equipment. But what you'll find new are all the benefits of a piston valve integrated into the same space-saving package.

Maximum Operating Conditions

Maximum allowable pressure (vessel design):	250 psig @ 450°F (17 bar @ 232°C)
Maximum operating pressure:	250 psig (17 bar)

Connections

Screwed NPT and BSPT

Materials

Cap and body:	ASTM A48 Class 30
Internals:	All stainless steel—304
Valve and seat:	Hardened chrome steel—17-4PH
Handwheel:	Ductile iron
Internals:	Stainless steel
Valve sealing rings:	Graphite and stainless steel
Blowdown valve	Stainless steel

Options

- Stainless steel internal check valve
- Thermic vent bucket
- Stainless steel pop drain
- Integral strainer
- Scrub wire
- Probe connection
- Blowdown valve (TVS 811 and TVS 812 only)

Specification

Inverted bucket steam trap, type ... in cast iron, with continuous air venting at steam temperature, free-floating stainless steel mechanism, and discharge orifice at the top of the trap. Integral upstream and downstream shutoff piston style valves in same dimensional space as standard bucket trap.

How to Order

Specify:

- Model number
- Size and type of pipe connection
- Maximum working pressure that will be encountered or orifice size
- Any options required

For a fully detailed certified drawing, refer to:
TVS 811 CD #1099
TVS 812/813 CD #1100

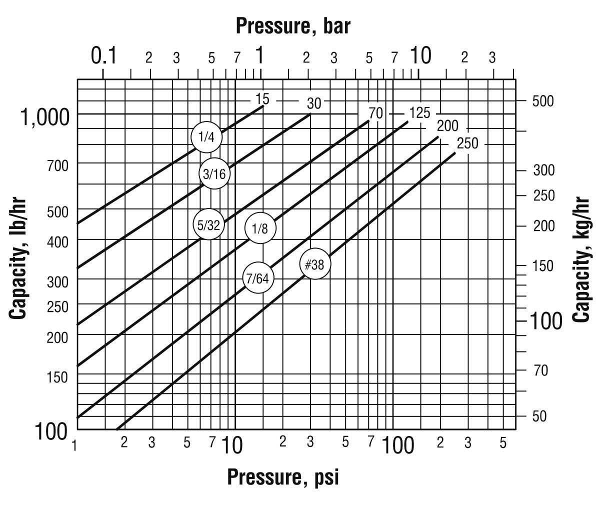
TVS 800 Series Trap Valve Station						
Model No.	**TVS 811**		**TVS 812**		**TVS 813**	
Pipe Connections	**in**	**mm**	**in**	**mm**	**in**	**mm**
	1/2, 3/4	15, 20	1/2, 3/4	15, 20	3/4, 1	20, 25
Test Plug	1/4	6	1/2	15	3/4	20
"A" Width Across Handwheels	8-1/4	210	13-3/4	349	15-1/8	384
"B" Outlet Valve Open	10-1/4	260	11-3/4	298	14-1/4	362
"C" Face to Face	5	127	6-1/2	165	7-3/4	197
"D" Connection ℄ to Bottom	3-11/16	94	4-3/4	121	7-1/4	184
"E"	7-5/8	194	13	330	14-3/8	365
"F"	3	76	4-1/2	114	4-7/8	124
Number of Bolts	6	6	6	6	6	6
Weight lb (kg)	12 (5.4)		25 (11.3)		47 (24)	

TVS 800 Series Trap Valve Station

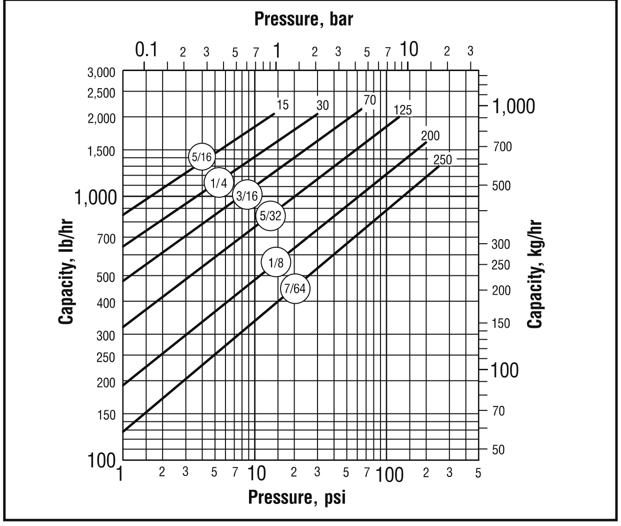
Cast Iron for Horizontal Installation, With Integral Piston Valves

For Pressures to 250 psig (17 bar)...Capacities to 4,400 lb/hr (2,000 kg/hr)

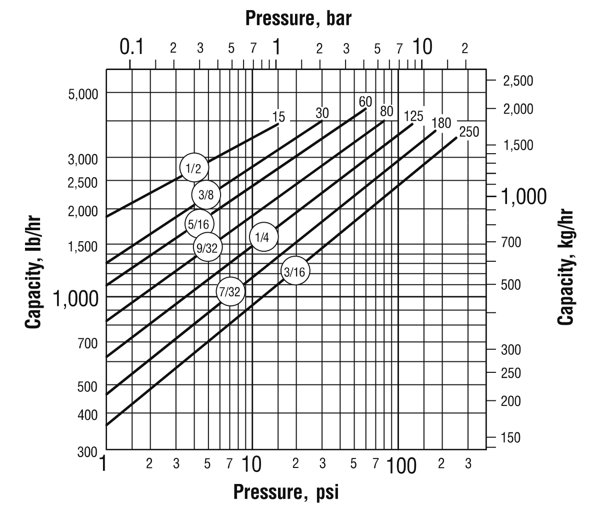
Model TVS 811 Capacity



Model TVS 812 Capacity



Model TVS 813 Capacity



Options

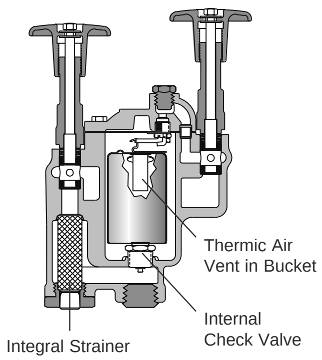
Internal Check Valves are spring-loaded stainless steel and screw directly into the trap inlet or into an extended inlet tube having a pipe coupling at the top to save fittings, labor and money.

Thermic Vent Buckets have a bimetal controlled auxiliary air vent for discharging large amounts of air on start-up.

Integral Strainer is made from 20 x 20 stainless steel screen.

Probe Connections are available for trap monitoring.

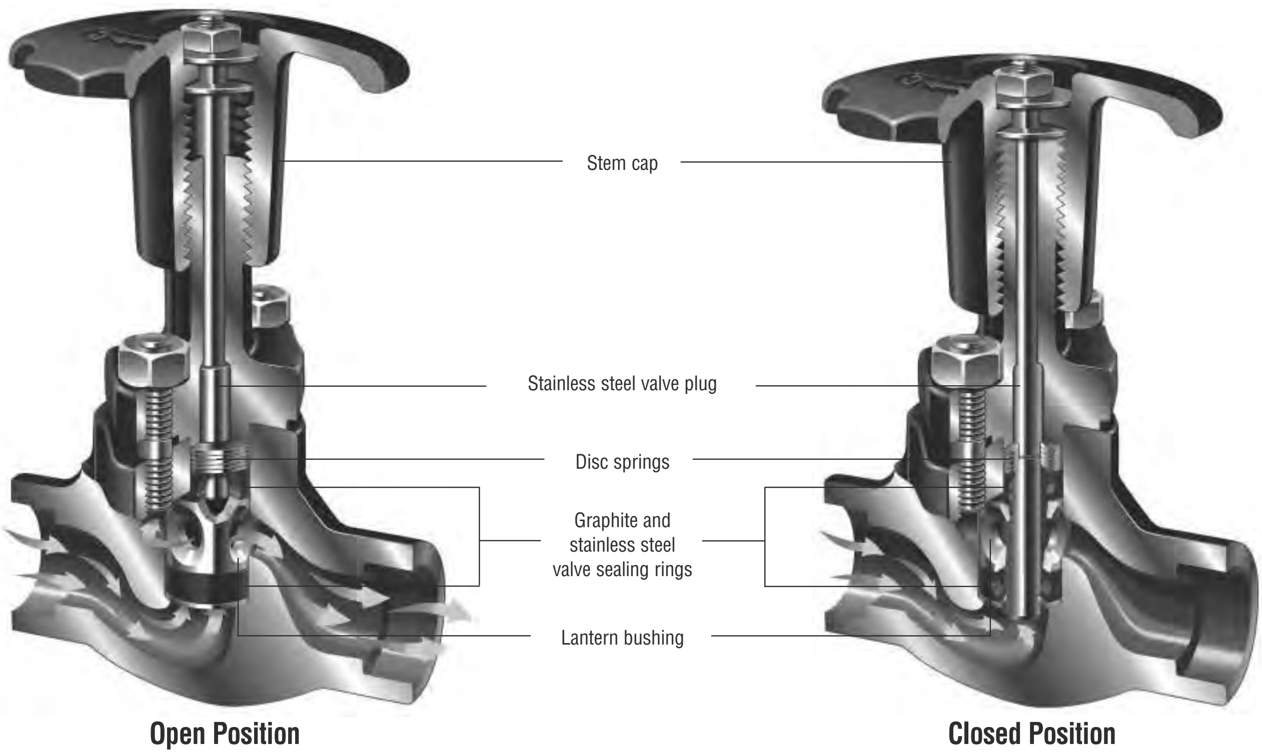
Blowdown Valve for clearing strainers of dirt and debris.



TVS 4000 Series Stainless Steel Trap Valve Station

The Piston Valve

Armstrong Steam Distribution Manifolds (MSD/SMSD) and TVS 4000 Trap Valve Stations incorporate advanced piston sealing technology for safer, longer lasting steam isolation service.



- **Dual sealing action.** The piston valve is a seatless valve that includes two graphite and stainless steel valve sealing rings that seal the stem and function as a seat. This combination provides long-term protection against leaks to the atmosphere and downstream piping.

- **Self-cleaning action.** Stainless steel piston slides without rotating between the two valve sealing rings, preventing dirt from damaging the surfaces.

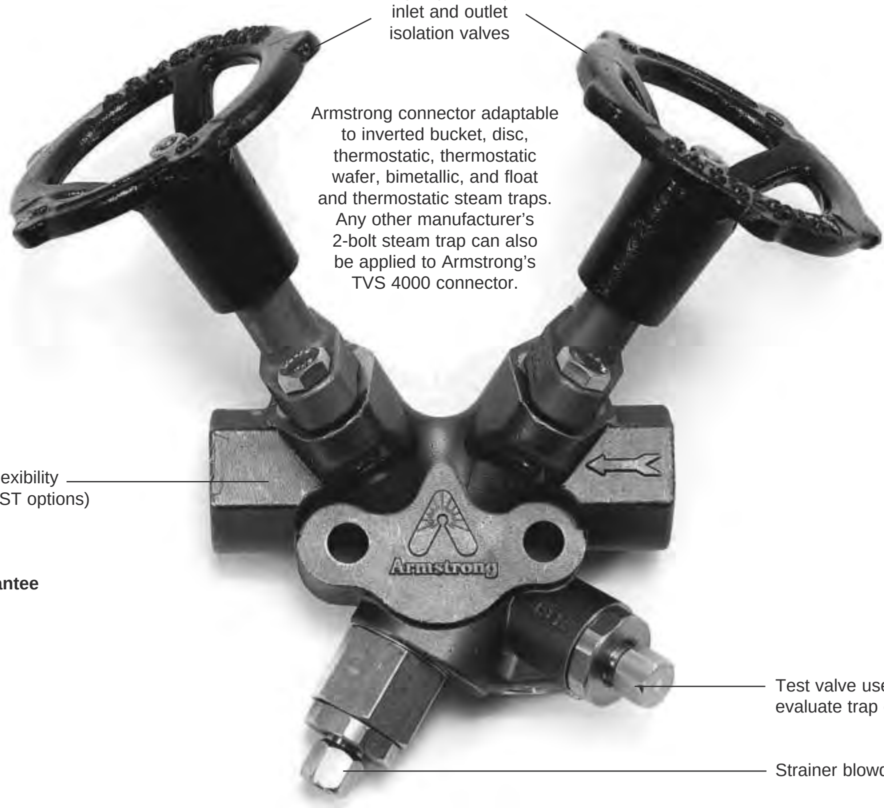
- **Sealing integrity.** Flexible disc springs automatically provide leak tightness by exerting pressure, which keeps the upper and lower valve sealing rings compressed at all times. Sealing tightness is ensured by the compression of the sealing rings against the piston and valve body. This combination of disc springs and dual valve seal rings protects against expansion and contraction due to heating and cooling. This ensures dependable operation, even after years of service.

- **Protected valve stem.** The valve stem and sealing surfaces are completely protected from dirt and corrosion by the stem cap, whether in an open or closed position.

- **In-line repairability.** All sealing valve components may be easily replaced in-line.

- **Long-term operation.** Piston valve design ensures actuation even after many years without operation.

TVS 4000 Series Stainless Steel Trap Valve Station



Description
Same principle. Different package with two piston-style isolation valves, test valve and integral stainless steel strainer with blowdown valve. What you'll find new are all the benefits of a piston valve integrated into the same space-saving package.

Maximum Operating Conditions
Maximum allowable pressure:
650 psig @ 600°F (45 bar @ 315°C)

Materials—TVS 4000 Connector

Connector:	ASTM A351 Gr. CF8M
Strainer screen:	Stainless steel
Test valve:	Stainless steel
Blowdown valve:	Stainless steel

Isolation Valve Components

All wetted parts:	Stainless steel
Valve sealing rings:	Graphite and stainless steel
Handwheel:	Ductile iron

Weight
6-1/2 lb (2.9 kg)

Features
- **Reduced costs.** TVS saves on these fronts: reduced leak points, installation and maintenance time.
- **A full range of features.** TVS has test and strainer blowdown valves. When installed with Armstrong Model 2011 and 2022 steam traps, it will also accommodate the Armstrong pop drain as well as TrapAlert™ and SteamEye®—remote steam trap monitoring and testing devices.
- **Reduced design time.** Permits combining products with exact face-to-face dimensions.
- **Three-year guarantee.** The TVS 4000 is guaranteed for three years.
- **Easy, in-line repairability with maximum safety.** TVS allows isolation at point of service with upstream/downstream depressurization.
- **Installation versatility.** The connector design makes the TVS adaptable to any manufacturer's 2-bolt steam trap and piping configuration.
- **Simplified trap testing.** TVS enhances your capability to check trap operation and offers a built-in method to block and bleed traps.

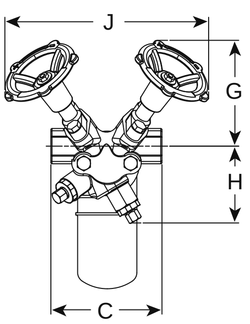
How to Order

Model	Connection	Type of Connection Inlet/Outlet	Flow Direction	Trap Type
TVS 4000	1/2" 3/4"	NPT SW BSPT Flanged*	R = Right to Left L = Left to Right	Inverted Bucket Disc Thermostatic wafer Bimetallic Float and Thermostatic

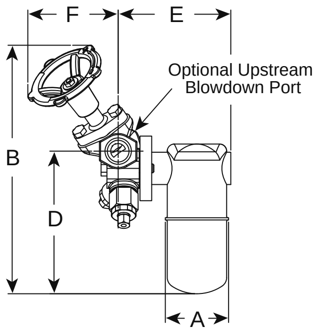
*Consult factory.

TVS 4000 Series Stainless Steel Trap Valve Station

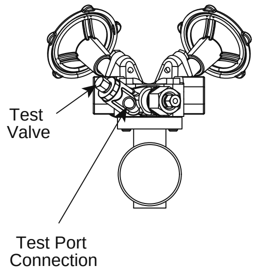
For Pressures to 650 psig (45 bar)...Capacities to 1,300 lb/hr (590 kg/hr) (Using 2000 Series Inverted Bucket Steam Traps)



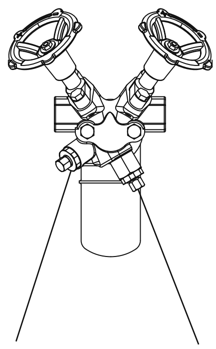
Model TVS 4000 With 2000 Series SS Trap
Front View



Model TVS 4000 With 2000 Series SS Trap
Side View



Model TVS 4000 With 2000 Series SS Trap
Bottom View



Test Valve
Used to test and evaluate trap operation

Strainer Blowdown Valve

Same principle. Different package with two piston-style isolation valves, test valve and integral stainless steel strainer with blowdown valve. Now the energy-saving performance and reliability of the inverted bucket steam trap are available in a versatile new package. You'll still enjoy all the familiar benefits. And the same efficient condensate drainage from virtually every kind of steam-using equipment. What you'll find new are all the benefits of a piston valve integrated into the same space-saving package.

Materials—TVS 4000 Connector

Connector:	ASTM A351 Gr. CF8M
Strainer screen:	Stainless steel
Screen retainer:	Stainless steel
Gasket:	Stainless steel
Retainer unit:	Stainless steel
Test valve:	Stainless steel
Blowdown valve:	Stainless steel

Isolation Valve Components

Handwheel:	Ductile iron
Nut:	Stainless steel
Stem, washers:	Stainless steel
Bonnet:	ASTM A351 Gr. CF8M
Bonnet, bolts:	DIN 933, Gr. 8.8 per DIN 267
Valve plug:	Stainless steel
Disc springs:	Stainless steel
Valve sealing rings:	Graphite and stainless steel
Lantern bushing:	Stainless steel
Valve washers:	Stainless steel

Materials—Series 2000 Traps

Body:	ASTM A240 Gr. 304L
Internals:	All stainless steel—304
Valve and seat:	Hardened chrome steel—17-4PH

For a fully detailed certified drawing, refer to CD #1232.

TVS 4000 Series With 2000 Series Inverted Bucket Steam Trap

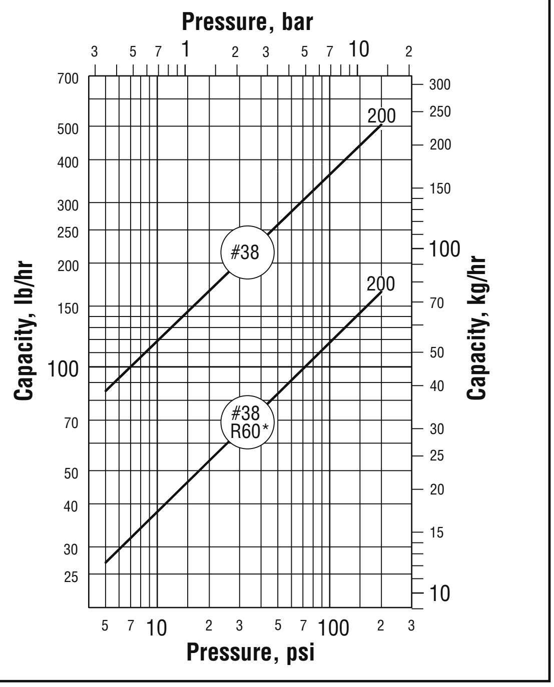
Model No.	2010		2011		2022	
Pipe Connections	in	mm	in	mm	in	mm
	1/2, 3/4	15, 20	1/2, 3/4	15, 20	1/2, 3/4	15, 20
"A" Trap Diameter	2-11/16	68	2-11/16	68	3-7/8	98
"B" Height (Valve Open)	8	203	10-1/2	268	12-1/2	318
"C" Face to Face	4-3/4	120	4-3/4	120	4-3/4	120
"D" Connection ℄ to Bottom	4-3/4	120	6	154	8	203
"E" Connection ℄ to Outside of Trap	4-1/2	114	4-13/16	122	5-7/8	149
"F" Connection ℄ to Front of Handwheel (Valve Open)	3-1/2	89	3-7/8	98	3-7/8	98
"G" Connection ℄ to Top of Handwheel (Valve Open)	3-1/4	83	4-1/2	114	4-1/2	114
"H" Connection ℄ to Bottom of Connector	1-7/8	47	3-1/4	83	3-1/4	83
"J" Width Across Handwheels (Valve Open)	9-1/4	235	8-3/4	222	8-3/4	222
Test Port Connection	1/4 NPT	6	1/4 NPT	6	1/4 NPT	6
Weight lb (kg)	9	4	9-1/2	4.3	12	5.4
Maximum Operating Pressure (Trap)	200 psi (14 bar)		400 psi (28 bar)		650 psig (45 bar)	
Maximum Allowable Pressure (Trap)	400 psi (28 bar) @ 750°F (399°C)				650 psig @ 600°F (45 bar @ 315°C)	

U.S. Patent 6,467,503

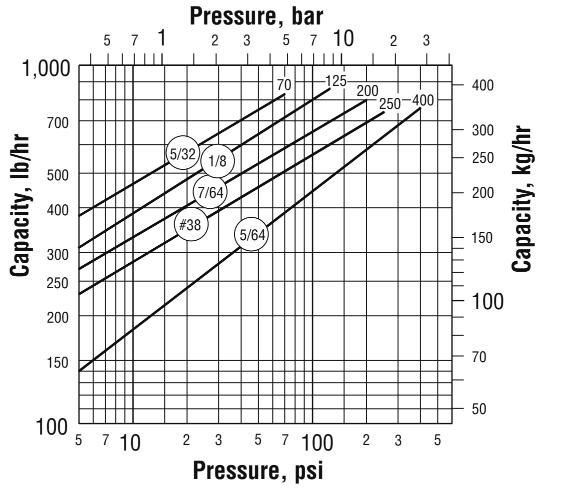
TVS 4000 Series Stainless Steel Trap Valve Station

For Pressures to 650 psig (45 bar)...Capacities to 1,300 lb/hr (590 kg/hr) (Using 2000 Series Inverted Bucket Steam Traps)

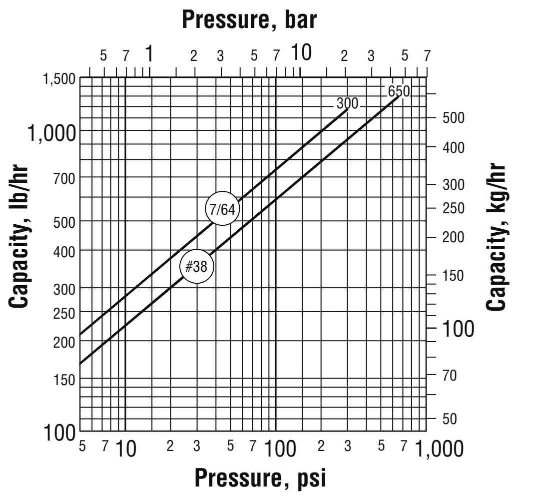
Model 2010 Capacity



Model 2011 Capacity



Model 2022 Capacity



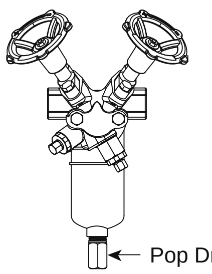
*NOTE: Because the orifice is located at the top, inverted bucket steam traps handle dirt and scale better than other types of traps. However, in applications where extremely dirty conditions exist, care should be exercised in the use of all types of restricted-orifice, reduced-capacity traps.

Options

Insu-Pak™
Now you can insulate the in-line traps in your plant without complicating regular trap maintenance. Insu-Pak, a simple reusable insulation package, cuts the time and cost of in-field installation because it goes on in a snap. And it comes off just as easily. The Insu-Pak can prevent trap freeze-up when used with a properly designed condensate manifold. Designed for use with Model 2010 and Model 2011 traps.

Pop Drain
Simple but effective against freeze-up. Properly installed and maintained at low points in your system, the simple, pressure-actuated pop drain opens for condensate drainage at 5 psig (0.35 bar) for Models 2011 and 2022.

Probe Connections are available for trap monitoring on Models 2011 and 2022.

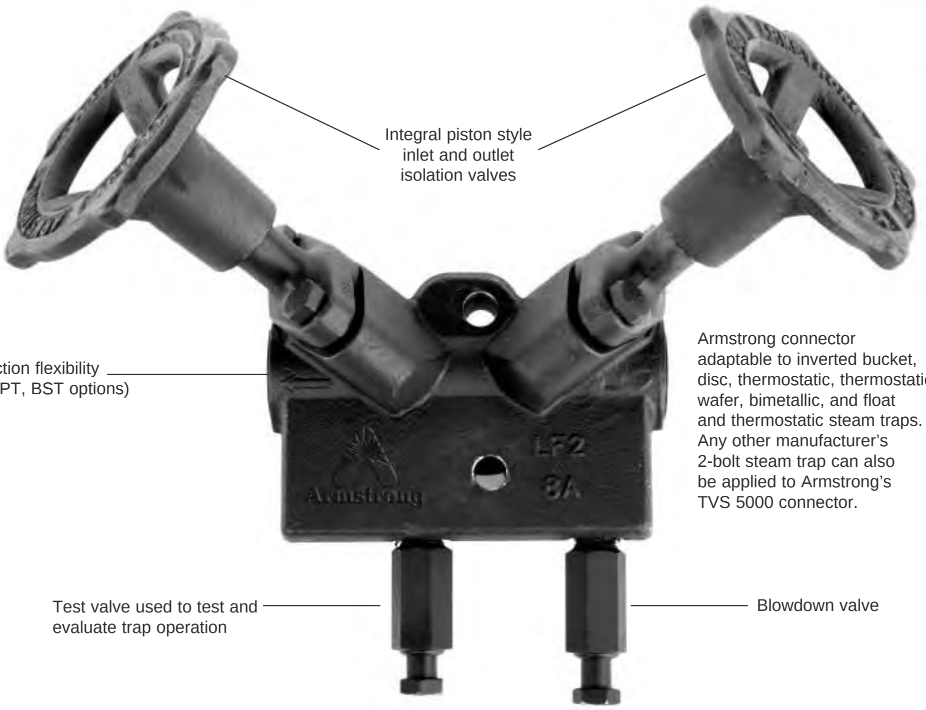


How to Order

Model	Connection	Type of Connection Inlet/Outlet	Flow Direction	Trap Type
TVS 4000	1/2" 3/4"	NPT SW BSPT Flanged*	R = Right to Left L = Left to Right	Inverted Bucket Disc Thermostatic wafer Bimetallic Float and Thermostatic

*Consult factory.

TVS 5000 Trap Valve Station



Description
Armstrong's TVS 5000 is designed as a one piece body equipped with a piston valve(s) combined with a removable steam trap mounted with a connecting flange.

Maximum Operating Conditions
Maximum allowable pressure:
650 psig @ 600°F (45 bar @ 315°C)

Materials—TVS 5000 Connector
Connector: ASTM A350 LF2
Test valve: ASTM A582 T303
Blowdown valve: ASTM A582 T303

Isolation Valve Components
Valve sealing rings: Graphite and stainless steel
Bonnet: ASTM A350 LF2
Bolts: DIN 933
Valve plug: ASTM A564
Lantern bushings: ASTM A582 T304
Valve washer: ASTM A582 T304
Disc springs: AISI T301
Nut: AISI T304
Handwheel: Ductile iron A536

Weight
11.71 lb (5.3 kg)

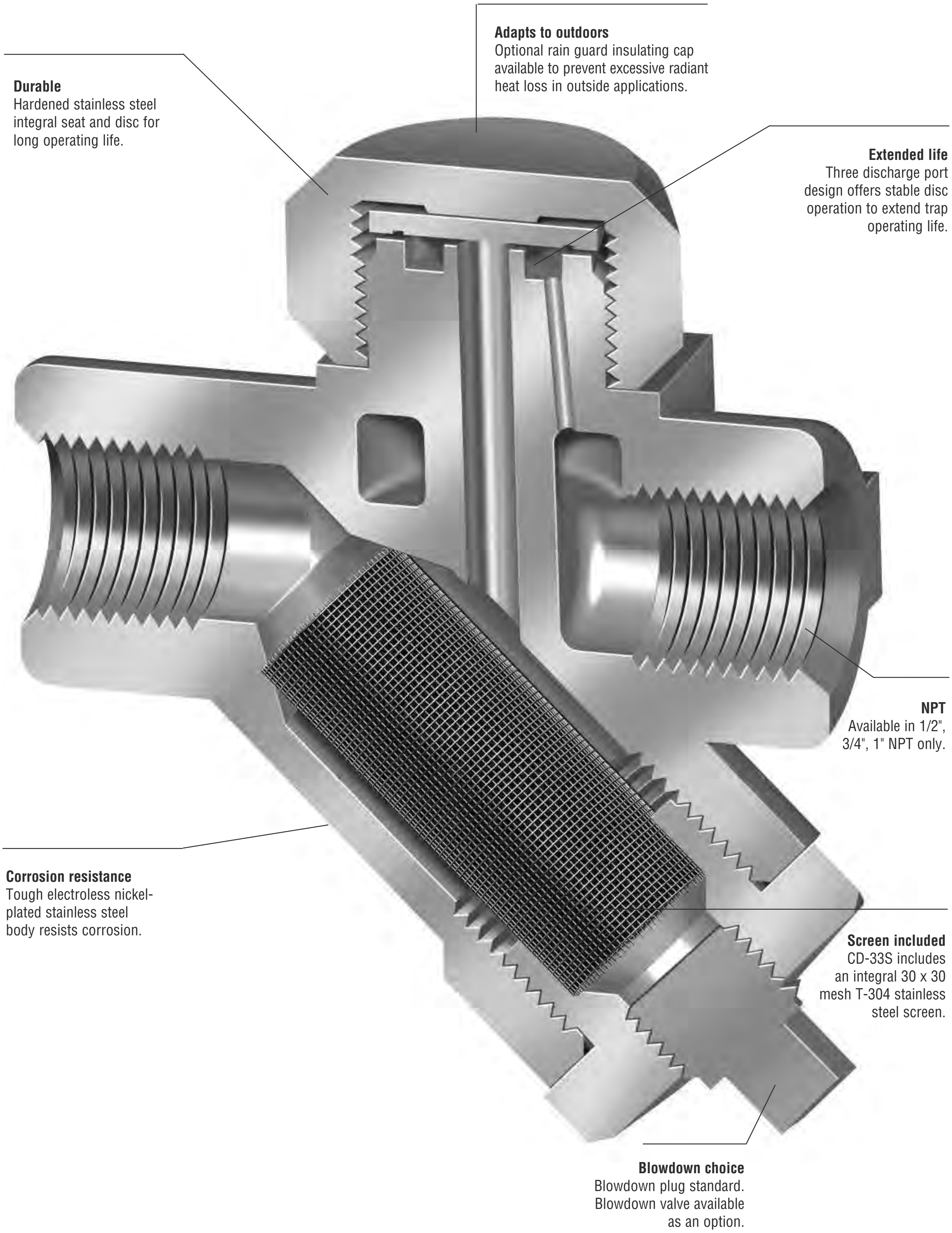
Features
- **Reduced costs.** TVS saves on these fronts: reduced leak points, installation and maintenance time.
- **Reduced design time.** Permits combining products with exact face-to-face dimensions.
- **Easy, in-line repairability with maximum safety.** TVS allows isolation at point of service with upstream/downstream depressurization.
- **Simplified trap testing.** TVS enhances your capability to check trap operation and offers a built-in method to block and bleed traps.

How to Order

Model	Connection	Type of Connection Inlet/Outlet	Flow Direction	Trap Type
TVS 5000	1/2" 3/4"	NPT SW BSPT Flanged*	R = Right to Left L = Left to Right	Inverted Bucket Disc Thermostatic wafer Bimetallic Float and Thermostatic

*Consult factory.

CD-33/CD-33S Disc Trap



CD-33/CD-33S Disc Trap

The Armstrong CD-33 is a disc style trap designed to control the trap's cycle rate. By reducing the cycle rate, the Armstrong CD-33 will have a longer service life than typical disc traps. This enhanced performance will ensure that maintenance time is minimized and steam costs are greatly reduced.

The CD-33 is designed with three discharge ports, which offer stable disc operation to extend trap operating life. The capacities of the Armstrong CD-33 have been engineered specifically for the following applications: large steam main drips, process equipment, and HVAC heating equipment on constant pressure. The CD-33L (low capacity) trap is designed for the low capacity applications of steam main drips and steam tracing lines. By ensuring that the capacities are designed to suit the application, and are not oversized, the CD-33 Series will last longer than other disc traps with excessive capacity ratings.

Advantages

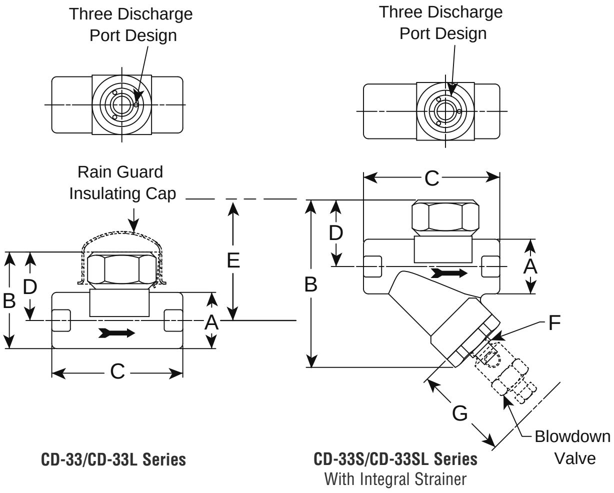
- Three discharge port design
- Minimum wear with controlled cycling
- Freeze-resistant
- Hardened seat and disc

Specification

Steam trap shall be stainless steel thermodynamic type, integral seat design with hardened disc and seating surfaces, and electroless nickel plated finish. When required, trap shall be supplied with an integral Y strainer, integral blowdown valve or rain guard insulating cap. Maximum allowable pressure (vessel design) shall be 915 psig @ 752°F (63 bar @ 400°C). Maximum operating pressure shall be 600 psig @ 752°F (42 bar @ 400°C).

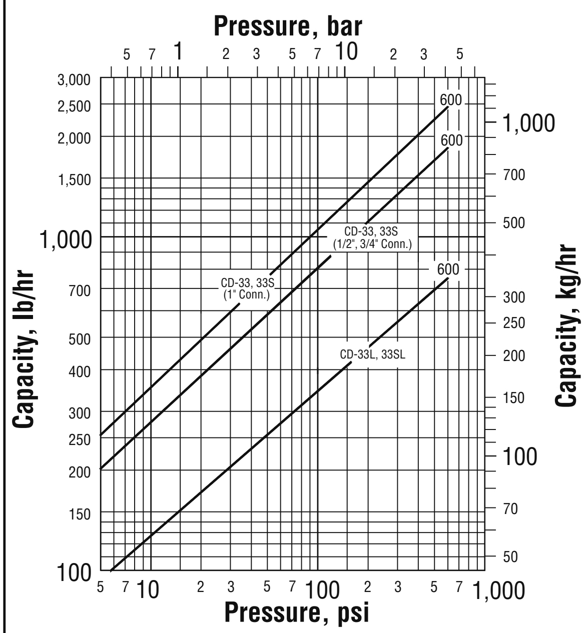
CD-33 Series Disc Trap

For Steam Service up to 600 psig (42 bar)...Capacities to 2,500 lb/hr (1,134 kg/hr)



List of Materials	
Name of Part	**Material**
Body	ASTM A743 Gr. CA40
Cap	ASTM A743 Gr. CA40
Disc	ASTM A276 Gr. 420
Strainer Screen	30 x 30 Mesh T-304 Stainless Steel
Screen Retainer	ASTM A743 Gr. CA40
Blowdown Plug (CD-33S only)	Carbon Steel
Options	
Blowdown Valve	Stainless Steel
Rain Guard Insulating Cap (1/2'', 3/4'' Sizes Only)	Stainless Steel

Model CD-33 Capacity



The Armstrong CD-33 is a disc style trap designed to control the trap's cycle rate. By reducing the cycle rate, the Armstrong CD-33 will have a longer service life than typical disc traps. This enhanced performance will ensure that maintenance time is minimized and steam costs are greatly reduced.

The CD-33 is designed with three discharge ports, which offer stable disc operation to extend trap operating life. The capacities of the Armstrong CD-33 have been engineered specifically for the following applications: large steam main drips, process equipment, and HVAC heating equipment on constant pressure. The CD-33L (low capacity 1/2" and 3/4" only) trap is designed for the low capacity applications of steam main drips and steam tracing lines. By ensuring that the capacities are designed to suit the application, and are not oversized, the CD-33 Series will last longer than other disc traps with excessive capacity ratings.

Advantages

- Three discharge port design
- Minimum wear with controlled cycling
- Freeze-resistant
- Hardened seat and disc

Specification

Steam trap shall be stainless steel thermodynamic type, integral seat design with hardened disc and seating surfaces, and electroless nickel plated finish. When required, trap shall be supplied with an integral Y strainer, integral blowdown valve or rain guard insulating cap. Maximum allowable pressure (vessel design) shall be 915 psig @ 752°F (63 bar @ 400°C). Maximum operating pressure shall be 600 psig @ 752°F (41 bar @ 400°C).

For a fully detailed certified drawing, refer to:
CD-33/33L CD #1116
CD-33S/33SL CD #1250

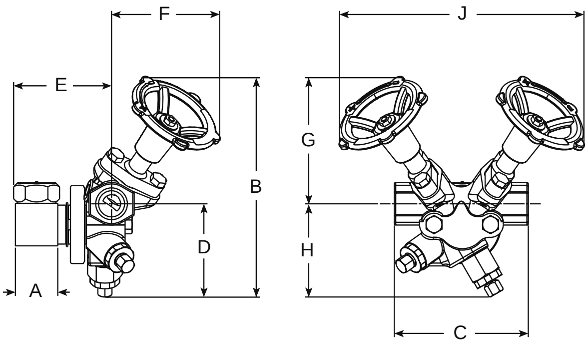
CD-33 Series Disc Trap												
Model No.	CD-33				CD-33S (w/strainer)				CD-33L (low capacity)		CD-33SL (w/strainer) (low capacity)	
Pipe Connection Size	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
	1/2, 3/4	15, 20	1	25	1/2, 3/4	15, 20	1	25	3/8, 1/2, 3/4	10, 15, 20	1/2, 3/4	15, 20
"A"	1-7/16	37	1-3/4	44	1-7/16	37	1-3/4	44	1-7/16	36	1-7/16	36
"B" Height	2-1/2	63	3-1/8	79	4-1/4	108	4-3/4	121	2-1/2	63	4-1/4	108
"C" Length	3-5/16	84	3-15/16	100	3-1/2	89	4-1/8	105	3-5/16	84	3-1/2	89
"D" ℄ to Top of Cap	1-3/4	44	2-1/4	57	1-3/4	44	2-1/4	57	1-3/4	44	1-3/4	44
"E" Withdrawal Distance Rain Guard Insulating Cap	–	–	–	–	3	76	3	76	–	–	3	76
"F" Blowdown Connection Size	–	–	–	–	1/4 NPT	6	1/4 NPT	6	–	–	1/4 NPT	6
"G" Withdrawal Distance Blowdown Valve	–	–	–	–	3-1/2	89	3-1/2	89	–	–	3-1/2	89
Weight, lb (kg)	1.4 (0.64)		2.5 (1.1)		2.2 (1.0)		3.25 (1.5)		1.41 (0.64)		2.2 (1.0)	
Maximum Allowable Pressure (Vessel Design)	915 psig @ 752°F (63 bar @ 400°C)											
Minimum Operating Pressure, psi (bar)	3.5 psig (0.24 bar)											
Maximum Operating Pressure, psi (bar)	600 psig @ 486°F (41 bar @ 252°C)											

Maximum Back Pressure as Percent of Inlet Pressure, 80%

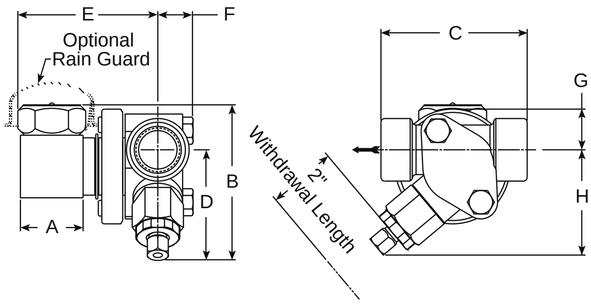
CD-3300 Series Disc Steam Traps

All Stainless With 360° Connector

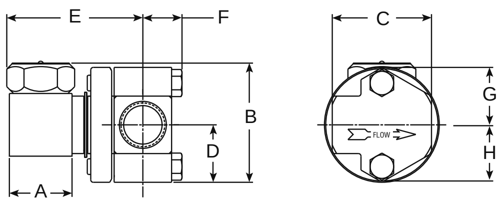
For Steam Pressures to 450 psig (31 bar)…Capacities to 800 lb/hr (363 kg/hr)



CD-3300 With TVS 4000 Trap Valve Station



CD-3300 With IS-2 Connector With Integral Strainer and Blowdown Valve



CD-3300 With Standard Connector

The Armstrong CD-3300 is a three discharge port design, which provides stable disc operation to extend operating life.

The CD-3300 is piped in-line by a 360° universal connector, which allows you to install the trap in virtually any piping configuration. Armstrong's unique standard connector or its IS-2 connector with integral strainer makes the CD-3300 easy to install, easy to renew. You save on labor time and cost because the connector simplifies piping and remains in-line.

Materials

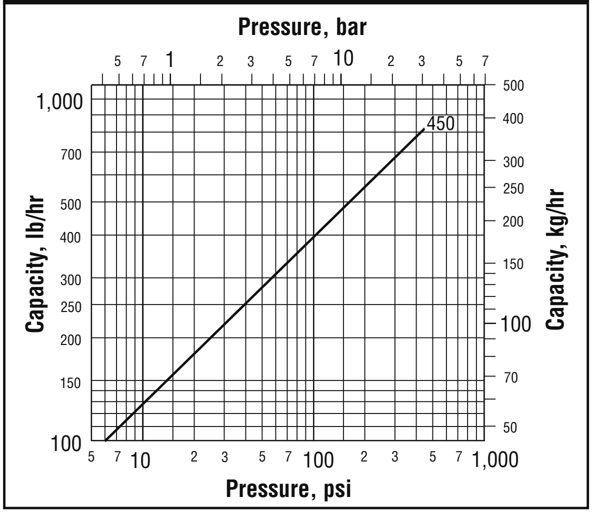
Trap cap:	ASTM A743 CA40
Trap disc:	ASTM A276 Gr. 420
Trap body:	ASTM A276 Gr. 420
Standard connector:	Stainless steel—304
IS-2 connector with integral strainer:	ASTM A351 Gr. CF8 20 x 20 mesh 304 SS Screen

Options

Rain guard insulating cap
Blowdown valve—IS-2 connector only

For a fully detailed certified drawing, refer to CD #1164.

CD-3300 Series Capacity



CD-3300 Series Disc Traps

Model	CD-3300							
	Standard Connector		IS-2 Connector With Integral Strainer				TVS 4000 Connector	
	in	mm	in	mm	in	mm	in	mm
Pipe Connections	1/2, 3/4	15, 20	1/2, 3/4	15, 20	1	25	1/2, 3/4	15, 20
"A" Trap Diameter	1-1/2	38	1-1/2	38	1-1/2	38	1-1/2	38
"B" Total Height	2-7/8	73	3-3/4	94	3-3/4	94	7-13/16	198
"C" Face-to-Face	2-3/8	60	3-1/2	89	4	101	4-3/4	120
"D" Connection ℄ to Bottom	1-3/8	35	2-5/8	67	2-5/8	67	3-1/4	83
"E" Connection ℄ to Outside of Trap	3-3/8	86	3-3/8	86	3-9/16	90	3-9/16	90
"F" Connection ℄ to Front of Connector	13/16	20	7/8	22	7/8	22	3-7/8	98
"G" Connection ℄ to Top	1-3/8	46	1	25	1	25	4-1/2	114
"H" Connection ℄ to Bottom of Connector	1-3/8	46	2-1/2	64	2-1/2	64	3-1/4	83
"J" Width Across Handwheels (Valve Open)	—	—	—	—	—	—	8-11/16	221
Test Port Connection	—	—	—	—	—	—	1/4 NPT	6
Trap Only Weight, lb (kg)	2 (0.91)							
Trap and Connector Weight, lb (kg)	3.6	1.6	3.9	1.8	4.2	2	8-1/2	3.8
Maximum Operating Pressure	450 psig @ 456°F (31 bar @ 236°C)							
Maximum Allowable Pressure (Vessel Design)	720 psig @ 750°F (50 bar @ 400°C)							

ARMSTRONG
FLOW CONTROL

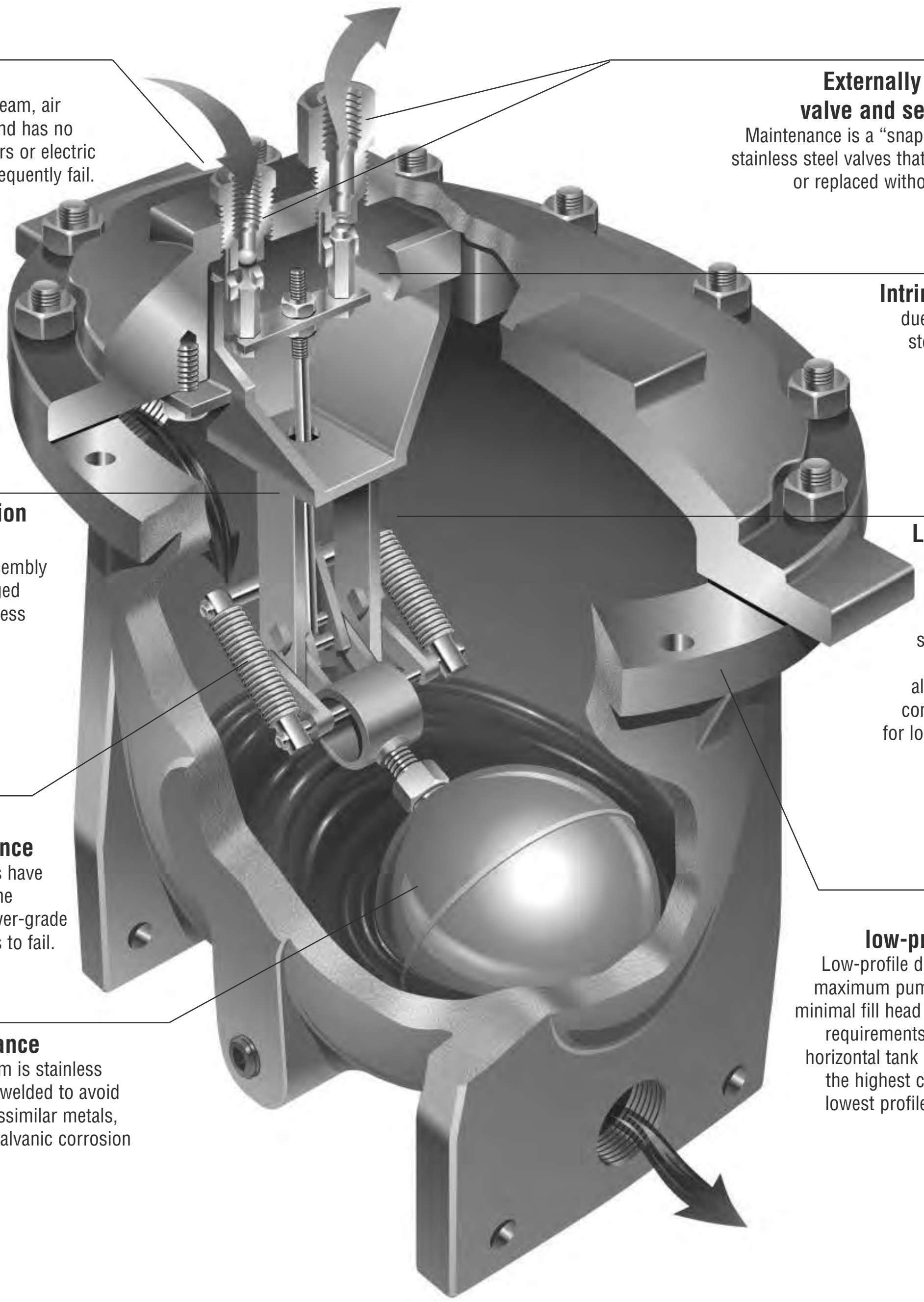
Condensate Management

Pumping Traps

Inside Advantages

Mechanical condensate pumps operate with a spring-assisted float mechanism, which means the springs themselves are a major wear point. Armstrong pumping traps have large-diameter Inconel X-750 springs, which provide superior corrosion resistance and longer service life than those in competitive models. For other inside advantages, see below.

Notice the difference in spring design from the industry standard spring set (left) and the Armstrong Inconel spring set.



Effective Condensate Management = Energy Savings

The most basic part of energy management is utilizing all valuable Btu within the steam system. Depending on the pressure, condensate exiting a trap contains approximately 20% of the heat energy transferred at the boiler in the form of sensible heat. Effective recovery of condensate reduces three tangible costs of producing steam:

- Fuel/energy costs associated with producing steam
- Boiler water make-up and sewage treatment
- Boiler water chemical treatment

These savings can be calculated using the attached savings form. Returning condensate saves money, energy and the environment. Pour money and energy savings back into your plant—not down the drain.

Condensate Recovery Savings Analysis

Location ____________________ Bldg ____________________

Energy costs will vary from plant to plant and regions of the world. Values shown are conservative. Complete this form using your facilities' numbers to determine annual savings in your plant by returning condensate. If some costs are not known, use the figures below for conservative estimates.

A) Condensate Load ....= **8,000 lb/hr**

B) Annual Hours of Operation ....= **7,200 hrs per year**

C) Total Water and Sewage Cost..................= **$.005 per gal**

- c1) Untreated water and sewage ....= **$.002 per gal**
- c2) Water treatment chemicals................= **$.003 per gal**

D) Make-Up Water Preheating Requirements = **140 Btu/lb**

- d1) Condensate Return Temperature.......= **200°F**
- d2) Make-Up Water Temperature ....= **60°F**

E) Steam Cost ....= **$ 5.00/1,000 lb**

F) Annual Water Savings ....= **$ 34,532.00**

$$\frac{(A)8000 \times (B)7200 \times (C).005}{8.34 \text{ lb/gal}}$$

G) Savings for Preheating Make-Up Water ....= **$ 40,320.00**

$$\frac{(A)8000 \times (B)7200 \times (D)140 \times (E)5.00}{{}^{*}1000 \times 1000}$$

H) Cost of Steam to Operate†
Armstrong Pump Trap ....= **$ 864.00**

$$\frac{3 \times (A)8000 \times (B)7200 \times (E)5.00}{1000 \times 1000}$$

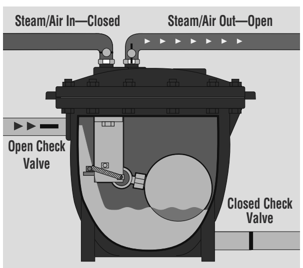
I) Total Dollars Saved Annually (F + G - H) ...... = **$ 73,988.00**

J) Payback Period in Years ....= **.27 Years**

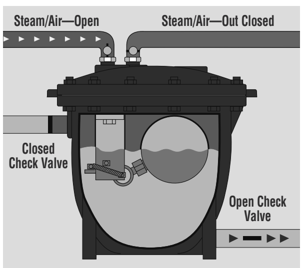
$$\frac{{}^{**}\text{(cost of equipment/installation) } \$20{,}000}{(I)\ 73{,}988}$$

* Btu/lb from direct steam injection
** Estimated equipment and installation cost
† Cost to operate in example assumes an "open" vented system. If pump trap is used in "closed loop" application, steam operation cost is negligible.

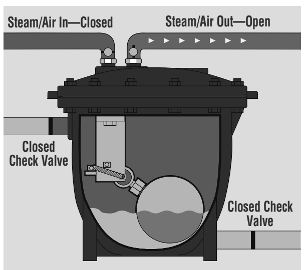
Pumping Trap Operation



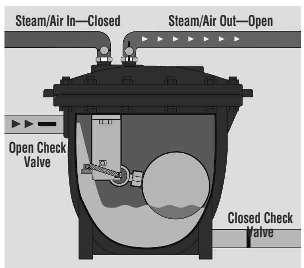
Filling
1. During filling, the steam, air or inert gas inlet and check valve on pumping trap outlet are closed. The vent and check valve on the inlet are open.



Begin Pumping
2. Float rises with level of condensate until it passes trip point, and then snap action reverses the internal valve positions shown in step one.

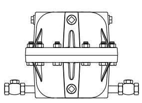
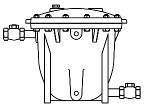
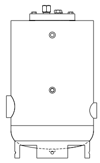
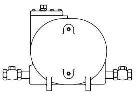
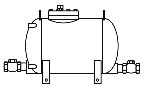
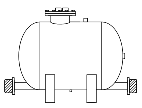
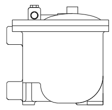
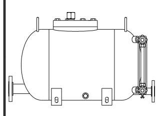
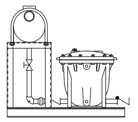


End Pumping
3. Float is lowered as level of condensate falls until snap action again reverses the internal valve positions.



Repeat Filling
4. Steam, air or inert gas inlet and trap outlet are again closed while vent and condensate inlet are open. Cycle begins anew.

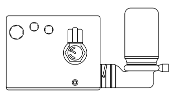
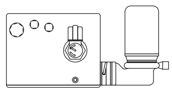
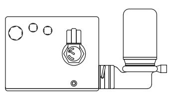
Pumping Trap ID Charts

Illustration	Type	Connection Type	Max. Allow. Press. psig	TMA °F	Body Material	Mechanism Material	Model	Max. Oper. Press. psig	Capacity Range lb/hr	Connection Size 1"	1-1/2"	2"	3" x 2"	Located on Page
	**Series PT-100**	Screwed	150	450	ASTM A48 Class 30 Cast Iron	Stainless Steel with Inconel X-750 Spring	PT-104	100	1,800	●				204
	**Series PT-200**	Screwed	150	450	ASTM A48 Class 30 Cast Iron	Stainless Steel with Inconel X-750 Spring	PT-204 PT-206	125	2,400 3,700	●	 ●			206
	**Series PT-400**	**Screwed	150	*650	**Fabricated Steel 150 psi ASME Sec. VIII Design "U" Stamped	Stainless Steel with Inconel X-750 Spring	PT-404 PT-406	125	3,600 5,500	●	 ●			208
	Series PT-400LL	**150# ANSI Flanged					PT-408 PT-412		7,400 12,200			●	 ●	219
	**Series PT-3500**	Screwed	150	450	ASTM A48 Class 30 Cast Iron	Stainless Steel with Inconel X-750 Spring	PT-3508 PT-3512	125	9,900 14,500			●	 ●	210
	**Series PT-300**	Screwed	150	*650	**Fabricated Steel 150 psi ASME Sec. VIII Design "U" Stamped	Stainless Steel with Inconel X-750 Spring	PT-308	125	11,600			●		212
	Series PT-300LL	**150# ANSI Flanged **300# ANSI Flanged		550			PT-312		16,600				●	219
	**Series PT-500**	**150# ANSI Flanged	150	500	**Fabricated Steel 150 psi ASME Sec. VIII Design "U" Stamped	Stainless Steel with Inconel X-750 Spring	PT-516	150	80,000	4" x 4"				216
	**Double Duty® 4**	Screwed	72	320	Ductile Iron	Stainless Steel	Simplex Duplex	72	up to 350	1" x 1"				220
	**Double Duty® 6**	**150# ANSI Flanged	200	400	Carbon Steel	Stainless Steel with Inconel X-750 Spring	Simplex Duplex Triplex Quadplex	200	up to 4,800	1-1/2" x 1"				222
	Double Duty® 12								up to 19,900	3" x 3"				224
	**Series 100, 200, 300, 3500 Low Boy™ Packages**	For detailed information, regarding Armstrong pre-piped pump packages, please contact the factory or visit our website at **armstrong**international.com												

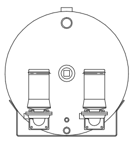
**Other connection type, receiver pressure vessel ratings and material type available upon request—consult factory.
*Standard mechanism: Maximim motive 125 psi; maximum allowable pressure 150 psi (vessel rating); maximum temperature 480°F (vessel rating).

Pumping Trap ID Charts

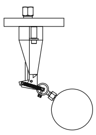
Electric Centrifugal Condensate Pump ID Chart

Illustration	Type	Sq. Ft. EDR	Pump Capacity GPM	Pump Disch. Press.	Motor HP	RPM	Disch. Size Inches	Inlet Size Inches	Receiver Cap. Gallons	Locate Page for Sizing
	**FHS Series** **FHC Series** **Simplex or Duplex**	8,000 thru 20,000	12 thru 30	Max. 20 psig	Simplex 1/3, 1/2, 3/4 Duplex 1/2 or 3/4	3,500 RPM Only Single Phase Only	3/4"	2" thru 3"	FHS Series 8 - 30 (Steel) FHC Series 15 - 36 (Cast Iron)	234
	**AFH-4100** **4200** **4300** **3500** **Simplex or Duplex**	2,000 thru 50,000	*3 thru 75	*20 thru 50	*1/3 thru 5	1,750 and 3,500 Single or Three Phase	3/4" thru 1-1/2"	2" thru 4"	AFH-4100/4300 8 - 120 (Steel/SS) AFH-4200 6 - 120 (Cast Iron)	237 thru 246
	**AFH-4400** **Simplex or Duplex**	4,000 thru 60,000	6 thru 90	*10 thru 50	1/3 thru 1-1/2"	3500 RPM	3/4" thru 1-1/2"	2" thru 2-1/2"	12 - 100	247

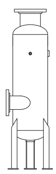
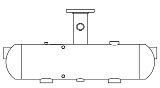
Boiler Feed Condensate Pump ID Chart

Illustration	Type	Boiler HP BHP	Pump Capacity GPM	Pump Disch. Press.	Motor HP	RPM	Disch. Size Inches	Inlet Size Inches	Receiver Cap. Gallons	Locate Page for Sizing
	**AFH-4100** **4200** **4300** ****3500** **5000**	15 to 700	*3 to 140	*20 to 50	1/3 to 7-1/2	1,750 and 3,500 Single or Three Phase	Consult Factory		30 to 714	242

Rescue Cap® Non-Electric Steam/Air Powered Pump Retrofit Assembly ID Chart

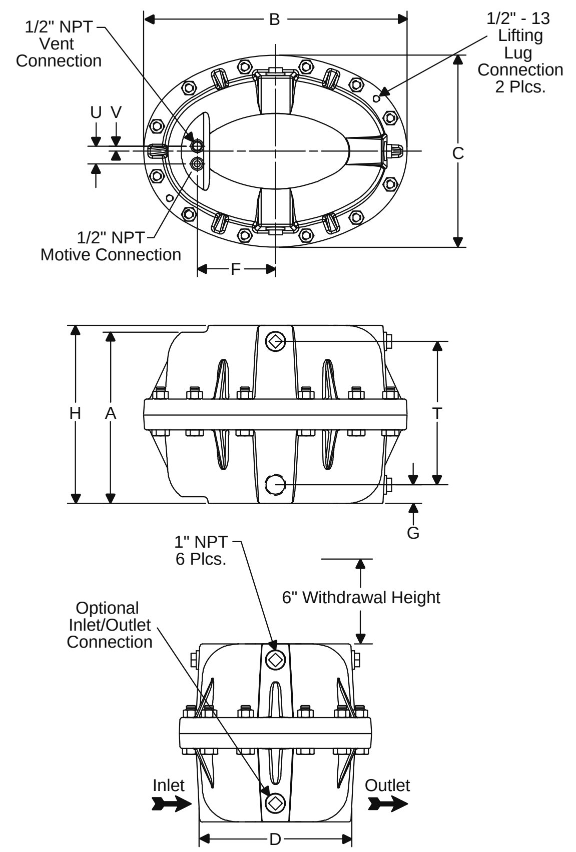
Illustration	Fits Competitors' Mechanical Pumps Listed Below							Page
	Spirax Sarco Models PPC & PPF PTC & PTF	Watson McDaniel Models PMPC & PMP	Spence & Nicholson Condensate Commanders	KADANT-Johnson Corporation	ITT Hoffman PCS	Yarway Series 65 Steel	Clark Reliance	232

Flash Tank ID Chart

	Type	Connections	Size	Pressure Rating	Sparge Pipe	Body Material	Page
	**VAFT Vertical Flash Tanks**	NPT Flanged	6” 8” 12” 16”	***150 psig	N/A	Carbon Steel	253
	**HAFT Horizontal Flash Tanks**	NPT Flanged	4” thru 30”				255

*Other capacities, discharge pressures and HP available - consult factory.
**3500 Series has elevated tank as standard.
***Other pressure ratings available upon request.

PT-104 Series Mini Pump Trap



The patented Armstrong PT-104 Mini Pump Trap is the smallest non-electric solution that can move condensate or other liquids from lower to higher points and from lower to higher pressures. Condensate can be returned at temperatures well above the 200°F (93°C) limit of conventional electric centrifugal pumps without the headaches of leaking seals or cavitation problems. The PT-104 Mini Pump Trap is the small solution for a big problem.

Features

- Economical non-electric operation. Uses inexpensive steam, air or inert gas.
- Low-maintenance operation. No leaking seals, impeller or motor problems means lower maintenance. No NPSH issues.
- Space-saving size. Low-profile body fits in tight spaces while allowing minimal fill head.
- Lower installation costs. Single trade required for installation and maintenance.
- Peace of mind. Standard unit is intrinsically safe.
- Cast iron durability. Rugged construction material means long service life.
- Corrosion resistance. Internals are all stainless steel for corrosion resistance and long life.
- Heavy-duty springs. Springs are made from long-lasting Inconel X-750.
- Efficiency. A closed loop means no motive or flash steam is lost. All valuable Btu's are captured and returned to the system.
- Safety. The pump can be used in flooded pits without fear of electrocution or circuit breaker defaults.

For a fully detailed certified drawing, refer to CDF #1028.

PT-104 Mini Pump Trap Physical Data

Symbol	in	mm
"A"	12	305
"B"	18-1/2	470
"C"	13-1/2	343
"D"	10-3/4	272
"F"	5-1/2	140
"G"	1-5/16	33
"H"	12-1/2	317
"U"	1-1/4	32
"V"	3/8	9
"T"	10-1/16	256
Weight lb (kg)	140 (64)	
Bronze Check Valves lb (kg)	4 (2)	
Stainless Steel Check Valve lb (kg)		
Maximum Operating Pressure	100 psig (7 bar)	
Maximum Allowable Pressure (vessel design)	150 psig @ 450°F (10 bar @ 232°C)	

PT-104 Mini Pump Trap Connection Sizes

Connection	Type	in	mm
Inlet	NPT	1	25
Outlet		1	25
Vent		1/2	15
Motive Pressure		1/2	15
Optional Gauge Glass		1	25
Optional Cycle Counter/Pressure Gauge		1	25

PT-104 Mini Pump Trap Materials

Name of Part	Material
Body and Cap	Cast iron ASTM A48 Cl.30
Vent/Inlet Valves	Stainless steel
Mechanism Assembly	Stainless steel
Spring	Inconel X-750
Gasket	Graphoil
Bolts	SA 449
Nuts	ASTM A194 Gr.2H
Plug	Cast iron

PT-104 Series Mini Pump Trap

Options

Use of external check valves required for operation of pumping trap.

- Inlet Swing Check Valve
  NPT Bronze ASTM B 62
  Teflon® Disc
  Class 150 (Minimum)
- Outlet
  Stainless Steel Check Valve
  Class 150 (Minimum)
- In-line Check Valves
  Stainless Steel Non-Slam Check Valves
- Bronze Gauge Glass Assembly
- Steel Gauge Glass Assembly
- Removable Insulation Jacket
- Digital Cycle Counter

Capacity Conversion Factors for Other Filling Heads

Filling Head				
in	0	6	12	* 24 or greater
mm	0	150	305	* 620 or greater
PT-104 Mini Pump Trap	0.7	1.0	1.2	* Consult factory

NOTE: Fill head measured from drain to top of cap. See figures on page 228.

PT-104 Mini Pump Trap Capacities

Motive Pressure		Total Lift or Back Pressure		Filling Head 6" (152 mm) Liquid Specific Gravity .09 - 1.0			
				Steam		Air	
psig	bar	psig	bar	lb/hr	kg/hr	lb/hr	kg/hr
15	1.0	5	0.34	1,125	510	2,100	952
25	1.7			1,300	590	2,200	998
50	3.5			1,550	703	2,275	1,032
75	5.0			1,650	748	2,300	1,043
100	7.0			1,400	635	2,350	1,066
25	1.7	15	1.0	650	295	1,900	862
50	3.5			700	363	2,050	930
75	5.0			750	317	2,100	952
100	7.0			800	340	2,150	975
35	2.5	25	1.5	400	181	1,800	816
50	3.5			450	204	1,935	878
75	5.0			500	227	2,050	930
100	7.0			550	249	2,075	941
50	3.5	40	3.0	250	113	1,620	735
75	5.0			300	136	1,850	823
100	7.0			350	159	1,950	884

NOTE: Published capacities are based on the use of external check valves supplied by Armstrong. Fill head measured from drain point to top of pump case. See figures on page 228.

PT-200 Series Low Profile Cast Iron Pump Trap

3-Year No Fail Warranty
3-Year No Fail
Pump Trap Mechanism

The Armstrong PT-200 Series Low Profile Pump Trap is a low maintenance, non-electric solution to move condensate or other liquids from low points, low pressures or vacuum spaces to an area of higher elevation or pressure. Condensate can be returned well above the 200°F (93°C) limit of conventional electric condensate pumps without the headaches of leaking seals or cavitation problems.

Features

- Economical non-electric operation. Uses inexpensive steam, air or inert gas.
- Low-maintenance operation. No leaking seals, impeller or motor problems means lower maintenance. No NPSH issues.
- Space-saving size. Low-profile body fits in tight spaces while allowing minimal fill head.
- Lower installation costs. Single trade required for installation and maintenance.
- Peace of mind. Standard unit is intrinsically safe.
- Cast iron durability. Rugged construction material means long service life.
- Corrosion resistance. Internals are all stainless steel for corrosion resistance and long life.
- Heavy-duty springs. Springs are made from long-lasting Inconel X-750.
- Efficiency. A closed loop means no motive or flash steam is lost. All valuable Btu's are captured and returned to the system.
- Safety. The pump can be used in flooded pits without fear of electrocution or circuit breaker defaults.
- Externally removable/replaceable seats. Seats can be replaced or cleaned without removing the mechanism assembly.

Options

Use of external check valves required for operation of pumping trap.

- Inlet Swing Check Valve
  NPT Bronze ASTM B 62
  Teflon® Disc
  Class 150 (Minimum)
- Outlet
  Stainless Steel Check Valve
  Class 150 (Minimum)
- In-line Check Valves
  Stainless Steel Non-Slam Check Valves
- Bronze Gauge Glass Assembly
- Steel Gauge Glass Assembly
- Removable Insulation Jacket
- Digital Cycle Counter

For a fully detailed certified drawing, refer to CDF #1000.

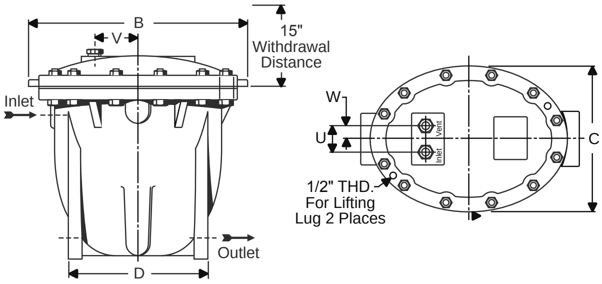
PT-200 Pumping Trap Materials

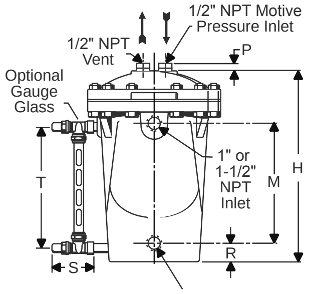
Name of Part	Series PT-200
Body and Cap	Cast iron ASTM A48 Cl. 30
Cap Gasket	Graphoil
Bolts	SA-449 Steel
Nuts	Alloy steel ASTM A194 Gr. 2H
Inlet Valve Assembly	Stainless steel
Vent Valve Assembly	Stainless steel
Valve Assembly Washers	Zinc plated steel
Plug	Steel
Mechanism Assembly	Stainless steel
Springs	Inconel X-750

PT-200 Pumping Trap Connection Sizes

Model	Cast Iron			
	PT-204		PT-206	
	in	mm	in	mm
Inlet Connection	1	25	1-1/2	40
Outlet Connection	1	25	1-1/2	40
Optional Low Inlet or Same Side Outlet Connection	1	25	1-1/2	40
Motive Pressure Connection	1/2	15	1/2	15
Vent Connection	1/2	15	1/2	15
Gauge Glass Connection	1/2	15	1/2	15

PT-200 Series Low Profile Cast Iron Pump Trap





PT-200 Pumping Trap Physical Data

	PT-204 PT-206	
	in	mm
"B"	20-7/16	519
"C"	13-1/2	342
"D"	12-15/16	328
"H"	19	482
"M"	11-35/64	293
"P"	23/32	18
"R"	2-1/32	51
"S"	4-3/8	111
"T"	12	305
"U"	2-1/4	57
"V"	4-1/8	104
"W"	1-1/8	28
Weight lb (kg)	210 (96)	
Number of Body/Cap Bolts	12	
Check Valve Conn. in (mm)	1 (25)	1-1/2 (40)
Bronze Check Valves lb (kg)	4 (2)	9 (4)
Stainless Steel Check Valves lb (kg)	4 (2)	9 (4)

Maximum Allowable Pressure (Vessel Design) 150 psig @ 450°F (10 bar @ 232°C)
Maximum Operating Pressure 125 psig (9 bar)

PT-200 Capacity Conversion Factors for Other Fill Heads

Fill Head		in	mm	in	mm	in	mm	in	mm	in	mm
		0	0	6	152	12	305	24	610	36	914
Model	PT-204	0.7		1		1.1		1.3		1.4	
	PT-206	0.7		1		1.1		1.3		1.4	

NOTE: Fill head is measured from drain point to top of cap. See figures on page 228.

PT-200 Pumping Trap Capacities

Motive Pressure		Total Lift or Back Pressure		PT-204 (6" Fill Head) 1" x 1"				PT-206 (6" Fill Head) 1-1/2" x 1-1/2"			
				Steam Motive		Air Motive		Steam Motive		Air Motive	
psig	bar	psig	bar	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr
15	1.0	5	0.34	1,800	816	2,100	953	2,700	1,225	3,000	1,361
25	1.7			2,025	919	2,300	1,043	3,200	1,451	3,500	1,588
50	3.5			2,100	953	2,500	1,134	3,400	1,542	3,600	1,633
75	5			2,200	998	2,700	1,225	3,500	1,588	3,700	1,678
100	7			2,300	1,043	*	*	3,600	1,633	*	*
125	8.5			2,400	1,089	*	*	3,700	1,678	*	*
25	1.7	15	1	1,500	680	2,000	907	2,400	1,088	2,700	1,225
50	3.5			2,000	907	2,250	1,021	3,200	1,451	3,400	1,542
75	5			2,100	953	2,500	1,134	3,300	1,497	3,500	1,588
100	7			2,110	957	*	*	3,350	1,520	*	*
125	8.5			2,125	964	*	*	3,400	1,542	*	*
35	2.5	25	1.5	1,500	680	1,700	771	2,100	953	2,300	1,043
50	3.5			1,700	771	2,000	907	2,400	1,089	2,600	1,179
75	5			1,900	862	2,300	1,043	2,700	1,225	2,900	1,315
100	7			2,000	907	*	*	2,800	1,270	*	*
125	8.5			2,100	953	*	*	2,900	1,315	*	*
50	3.5	40	3	1,400	635	1,700	771	1,500	680	2,000	907
60	4			1,500	680	2,000	907	2,000	907	2,300	1,043
75	5			1,700	771	2,200	998	2,300	1,043	2,500	1,134
100	7			1,800	816	*	*	2,400	1,089	*	*
125	8.5			1,920	871	*	*	2,500	1,134	*	*
70	4.5	60	4	1,100	499	2,000	907	1,150	522	2,000	907
75	5			1,300	590	2,300	1,043	1,325	601	2,300	1,043
100	7			1,600	726	*	*	1,900	862	*	*
125	8.5			1,720	780	*	*	2,000	907	*	*

NOTES: Published capacities are based on the use of external check valves supplied by Armstrong. Fill head measured from drain point to top of pump cap. See figures on page 228.
Although motive pressures are shown at high pressure differentials (difference between motive inlet pressure and total lift or back pressure), it is preferable to use a motive pressure of 10 - 15 psig (0.65 - 1.0 bar) above discharge (outlet) pressure. This ensures longevity of economical (bronze) check valves and reduces both venting time and temperature differential (on steam). If a higher differential is used, stainless steel check valves are recommended.
*Consult factory.

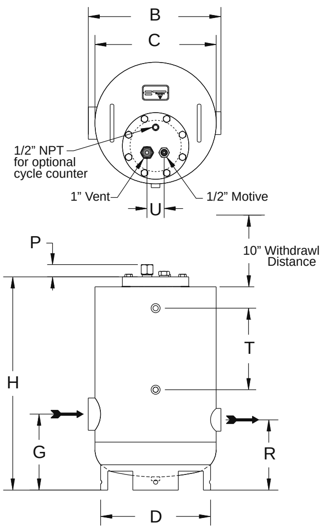
PT-400 Series Vertical Steel Pump Trap

3-Year No Fail Warranty
3-Year No Fail
Pump Trap Mechanism

The Armstrong PT-400 Series Vertical Pump Trap is the low maintenance, non-electric solution to move condensate or other liquids from low points, low pressures or vacuum spaces to an area of higher elevation or pressure. Condensate can be returned at temperatures well above the 200°F (93°C) limit of conventional electric condensate pumps without the headaches of leaking seals or cavitation problems.

Features

- Economical non-electric operation. Uses inexpensive steam, air or inert gas.
- Low-maintenance operation. No leaking seals, impeller or motor problems means lower maintenance. No NPSH issues.
- Lower installation costs. Single trade required for installation and maintenance.
- Peace of mind. Standard unit is intrinsically safe.
- Durable construction. ASME code-stamped carbon steel body vessel.
- Corrosion resistance. Internals are all stainless steel for corrosion resistance and long life.
- Heavy-duty springs. Springs are made from long-lasting Inconel X-750.
- Efficiency. A closed loop means no motive or flash steam is lost. All valuable Btu's are captured and returned to the system.
- Safety. The pump can be used in flooded pits without fear of electrocution or circuit breaker defaults.
- Externally removable/replaceable seats. Seats can be replaced or cleaned without removing the mechanism assembly.



Options

Use of external check valves required for operation of pumping trap.

- Inlet Swing Check Valve
  - NPT Bronze ASTM B 62
  - Teflon® Disc
  - Class 150 (Minimum)
- Outlet
  - Stainless Steel Check Valve
  - Class 150 (Minimum)
- In-line Check Valves
  - Stainless Steel Non-Slam Check Valves
- Bronze Gauge Glass Assembly
- Steel Gauge Glass Assembly
- Removable Insulation Jacket
- Digital Cycle Counter

For a fully detailed certified drawing, refer to CDF #1004.

PT-400 Pumping Trap Physical Data

Model Number	PT-404, PT-406, PT-408 and PT-412			
	in		mm	
"B"	17-1/2		445	
"C"	16		406	
"D"	14-1/2		368	
"G"	10		254	
"H"	28		711	
"P"	1-5/8		41	
"R"	9-1/4		235	
"T"	12		305	
"U"	2-1/4		57	
Weight, lb (kg)	166 (75)			
Number of Body/Cap Bolts	8			
Model Number	**PT-404**	**PT-406**	**PT-408**	**PT-412**
Check Valve Conn., in (mm)	1 (25)	1-1/2 (40)	2 (50)	3 (75)
Bronze Check Valves, lb (kg)	4 (2)	9 (4)	16 (7)	29 (13)
Stainless Steel Check Valves, lb (kg)	4 (2)	9 (4)	15 (7)	38 (17)

PT-400 Series Vertical Steel Pump Trap

PT-400 Pumping Trap Connection Sizes

Model	Vertical Steel							
	PT-404		PT-406		PT-408		PT-412	
	in	mm	in	mm	in	mm	in	mm
Inlet ction Conne	1	25	1-1/2	40	2	50	3	80
Outlet ction Conne	1	25	1-1/2	40	2	50	2	50
Motive Pressure Connection	1/2	15	1/2	15	1/2	15	1/2	15
Vent ction Conne	1	25	1	25	1	25	1	25
Gauge Glass Connection	1/2	15	1/2	15	1/2	15	1/2	15

NOTES: Optional flanged connections available. Consult factory. Inlet/outlet socketweld connections available. Consult factory.

PT-400 Pumping Trap Capacities

Motive Pressure		Total Lift or Back Pressure		PT-404 (12" Fill Head) 1" x 1"				PT-406 (12" Fill Head) 1-1/2" x 1-1/2"				PT-408 (12" Fill Head) 2" x 2"				PT-412 (12" Fill Head) 3" x 2"			
				Steam Motive		Air Motive		Steam Motive		Air Motive		Steam Motive		Air Motive		Steam Motive		Air Motive	
psig	bar	psig	bar	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr
15	1.0	5	0.34	1,900	862	2,250	1,021	3,100	1,406	3,350	1,520	4,500	2,041	4,850	2,200	7,500	3,402	8,100	3,674
25	1.7			2,500	1,134	2,650	1,202	4,600	2,086	4,875	2,211	6,600	2,994	7,000	3,175	11,000	4,990	11,650	5,284
50	3.5			3,100	1,406	3,225	1,463	4,900	2,222	5,100	2,313	7,100	3,220	7,375	3,345	11,700	5,307	12,150	5,511
75	5			3,400	1,542	3,500	1,588	5,200	2,359	5,300	2,404	7,200	3,266	7,400	3,357	12,000	5,443	12,350	5,602
100	7			3,500	1,588	*	*	5,400	2,449	*	*	7,300	3,311	*	*	12,100	5,488	*	*
125	8.5			3,600	1,633	*	*	5,500	2,495	*	*	7,400	3,357	*	*	12,200	5,534	*	*
25	1.7	15	1	2,200	999	2,525	1,145	3,500	1,588	4,025	1,826	5,400	2,449	6,200	2,812	7,200	3,266	8,275	3,753
50	3.5			2,600	1,179	2,800	1,270	4,100	1,860	4,425	2,007	6,300	2,857	6,800	3,084	10,400	4,717	11,250	5,103
75	5			2,800	1,270	2,950	1,338	4,400	1,996	4,750	2,155	6,500	2,948	6,900	3,130	10,800	4,899	11,450	5,194
100	7			3,100	1,406	*	*	4,800	2,177	*	*	6,700	3,039	*	*	11,000	4,990	*	*
125	8.5			3,200	1,451	*	*	4,900	2,222	*	*	6,800	3,084	*	*	11,200	5,080	*	*
35	2.5	25	1.5	2,000	907	2,350	1,066	2,900	1,315	3,425	1,554	4,200	1,905	4,950	2,245	6,900	3,130	8,150	3,697
50	3.5			2,400	1,088	2,675	1,213	4,000	1,814	4,500	2,041	5,800	2,631	6,400	2,903	9,700	4,400	10,850	4,921
75	5			2,600	1,179	2,800	1,270	4,300	1,950	4,550	2,064	6,000	2,721	6,500	2,948	10,000	4,536	10,900	4,944
100	7			2,800	1,270	*	*	4,700	2,132	*	*	6,100	2,767	*	*	10,200	4,626	*	*
125	8.5			2,900	1,315	*	*	4,800	2,711	*	*	6,400	2,903	*	*	10,400	4,717	*	*
50	3.5	40	3	1,900	862	2,350	1,066	3,300	1,451	4,050	1,837	4,350	1,973	5,350	2,427	5,800	2,631	7,125	3,232
60	4			2,200	999	2,600	1,179	3,600	1,633	4,250	1,927	5,100	2,313	6,000	2,722	6,900	3,130	8,150	3,697
75	5			2,400	1,088	2,675	1,213	4,000	1,814	4,475	2,030	5,700	2,585	6,375	2,892	7,600	3,447	8,500	3,856
100	7			2,500	1,135	*	*	4,200	1,905	*	*	6,000	2,721	*	*	8,100	3,674	*	*
125	8.5			2,700	1,225	*	*	4,500	2,041	*	*	6,200	2,612	*	*	8,500	3,856	*	*
70	4.5	60	4	1,800	816	2,400	1,088	3,200	1,451	4,300	1,950	3,800	1,724	5,050	2,291	5,000	2,268	6,650	3,016
75	5			2,000	907	2,450	1,111	3,500	1,588	4,650	2,109	4,100	1,859	5,175	2,347	5,400	2,450	6,900	3,130
100	7			2,300	1,233	*	*	3,700	1,678	*	*	4,500	2,041	*	*	6,000	2,722	*	*
125	8.5			2,400	1,088	*	*	3,800	1,724	*	*	4,800	2,177	*	*	6,400	2,903	*	*

NOTES: Published capacities are based on the use of external check valves supplied by Armstrong. Fill head measured from drain point to top of pump cap. See figures on page 228. Although motive pressures are shown at high pressure differentials (difference between motive inlet pressure and total lift or back pressure), it is preferable to use a motive pressure of 10 - 15 psig (0.65 - 1 bar) above discharge (outlet) pressure. This ensures longevity of economical (bronze) check valves and reduces both venting time and temperature differential (on steam). If a higher differential is used, stainless steel check valves are recommended.
*Consult factory.

PT-400 Series Pumping Trap Materials

Name of Part	Series PT-400*
Body and Cap	Fabricated steel 150 psi ASME Sec. VIII design “U” stamped
Cap Gasket	Graphoil
Bolts	SA-449 steel
Nuts	None
Inlet Valve Assembly	Stainless steel
Vent Valve Assembly	Stainless steel
Valve Assembly Washers	Zinc-plated steel
Plug	Steel
Mechanism Assembly	Stainless steel
Springs	Inconel X-750

*Series PT-400 is available in all stainless steel. Consult factory.

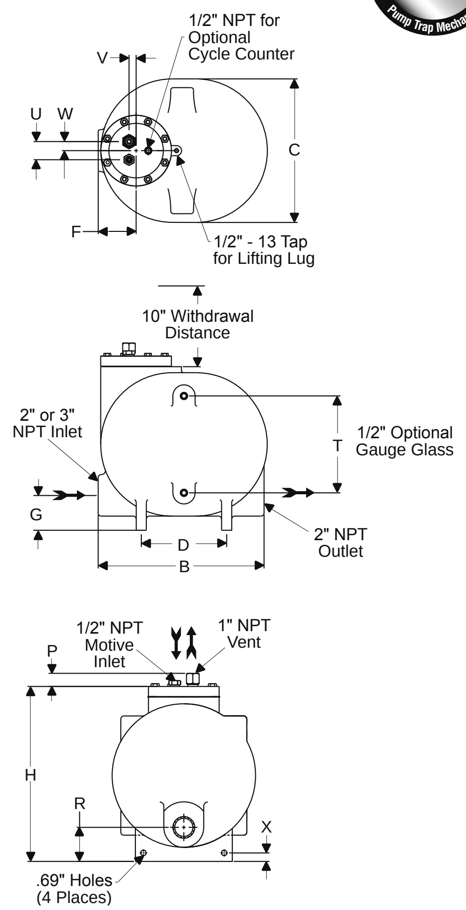
PT-400 Capacity Conversion Factors for Other Fill Heads

Fill Head		in	mm	in	mm	in	mm	in	mm	in	mm
		0	0	6	152	12	305	24	610	36	914
Model	PT-404	0.7		0.85		1.0		1.3		1.4	
	PT-406	0.7		0.85		1.0		1.2		1.35	
	PT-408	0.7		0.85		1.0		1.2		1.35	
	PT-412	0.7		0.85		1.0		1.08		1.2	

NOTES: Fill head is measured from drain point to top of cap. See figures on page 228.

PT-3500 Series Low Profile Pump Trap

3-Year No Fail Warranty
3-Year No Fail
Pump Trap Mechanism



The Armstrong PT-3500 Series Low Profile Pump Trap is the low maintenance, non-electric solution to move condensate or other liquids from low points, low pressures or vacuum spaces to an area of higher elevation or pressure. Condensate can be returned at temperatures well above the 200°F (93°C) limit of conventional electric pumps without the headaches of leaking seals or cavitation problems.

Features

- Economical non-electric operation. Uses inexpensive steam, air or inert gas.
- Low-maintenance operation. No leaking seals, impeller or motor problems means lower maintenance. No NPSH issues.
- Space-saving size. Low-profile body fits in tight spaces while allowing minimal fill head.
- Lower installation costs. Single trade required for installation and maintenance.
- Peace of mind. Standard unit is intrinsically safe.
- Cast iron durability. Rugged construction material means long service life.
- Corrosion resistance. Internals are all stainless steel for corrosion resistance and long life.
- Heavy-duty springs. Springs are made from long-lasting Inconel X-750.
- Efficiency. A closed loop means no motive or flash steam is lost. All valuable Btu's are captured and returned to the system.
- Safety. The pump can be used in flooded pits without fear of electrocution or circuit breaker defaults.
- Externally removable/replaceable seats. Seats can be replaced or cleaned without removing the mechanism assembly.

Options

Use of external check valves required for operation of pumping trap.

- Inlet Swing Check Valve
  NPT Bronze ASTM B 62
  Teflon® Disc
  Class 150 (Minimum)
- Outlet
  Stainless Steel Check Valve
  Class 150 (Minimum)
- In-line Check Valves
  Stainless Steel Non-Slam Check Valves
- Bronze Gauge Glass Assembly
- Steel Gauge Glass Assembly
- Removable Insulation Jacket
- Digital Cycle Counter

For a fully detailed certified drawing, refer to CDF #1041.

PT-3500 Series Pump Trap Physical Data

		PT-3508 and PT-3512	
		in	mm
"B"		20-1/4	514
"C"		17-3/4	451
"D"		10-9/16	268
"F"		4-3/4	120
"G"		4-5/16	110
"H"		21-11/16	550
"P"		1-5/8	41
"R"		4-5/16	110
"T"		12	305
"U"		2-1/4	27
"V"		7/8	22
"W"		1-1/4	32
"X"		1-1/16	27
Weight		**PT-3508**	**PT-3512**
Pump Trap Weight	lb (kg)	244 (111)	243 (110)
Bronze Check Valve	lb (kg)	16 (7)	29 (13)
Stainless Check Valve	lb (kg)	15 (7)	38 (17)

Maximum Operating Pressure: 125 psig (9 bar)
Maximum Allowable Pressure: Cast iron 150 psig @ 450°F (10 bar @ 232°C)

PT-3500 Series Low Profile Pump Trap

PT-3500 Series Low Profile Pump Trap Capacities

Operating Inlet Pressure		Total Lift or Back Pressure		Filling Head 12" (305 mm) Liquid Specific Gravity 0.09 - 1.0							
				PT-3508 2" x 2"				PT-3512 3" x 2"			
				Steam		Air		Steam		Air	
psig	bar	psig	bar	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr
15	1.0			6,100	2,767	8,100	3,674	8,300	3,765	10,300	4,627
25	1.7			8,700	3,946	9,300	4,818	12,100	5,489	12,950	5,874
50	3.5	5	0.34	8,900	4,037	9,675	4,389	13,400	6,078	14,000	6,350
75	5			9,200	4,173	9,800	4,452	13,700	6,214	14,300	6,486
100	7			9,400	4,264	*	*	14,000	6,350	*	*
125	8.5			9,900	4,491	*	*	14,400	6,532	*	*
25	1.7			6,300	2,858	8,200	3,719	8,100	3,674	9,800	4,445
50	3.5			8,200	3,719	10,400	4,717	11,600	5,262	12,600	5,715
75	5	15	1	9,200	4,173	11,100	5,035	12,500	5,670	13,300	6,033
100	7			9,600	4,354	*	*	12,600	5,715	*	*
125	8.5			9,800	4,445	*	*	13,400	6,078	*	*
35	2.5			6,100	2,767	7,900	3,583	7,600	3,447	9,900	4,491
50	3.5			7,100	3,221	9,600	4,355	10,000	4,536	10,650	4,831
75	5	25	15	8,600	3,901	10,800	4,899	11,200	5,080	12,200	5,534
100	7			8,700	3,946	*	*	11,450	5,194	*	*
125	8.5			9,100	4,128	*	*	11,600	5,262	*	*
50	3.5			5,000	2,268	6,500	2,948	6,200	2,812	8,500	3,856
60	4			5,900	2,676	7,400	3,357	7,700	3,493	9,400	4,264
75	5	40	3	6,650	3,016	8,300	3,765	8,700	3,946	10,600	4,800
100	7			7,200	3,266	*	*	9,100	4,128	*	*
125	8.5			7,800	3,538	*	*	9,400	4,264	*	*
75	5			4,500	2,042	6,300	2,858	5,900	2,676	8,700	3,946
100	7	60	4	5,500	2,495	*	*	6,500	2,948	*	*
125	8.5			5,700	2,586	*	*	6,900	3,130	*	*

NOTES: Published capacities based on use of external check valves supplied by Armstrong. Although motive pressures are shown at high pressure differential (difference between motive inlet pressure and total lift or back pressure), it is preferable to use a motive pressure of 10 - 15 psig (0.65 - 1.0 bar) above discharge (outlet) pressure. This ensures longevity of economical (brass) check valves and reduces both venting time and temperature differential (on steam). Shading indicates sizing example shown on page 214.
*Consult factory.

PT-3500 Capacity Conversion Factors for Other Fill Heads

Fill Head		in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
		0	0	6	152	12	305	18	457	24	610	36	914
Model	PT-3508	0.7		0.85		1.0		1.1		1.2		1.35	
	PT-3512	0.7		0.85		1.0		1.04		1.08		1.2	

NOTE: Fill head measured from drain point to top of cap. See figures on page 228.

PT-3500 Series Low Profile Pump Trap Materials

Name of Part	Material
Body	Cast iron - ASTM A48 class 30
Cap	Carbon steel SA-516-70
Cap Gasket	Graphoil
Inlet Valve Assembly	Stainless steel
Vent Valve Assembly	Stainless steel
Valve Assembly Washers	Zinc-plated steel
Plug	Steel
Mechanism Assembly and Float	Stainless steel
Springs	Inconel X-750

PT-3500 Series Low Profile Pump Trap Connection Sizes

Model Number	PT-3508		PT-3512	
	in	mm	in	mm
Inlet Connection	2	50	3	75
Outlet Connection	2	50	2	50
Motive Pressure Connection	1/2	15	1/2	15
Vent Connection	1	25	1	25
Gauge Glass Connection	1/2	15	1/2	15

PT-300 Series Horizontal Steel, Low Profile Pump Trap

3-Year No Fail Warranty
3-Year No Fail
Pump Trap Mechanism

The Armstrong PT-300 Series Horizontal, Low Profile Pump Trap is the low maintenance non-electric solution to move condensate or other liquids from low points, low pressures or vacuum spaces to an area of higher elevation or pressure. Condensate can be returned at temperatures well above the 200°F (93°C) limit of conventional electric condensate pumps without the headaches of leaking seals or cavitation problems.

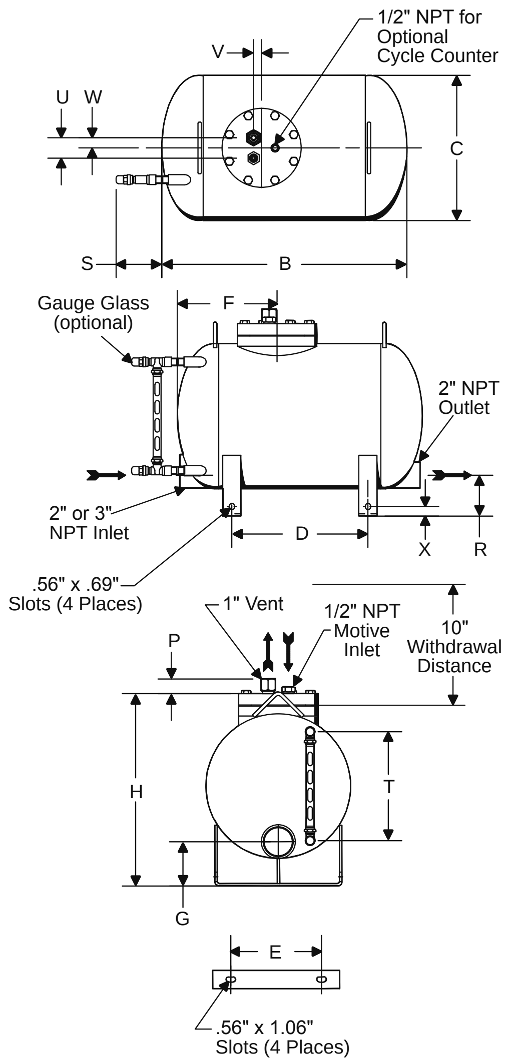
Features

- Economical non-electric operation. Uses inexpensive steam, air or inert gas.
- Low-maintenance operation. No leaking seals, impeller or motor problems means lower maintenance. No NPSH issues.
- Space-saving size. Low-profile body fits in tight spaces while allowing minimal fill head.
- Lower installation costs. Single trade required for installation and maintenance.
- Peace of mind. Standard unit is intrinsically safe.
- Durable construction. ASME code-stamped carbon steel body vessel.
- Corrosion resistance. Internals are all stainless steel for corrosion resistance and long life.
- Heavy-duty springs. Springs are made from long-lasting Inconel X-750.
- Efficiency. A closed loop means no motive or flash steam is lost. All valuable Btu's are captured and returned to the system.
- Safety. The pump can be used in flooded pits without fear of electrocution or circuit breaker defaults.
- Externally removable/replaceable seats. Seats can be replaced or cleaned without removing the mechanism assembly.

PT-300 Pumping Trap Physical Data

Model Number	PT-308 PT-312	
	in	mm
"B"	27	686
"C"	16	406
"D"	15	381
"E"	10	254
"F"	11	279
"G"	5-7/16	138
"H"	21-3/16	538
"P"	1-5/8	41
"R"	4-13/16	122
"S"	5-1/32	128
"T"	12	305
"U"	2-1/4	57
"V"	7/8	22
"W"	1-1/4	32
"X"	1-1/16	27
Face to Face	27-1/2*	698
Weight lb (kg)	154 (70)	
Number of Body/Cap Bolts	8	
Check Valve Conn. in (mm)	**2 (50)**	**3 (75)**
Bronze Check Valves lb (kg)	16 (7)	29 (13)
Stainless Steel Check Valves lb (kg)	15 (7)	38 (17)

Maximum Allowable Pressure (Vessel Design): 150 psig @ 650°F (10 bar @ 343°C)
Maximum Operating Pressure: 125 psig (9 bar)
*Tolerance +/- 1/2"



For a fully detailed certified drawing, refer to CDF #1001.

PT-300 Series Horizontal Steel, Low Profile Pump Trap

PT-300 Pumping Trap Materials

Name of Part	Series PT-300*
Body and Cap	Fabricated steel 150 psi ASME Sec. VIII design "U" stamped
Cap Gasket	Graphoil
Bolts	SA-449 steel
Nuts	None
Inlet Valve Assembly	Stainless steel
Vent Valve Assembly	Stainless steel
Valve Assembly Washers	Zinc plated steel
Plug	Steel
Mechanism Assembly	Stainless steel
Springs	Inconel X-750

NOTES: Optional flanged or socketweld connections available. Consult factory.
*Series PT-300 is available in all stainless steel. Consult factory.

PT-300 Pumping Trap Connection Sizes

Model	Horizontal Steel			
	PT-308		PT-312	
	in	mm	in	mm
Inlet Connection	2	50	3	80
Outlet Connection	2	50	2	50
Motive Pressure Connection	1/2	15	1/2	15
Vent Connection	1	25	1	25
Optional Gauge ass Gl Cotione	1/2	15	1/2	15

PT-300 Pumping Trap Capacities

Motive Pressure		Total Lift or Back Pressure		PT-308 (12" Fill Head) 2" x 2"				PT-312 (12" Fill Head) 3" x 2"			
				Steam Motive		Air Motive		Steam Motive		Air Motive	
psig	bar	psig	bar	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr
15	1.0	5 0.	34	6,900	3,130	9,200	4,173	9,000	4,082	12,300	5,579
25	1.7			10,200	4,622	10,900	4,944	13,200	5,987	14,200	6,441
50	3.5			10,600	4,808	11,100	5,035	15,100	6,849	15,800	7,167
75	5			10,800	4,898	11,300	5,126	15,300	6,940	16,100	7,303
100	7			11,200	5,080	*	*	15,500	7,031	*	*
125	8.5			11,600	5,261	*	*	16,600	7,530	*	*
25	1.7	15	1	7,000	3,175	10,100	4,581	9,000	4,082	11,200	5,080
50	3.5			9,600	4,354	10,900	4,944	12,800	5,806	13,800	6,260
75	5			10,750	4,876	11,100	5,035	14,200	6,441	15,000	6,804
100	7			10,900	4,944	*	*	14,300	6,486	*	*
125	8.5			11,300	5,125	*	*	15,100	6,849	*	*
35	2.5	25	1.5	7,100	3,221	9,200	4,173	8,100	3,674	11,500	5,216
50	3.5			8,300	3,765	10,200	4,627	10,200	4,627	12,750	5,783
75	5			10,100	4,581	11,000	4,989	12,500	5,670	13,500	6,123
100	7			10,200	4,627	*	*	12,700	5,761	*	*
125	8.5			10,300	4,672	*	*	13,000	5,897	*	*
50	3.5	40	3	5,700	2,585	7,600	3,447	6,600	2,994	9,800	4,445
60	4			6,600	2,994	8,800	3,992	8,400	3,810	10,500	4,763
75	5			7,600	3,447	10,100	4,581	9,800	4,445	12,700	5,761
100	7			8,400	3,810	*	*	10,100	4,581	*	*
125	8.5			9,400	4,264	*	*	10,300	4,672	*	*
70	4.5	60	4	4,500	2,041	7,000	3,175	6,000	2,722	10,200	4,627
75	5			4,700	2,132	7,100	3,221	6,400	2,903	10,400	4,717
100	7			6,400	2,903	*	*	7,100	3,221	*	*
125	8.5			6,600	2,994	*	*	7,400	3,357	*	*

NOTES: Published capacities are based on the use of external check valves supplied by Armstrong. Fill head measured from drain point to top of pump cap. See figures on page 228. Although motive pressures are shown at high pressure differentials (difference between motive inlet pressure and total lift or back pressure), it is preferable to use a motive pressure of 10 - 15 psig (0.65 - 1 bar) above discharge (outlet) pressure. This ensures longevity of economical (brass) check valves and reduces both venting time and temperature differential (on steam). If a higher differential is used, stainless steel check valves are recommended.
*Consult factory.

PT-300 Capacity Conversion Factors for Other Fill Heads

Fill Head		in	mm	in	mm	in	mm	in	mm	in	mm
		0	0	6	152	12	305	24	610	36	914
Model	PT-308	0.7		0.85		1.0		1.2		1.3	
	PT-312	0.7		0.85		1.0		1.08		1.2	

NOTES: Fill head is measured from drain point to top of cap. See figures on page 228.

Options

Use of external check valves required for operation of pumping trap.

- Inlet Swing Check Valve
  - NPT Bronze ASTM B 62
  - Teflon® Disc
  - Class 150 (Minimum)
- Outlet
  - Stainless Steel Check Valve
  - Class 150 (Minimum)
- In-line Check Valves
  - Stainless Steel Non-Slam Check Valves
- Bronze Gauge Glass Assembly
- Steel Gauge Glass Assembly
- Removable Insulation Jacket
- Digital Cycle Counter

Sizing and Selection—PT-100/200/300/3500/400/DD-4/DD-6 Series

The Armstrong non-electric pump trap is sized based on actual condensate load (lb/hr or kg/hr) being pumped. The following steps are used to size the pump.

1. Determine the total condensate load to be pumped in lb/hr or kg/hr. See table on page 211 for conversion factors.
2. Determine the total back pressure the pump will operate against. Total back pressure is the sum of the following:
    - Vertical lift expressed in psig. See conversion formula below to convert lift to psig
    - Existing pressure in condensate return line or D.A. tank
    - Frictional loss from pipe, valves and fittings
3. Determine type of motive gas to be used (steam, air or other inert gas) and pressure available.

Example:

- Condensate load = 7,100 lb/hr (3,221 kg/hr).
- Total back pressure = 25 psig (1.5 bar)
(25 foot vertical lift = 10.8 psig, 14 psig in condensate return line).
- Motive pressure is steam at 50 psig (3.5 bar).

Solution: Model PT-3508
Find 25 psig total lift or back pressure in column two of Low Profile Pump Trap Capacities table on page 211. Then find 50 psig motive pressure in column one. Move across the capacity table until you reach a model number with the correct capacity. A PT-3508 has been highlighted on page 211 for this example.

Either a closed reservoir pipe or a vented receiver is required for proper condensate storage during the pump-down cycle of the pumping trap.

For vented/open system receiver sizing:
- Determine the pressure from where the condensate is being discharged.
- Determine condensate load.

Reference Percentage of Flash Steam chart on page 215 to find the pressure that corresponds with the discharge condensate pressure. For this example, use 15 psig.

Follow 15 psig on the horizontal axis where it intersects the curve. Move left from the intersecting lines to the vertical axis for the percentage of flash steam that is created. For this example it will be 3% (see shaded area on Percentage of Flash Steam chart).

Multiply 3% by the condensate load. Using example above 7,100 lb/hr. 7,100 x .03 = 213 lb/hr flash steam.

Using the Vented Receiver Sizing table on page 215, find the amount of flash steam in column one. Follow the table across to determine the size of the vented receiver. (See shaded area on Inlet Reservoir Pipe Sizing table—page 215 for this example.)

For closed reservoir piping:
1. Determine condensate load (using example above 7,100 lb/hr).

Reference the inlet reservoir pipe sizing for closed systems on page 215. Find 7,100 lb/hr in column one. Move horizontally across to find proper pipe size. (Note length or diameter may be slightly enlarged when capacity falls between given condensate loads in column one.) Selection is shaded.

Metric Conversion Formulas

Convert lb/hr to kg/hr—By dividing by 2.2046 Example: 1,800 lb/hr ÷ 2.2046 = 816 kg/hr

Convert psig to bar—By dividing by 14.5 Example: 15 psi ÷ 14.5 = 1.03 bar

Convert psig to kg/cm²—By dividing by 14.22 Example: 15 psi ÷ 14.22 = 1.05 kg/cm²

Reservoir Sizing—PT-100/200/300/3500/400/DD-4/DD-6 Series

Inlet Reservoir Pipe Sizing for Closed Systems

Condensate Load		Reservoir Pipe Diameter											
		in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
lb/hr	kg/hr	2	50	3	75	4	100	6	150	8	200	10	250
up to		Length of Pipe											
		ft	m	ft	m	ft	m	ft	m	ft	m	ft	m
500	227	4	1.2	2-1/2	0.7	1-1/2	0.4						
1,000	453	4-1/2	1.4	2	0.6	1-1/2	0.4						
1,500	680	7	2.1	3	0.9	2	0.6						
2,000	907	9	2.7	4	1.2	2-1/2	0.7						
2,500	1,134	11	3.4	5	1.5	3	0.9	1-3/4	0.5				
3,000	1,360	13-1/2	4.1	6	1.8	3-1/2	1.1	2	0.6				
4,000	1,814	18	5.5	8-1/2	2.6	5	1.5	2-1/2	0.7				
5,000	2,268			10	3.0	6	1.8	3	0.9	1-1/2	0.4		
6,000	2,722			12	3.7	7	2.1	3-1/2	1.1	2	0.6		
7,000	3,175			14-1/2	4.4	8-1/2	2.6	4	1.2	2	0.6		
8,000	3,629			16-1/2	5.0	9-1/2	2.9	4-1/2	1.4	2-1/2	0.7	1-1/2	0.4
9,000	4,082					11	3.4	5	1.5	3	0.9	2	0.6
10,000	4,536					12	3.7	5-1/2	1.7	3	0.9	2	0.6
11,000	4,990					13	4.0	6	1.8	3-1/2	1.1	2	0.6
12,000	5,443					14	4.3	6-1/2	2.0	4	1.2	2-1/2	0.7

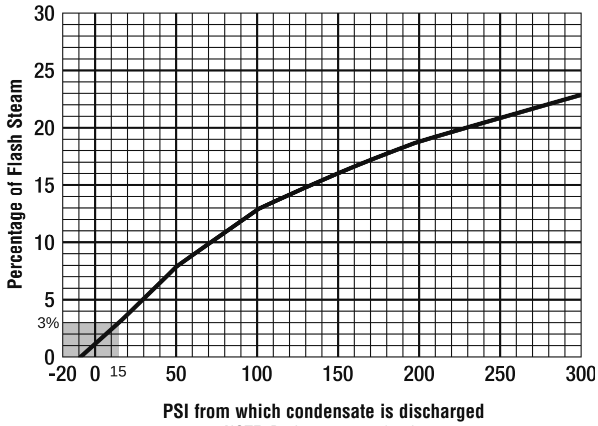
NOTE: When draining condensate from a single piece of equipment in a **closed system**, to achieve maximum energy efficiency a reservoir should be installed horizontally above and ahead of the pump trap. Sufficient reservoir volume is required above the filling head level to hold condensate during the pump trap discharge cycle. The chart above shows the minimum reservoir sizing, based on the condensate load, to prevent equipment flooding during the pump trap discharge cycle.

Vented Receiver Sizing for Open Systems

Flash Steam		Receiver Diameter		Receiver Length		Vent Line Diameter	
lb/hr	kg/hr	in	mm	in	mm	in	mm
up to							
75	34	4	102	36	914	1-1/2	40
150	68	6	152			2	50
300	136	9	229			2-1/2	65
600	272	10	254			3	75
900	408	12	300			4	100
1,200	544	16	405			6	150
2,000	907	20	508			8	200

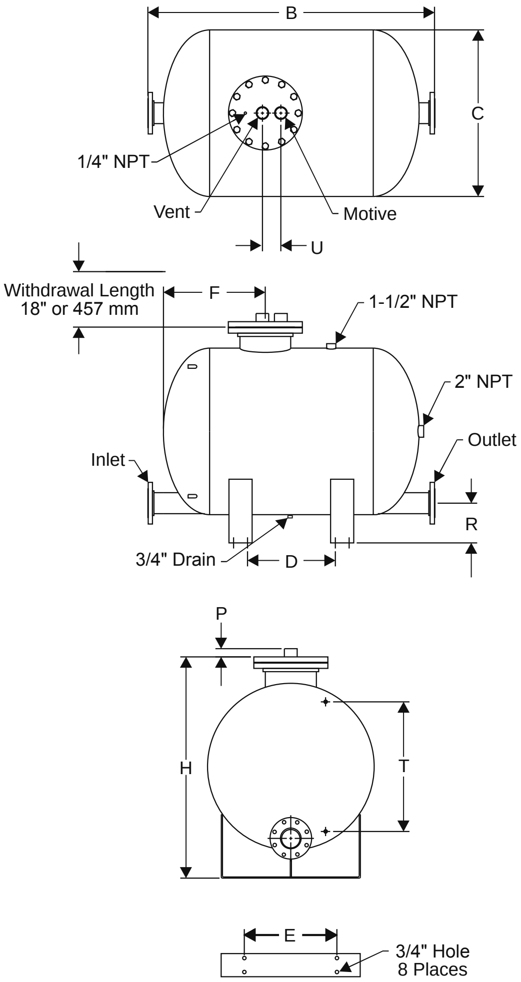
NOTE: When draining from single or multiple pieces of equipment in an **open system,** a vented receiver should be installed horizontally above and ahead of the pump trap. In addition to sufficient holding volume of the condensate above the fill head of the pump trap to hold the condensate during the pump trap cycle, the receiver **must** also be sized to allow enough area for flash steam and condensate separation. An overflow could also be added when required. The minimum recommended water seal is 12" (300 mm). This table shows proper receiver tank sizing based on flash steam present. See the chart at right to calculate the percentage of flash steam at a given pressure drop.

Percentage of Flash Steam Formed When Discharging Condensate to Reduce Pressure



NOTE: Back pressure = 0 psig

PT-516 High Capacity Pump Trap



Effective recovery and return of hot condensate are essential to overall plant efficiency while conserving energy. Large amounts of condensate provide the best opportunities to save energy.

The Armstrong PT-516 High Capacity Pump Trap is the low maintenance, non-electric solution to moving large amounts of condensate and other liquids from low points, low pressures or vacuum spaces to an area of higher elevation or pressure. Condensate can be returned at temperatures well above the 200°F (93°C) limit of conventional electric pumps without the headaches of leaking seals or cavitation.

Features

- Economical non-electric operation. Uses inexpensive steam air or inert gas.
- Low-maintenance operation. No leaking seals, impeller or motor problems means lower maintenance. No NPSH issues.
- Lower installation costs. Single trade required for installation and maintenance.
- Peace of mind. Standard unit is intrinsically safe—explosion-proof.
- Durable construction. ASME code-stamped carbon steel body vessel.
- Corrosion resistance. Internals are all stainless steel for corrosion resistance and long life.
- Heavy-duty springs. Springs are made from long-lasting Inconel X-750.
- Efficiency. A closed loop means no motive or flash steam is lost. All valuable Btu's are captured and returned to the system.
- Safety. The pump can be used in flooded pits without fear of electrocution or circuit breaker defaults.
- Externally removable/replaceable seats. Seats can be replaced or cleaned without removing the mechanism assembly.

For a fully detailed certified drawing, refer to CDF #1017.

PT-516 High Capacity Pump Trap Physical Data

	in	mm
Inlet Connection	4 150# ANSI Flg.	100 150# ANSI Flg.
Outlet Connection	4 150# ANSI Flg.	100 150# ANSI Flg.
Motive Connection	2 NPT	50 NPT
Vent Connection	2 NPT	50 NPT
Gauge Glass Conn.	1/2 NPT	15 NPT
"B"	62	1,574
"C"	36	914
"D"	19-1/16	484
"E"	20	508
"F"	22	559
"H"	48	1,219
"P"	1-3/4	44
"R"	8-3/4	222
"T"	28	711
"U"	4	100
Weight	807	366
Number of Bolts	12	12

Maximum Operating Pressure on standard unit: 150 psig (10 bar).
For higher pressure, consult factory.
Maximum Allowable Pressure (standard vessel deisgn): 150 psig @ 500°F (10 bar @ 277°C).
300 psi (21 bar) vessel available upon request.

PT-516 Capacity Conversion Factors for Other Fill Heads

Fill Head	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
	0	0	6	152	12	305	16	406	24	610	36	914
PT-516	0.7		0.75		0.8		0.85		1.0		1.08	

PT-516 High Capacity Pump Trap

Typical Applications

- Low pressure heating systems
- Process heat exchanger or coils with modulating steam control
- Remote installations (tracing, tank farms or remote coils)
- Systems under vacuum
- Hazardous (explosion proof) areas
- Caustic environments
- Sumps or submersed areas

PT-516 High-Capacity Pump Trap Materials	
Name of Part	**Description**
Cap, Body, Bolting	Fabricated steel 150 psi ASME Sec. VIII design “U” stamp coded
Cap Gasket	Stainless steel spiral wound
Inlet Valve Assembly	Stainless steel
Vent Valve Assembly	Stainless steel
Mechanism Assembly: Frame, Float and Spring	Stainless steel

NOTES: 300 psi ASME vessel available upon request. PT-516 available in all stainless steel. Consult factory.

Armstrong PT-516 Pump Trap Sizing and Selection

PT-516 Pump Trap Capacities

Motive Pressure		Total Lift or Back Pressure		4" x 4" Connections 24" Fill Head			
				Steam Motive		Air Motive	
psig	bar	psig	bar	lb/hr	kg/hr	lb/hr	kg/hr
15	1.0			28,962	13,137	57,619	26,136
25	1.7			37,162	16,857	61,911	28,083
35	2.5			42,563	19,307	64,738	29,365
50	3.5			48,288	21,903	67,735	30,725
60	4	5 0.	34	51,214	23,231	69,267	31,420
70	4.5			53,688	24,138	70,562	32,007
75	5			54,796	24,855	71,142	32,270
100	7			59,414	26,950	73,559	33,366
125	8.5			62,995	28,575	*	*
150	10.34			65,922	29,902	*	*
25	1.7			36,720	16,656	50,783	23,035
35	2.5			40,611	18,421	54,293	24,627
50	3.5			45,196	20,501	58,013	26,315
60	4			47,740	21,655	59,915	27,177
70	4.5	15	1	50,005	22,682	61,523	27,907
75	5			51,054	23,159	62,243	28,233
100	7			55,675	25,254	65,243	29,594
125	8.5			59,552	27,013	*	*
150	10.34			62,923	28,542	*	*

Motive Pressure		Total Lift or Back Pressure		4" x 4" Connections 24" Fill Head			
				Steam Motive		Air Motive	
psig	bar	psig	bar	lb/hr	kg/hr	lb/hr	kg/hr
35	2.5			29,212	13,251	46,238	20,973
50	3.5			33,413	15,156	50,962	23,116
60	4			35,672	16,181	53,376	24,211
70	4.5	25	1.7	37,646	17,076	55,418	25,138
75	5			38,548	17,485	56,313	25,544
100	7			42,454	19,257	60,141	27,280
125	8.5			45,649	20,706	*	*
150	10.34			*	*	*	*
50	3.5			26,210	11,889	41,244	18,708
60	4			27,353	12,407	44,028	19,971
70	4.5			28,319	12,846	46,382	21,039
75	5	40	3	28,752	13,042	47,435	21,517
100	7			30,555	13,860	51,828	24,022
125	8.5			31,954	14,494	*	*
150	10.34			33,097	15,013	*	*
70	4.5			25,973	11,781	32,026	14,527
75	5			26,373	11,963	33,514	15,202
100	7	60	4	28,042	12,720	40,951	18,575
125	8.5			29,336	13,307	*	*
150	10.34			30,394	13,787	*	*
100	7			23,892	10,837	34,893	15,827
125	8.5	80	5.5	24,231	10,991	*	*
150	10.34			24,570	11,145	*	*

NOTES: Published capacities above are based on actual steam testing using a minimum 200°F condensate. Published capacities are based on the use of external check valves supplied by Armstrong.
*Consult factory.

Options

External check valves required for use of pumping trap.

- Inlet/Outlet Check Valve
  CS/SS Wafer Style or All Stainless Steel Wafer Style
- Bronze Gauge Glass Assembly
- Removable Insulation Jacket
- Digital Cycle Counter

Reservoir Sizing — DD-12/PT-516 Series High Capacity

Either a closed reservoir pipe or a vented receiver is required for proper condensate storage during the pump-down cycle of the pumping trap. Refer to the tables for sizing.

For Closed Reservoir Piping

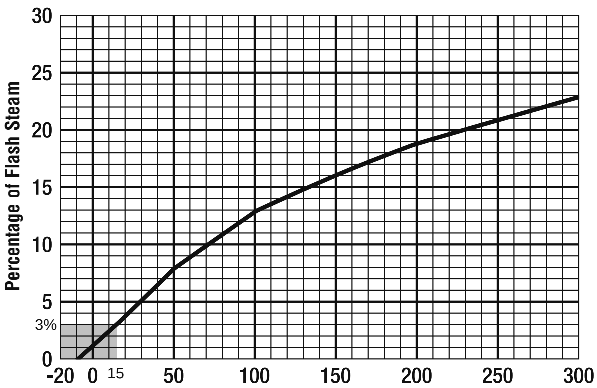
1. Determine condensate load.
   Example 30,000 lb/hr:
   - Reference the Inlet Reservoir Pipe table top right. Find the 30,000 lb/hr condensate load in column one. Move across the columns to find the proper pipe sizing.

For Vented Receiver Sizing

1. Determine the pressure from where the condensate is being discharged.
2. Determine condensate load.
   - Reference the chart below to find the pressure that corresponds with the discharge condensate pressure. For this example, use 15 psig.
   - Follow 15 psig to where it intersects the “0” psig curve. Move to the left from intersecting lines for the percentage of flash that will be created. For this example, it will be 3%.
   - Multiply the 3% by the condensate load. For this example, it is 30,000 lb/hr. Thus, 30,000 x .03 = 900 lb/hr of flash steam.

Using the Vented Receiver table bottom right, find the amount of flash steam in column one. Follow the table across to determine the sizing of the vented receiver.

Percentage of Flash Steam Formed
When Discharging Condensate to Reduce Pressure



PSI from which condensate is discharged
NOTE: Back pressure = 0 psig

PT-516 Inlet Reservoir Pipe Sizing for Closed Systems

Condensate Load lb/hr	Reservoir Pipe Diameter (in)					
	8	10	12	16	20	24
up to	Length of Pipe (feet)					
10,000	6-1/2	6	5	3	2	
20,000	12	11-1/2	10	7	4	
30,000		12	10-1/2	9	6	4
40,000		17	14	12	8	6
50,000			16	13	9	6
60,000				15	11	8
70,000					15	10

NOTE: When BP/MP is less than 50%, the reservoir diameters above can be reduced by 1/2" (15 mm). When draining condensate from a single piece of equipment in a **closed system,** to achieve maximum energy efficiency (see Closed System figure on page 228) a reservoir should be installed horizontally above and ahead of the pump trap. Sufficient reservoir volume is required above the filling head level to hold condensate during the pump trap discharge cycle. The table above shows the minimum reservoir sizing, based on the condensate load, to prevent equipment flooding during the pump trap discharge cycle.

PT-516 Vented Receiver for an Open System

Flash Steam lb/hr	Receiver Diameter (in)	Receiver Length (in)	Vent Line Diameter (in)
up to			
1,000	16	60	6
2,000	20	60	8
3,000	24	60	8
4,000	26	60	10
5,000	28	60	10
6,000	30	72	12
7,000	32	72	12
8,000	36	72	14

NOTE: When draining from single or multiple pieces of equipment in an **open system,** a vented receiver should be installed horizontally above and ahead of the pump trap (see Open System figure on page 228). In addition to sufficient holding volume of the condensate above the fill head of the pump trap to hold the condensate during the pump trap cycle, the receiver must also be sized to allow enough area for flash steam and condensate separation. An overflow could also be added when required. The minimum recommended water seal is 12" (305 mm). The table above shows proper receiver tank sizing based on flash steam present. See chart left to calculate the percentage (%) of flash steam at a given pressure drop.

PT-300LL/PT-400LL Light Liquid Pump Traps

Features
- Economical non-electric operation. Uses inexpensive steam or inert gas.
- Low-maintenance operation. No leaking seals, impeller or motor problems means lower maintenance. No NPSH issues.
- Lower installation costs. Single trade required for installation and maintenance.
- Peace of mind. Standard unit is intrinsically safe.
- Durable construction. ASME code-stamped carbon steel body vessel.
- Corrosion resistance. Internals are all stainless steel for corrosion resistance and long life.
- Heavy-duty springs. Springs are made from long-lasting Inconel X-750.
- Efficiency. A closed loop means no motive or flash steam is lost. All valuable Btu's are captured and returned to the system.
- Safety. The pump can be used in flooded pits without fear of electrocution or circuit breaker defaults.
- Externally removable/replaceable seats. Seats can be replaced or cleaned without removing the mechanism assembly.
- Specific gravity range. Pumps can accommodate specific gravity down to 0.65.

Typical Applications
- Hydrocarbon knockout drum/separator
- Flare header drain
- Applications where the specific gravity of the liquid could be as low as 0.65
- Applications where hydrocarbons may be present

Technical Data
Back Pressure
- Maximum back pressure for the PT-300LL or PT-400LL is 60 psig (4.1 bar)

Motive Pressure
- Maximum motive pressure (Nitrogen or Inert Gas) is 100 psig (6.9 bar)

NOTE: To determine the lb/hr of liquid being pumped, use the following formula:

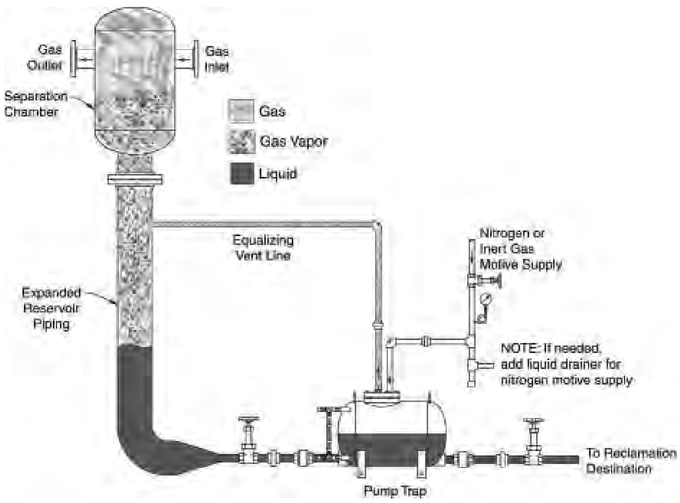
lb/hr of liquid = capacities x specific gravity of liquid

To size the Light Liquid Pumps, use the sizing charts on pages 209 and 213.

Consult Armstrong for engineered pre-piped receiver packages.

PT-300LL Light Liquid Pump Trap

PT-400LL Light Liquid Pump Trap



Hydrocarbon Knockout Drum Separator

Double Duty® 4
Steam Trap/Pump Combination

Description
Armstrong's Double Duty® Series steam trap/pump combination offers a low profile solution to draining heat exchangers in various applications.

The Double Duty® 4 is a low profile pump that offers you the versatility of combining a pump within a steam trap to aide in condensate drainage from a heat exchanger under all operating conditions.

Features
- Economical. non-electric operation
- Low-maintenance operation. No leaking seals, impeller or motor problems. No NPSH issues.
- Space-saving size. Low-profile body fits in tight spaces while allowing minimal fill head.
- Lower installation costs. Single trade installation.
- Peace of mind. Intrinsically safe.
- Ductile iron durability. Rugged construction material means long service life.
- Efficiency. A closed loop means no motive or flash steam is lost. All valuable Btu's are captured and returned to the system.
- Safety. The trap/pump can be used in pits or sumps without fear of electrocution or circuit breaker defaults.

Maximum Operating Conditions
Maximum allowable pressure
DD-4 72 psig @ 320°F (5 bar @ 160°C)

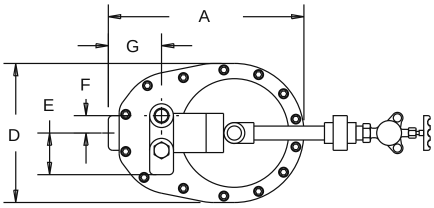
Maximum operating pressure:
DD-4 72 psig @ 320°F (5 bar @ 160°C)

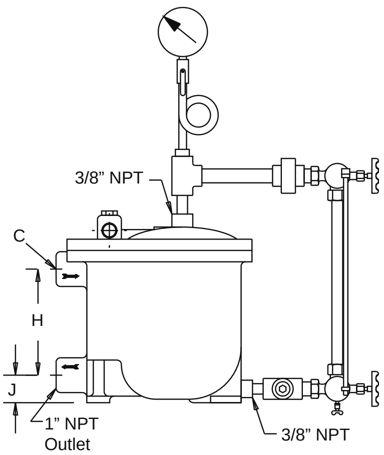
Materials
Body:	Ductile iron
Mechanism:	All stainless steel
Springs:	304 Stainless steel
Float:	All stainless steel

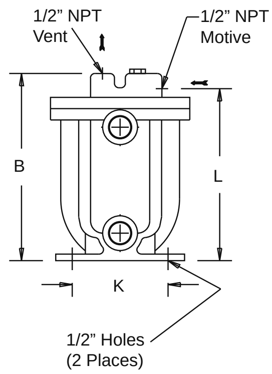
For a fully detailed certified drawing, refer to CD-2030.

Double Duty® 4 Physical Data		
	in	mm
"A"	11-3/16	284
"B"	10-13/16	274
"C"	1	25
"D"	8	203
"E"	2-7/16	61
"F"	1	25
"G"	3	76
"H"	6-1/8	155
"J"	1-5/8	41
"K"	5-1/2	140
"L"	9-15/16	251
Weight lb (kg)	37 (17)	

Double Duty® 4







Double Duty® 4
Steam Trap/Pump Combination

Double Duty® 4 Pump Capacities

Motive		Back Pressure		Capacity	
psi	bar	psi	bar	lb/hr	kg/hr
15	1	5	0.34	220	100
25	1.7			300	136
50	3.5			348	158
70	4.5			350	159
25	1.7	15	1	220	100
50	3.5			345	156
70	4.5			348	158
35	2.5	25	1.7	220	100
50	3.5			325	147
70	4.5			348	158
50	3.5	40	3	220	100
60	4			300	136
70	4.5			335	152
70	4.5	60	4	220	100

NOTE: Published capacities are based on the use of external check valves supplied by Armstrong. Fill head measured from drain point to top of pump case.

Double Duty® 4 Trap Capacities

Differential Pressure		Capacity	
psi	bar	lb/hr	kg/hr
5	0.34	1,342	610
10	0.7	1,980	900
20	1.4	2,860	1300
30	2.1	3,410	1550
40	3	3,795	1725
50	3.4	4,070	1850
60	4.1	4,235	1925
70	4.8	4,400	2000

Capacity Conversion Factors for Other Filling Heads

Filling Head			
in	0	2	6
mm	0	50	152
Double Duty DD-4	.65	1.0	1.10

NOTE: Fill head measured from drain to top of cap.

Double Duty® 6
Steam Trap/Pump Combination

Description
Armstrong's Double Duty® Series steam trap/pump combination offers a low profile solution to draining heat exchangers in various applications.

The Double Duty® 6 is an ASME code stamped carbon steel vessel. The Double Duty® 6 offers you the versatility of combining a pump within a steam trap to aide in condensate drainage under all operating conditions.

Features
- Economical. non-electric operation
- Low-maintenance operation. No leaking seals, impeller or motor problems. No NPSH issues.
- Space-saving size. Low-profile body fits in tight spaces while allowing minimal fill head.
- Lower installation costs. Single trade installation.
- Peace of mind. Intrinsically safe.
- ASME Carbon Steel durability. Rugged construction material means long service life.
- Efficiency. A closed loop means no motive or flash steam is lost. All valuable Btu's are captured and returned to the system.
- Safety. The trap/pump can be used in pits or sumps without fear of electrocution or circuit breaker defaults.

Maximum Operating Conditions
Maximum allowable pressure
DD-6 200 psig @ 400°F (14 bar @ 204°C)

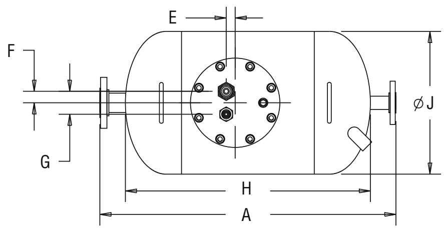
Maximum operating pressure:
DD-6 200 psig @ 400°F (14 bar @ 204°C)

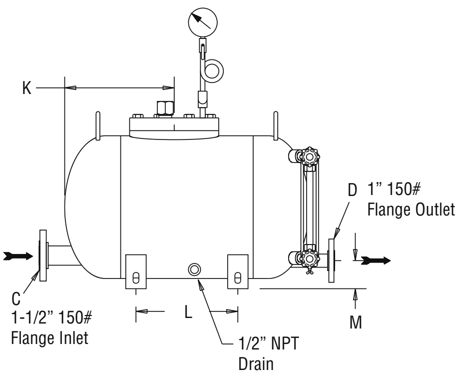
Materials
Body:	ASME Code Stamped Carbon Steel
Springs:	Inconel X-750
Internals:	All stainless steel

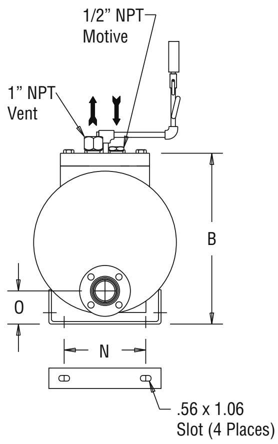
For a fully detailed certified drawing, refer to CD2035.

Double Duty® 6 Physical Data		
	in	mm
"A"	29	737
"B"	16-11/16	424
"C"	1-1/2	38
"D"	1	25
"E"	7/8	22
"F"	1-1/8	28
"G"	2-1/4	57
"H"	24	610
"J"	14	356
"K"	10-13/16	275
"L"	10	254
"M"	2-13/16	71
"N"	8	203
"O"	3-3/16	81
Weight lb (kg)	140 (64)	

Double Duty® 6







Double Duty® 6
Steam Trap/Pump Combination

Double Duty® 6 Pump Capacities

Motive		Back Pressure		Capacity	
psi	bar	psi	bar	lb/hr	kg/hr
15	1	5	0.34	2,400	1,089
25	1.7			3,000	1,361
50	3.5			4,000	1,814
75	5			4,500	2,041
100	7			4,600	2,087
125	8.5			4,700	2,132
150	10.34			4,800	2,177
175	12			4,800	2,177
200	14			4,600	2,087
25	1.7	15	1	2,000	907
50	3.5			2,800	1,270
75	5			3,400	1,542
100	7			3,600	1,633
125	8.5			3,700	1,678
150	10.34			3,800	1,724
175	12			3,600	1,633
200	14			3,500	1,588
35	2.5	25	1.7	1,800	816
50	3.5			2,300	1,043
75	5			2,900	1,315
100	7			3,000	1,361
125	8.5			3,000	1,361
150	10.34			2,900	1,315
175	12			2,500	1,134
200	14			2,300	1,043
50	3.5	40	3	1,400	635
75	5			2,000	907
100	7			2,400	1,089
125	8.5			2,500	1,134
150	10.34			2,500	1,134
175	12			1,800	816
200	14			1,700	771
75	5	60	4	1,500	680
100	7			1,800	816
125	8.5			2,000	907
150	10.34			1,700	771
175	12			1,500	680
200	14			1,400	635

NOTE: Published capacities are based on the use of external check valves supplied by Armstrong. Fill head measured from drain point to top of pump case.

Double Duty® 6 Trap Capacities

Differential Pressure		Capacity	
psi	bar	lb/hr	kg/hr
2	0.14	9,500	4,309
5	0.34	12,400	5,625
10	0.7	15,000	6,804
25	1.7	20,400	9,253
50	3.5	22,500	10,206
75	5.2	22,500	10,206
100	6.9	22,500	10,206
150	10.3	22,500	10,206
200	13.8	22,500	10,206

Capacity Conversion Factors for Other Filling Heads

	Filling Head			
in	0	6	12	* 24 or greater
mm	0	150	305	* 620 or greater
Double Duty DD-6	0.7	1.0	1.08	* Consult factory

NOTE: Fill head measured from drain to top of cap.

Double Duty® 12

Steam Trap/Pump Combination

Description

Armstrong's Double Duty-12 steam trap/pump combination offers a unique solution for draining condensate from heat exchangers and coils in various applications.

The Double Duty-12 is an ASME code stamped carbon steel vessel which offers you the versatility of combining a pump mechanism within a steam trap to assist in condensate drainage under all operating conditions.

Features

- ASME Section VIII "U" stamped vessel
- Inconel X-750 springs for long service life
- All stainless steel internals
- Easy access to the steam trap mechanism without removing cap assembly
- Externally removable vent and motive seats
- Separate pump and trap mechanisms

Maximum Operating Conditions

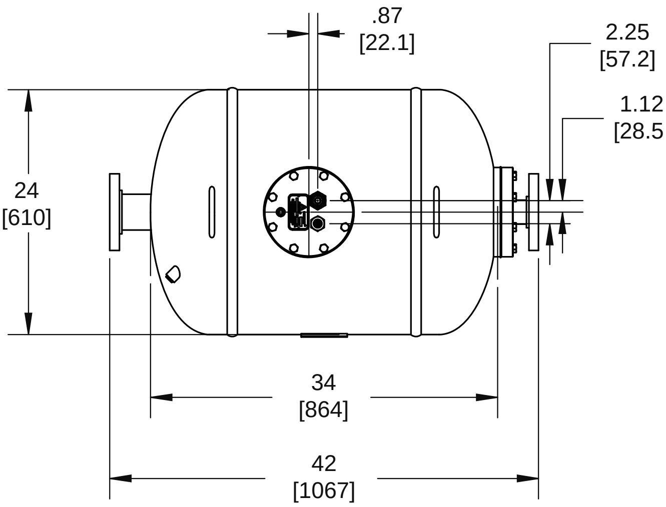
Maximum allowable pressure: 200 psig @ 400°F (14 bar @ 204°C)
Maximum operating pressure: 200 psig @ 400°F (14 bar @ 204°C)

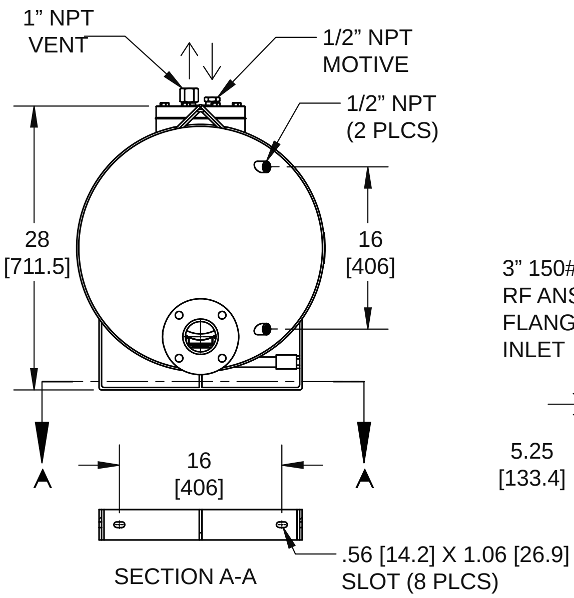
(Consult factory for different pressure/temperature ratings)

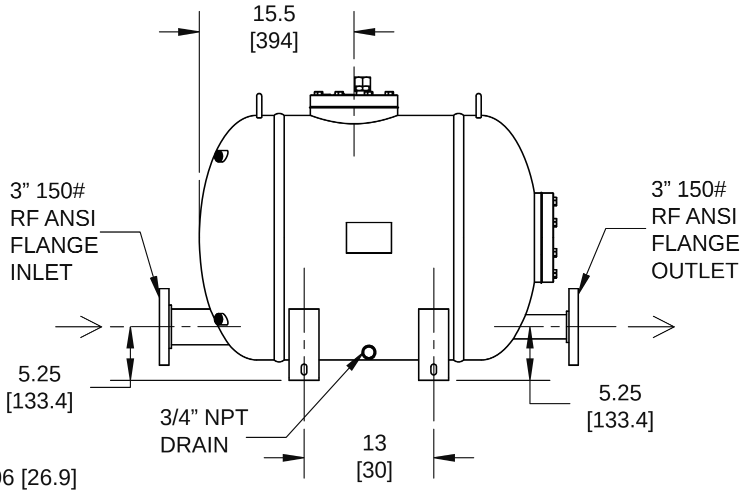
Materials

Body:	ASME code carbon steel
Springs:	Inconel X-750
Internals:	Stainless steel

For a fully detailed certified drawing, refer to CD-2472.







Double Duty® 12

Steam Trap/Pump Combination

Double Duty® 12 Pump Capacities

Motive		Back Pressure		Capacity	
psi	bar	psi	bar	lb/hr	kg/hr
15	1	5	0.34	9,800	4,445
25	1.7			12,900	5,581
50	3.5			16,500	7,484
75	5			18,200	8,255
100	7			18,900	8,573
125	8.5			19,300	8,754
150	10.34			19,800	8,981
175	12			19,900	9,026
200	14			19,900	9,026
25	1.7	15	1	8,500	3,856
50	3.5			12,900	5,851
75	5			14,800	6,713
100	7			16,000	7,257
125	8.5			16,400	7,439
150	10.34			17,200	7,802
175	12			17,300	7,847
200	14			17,300	7,847
35	2.5	25	1.7	7,200	3,266
50	3.5			10,300	4,672
75	5			12,300	5,579
100	7			13,700	6,214
125	8.5			13,700	6,214
150	10.34			14,700	6,668
175	12			14,800	6,713
200	14			15,000	6,804
50	3.5	40	3	6,700	3,039
75	5			9,500	4,309
100	7			10,600	4,808
125	8.5			10,900	4,944
150	10.34			11,300	5,126
175	12			11,300	5,126
200	14			11,400	5,171
75	5	60	4	6,900	3,130
100	7			8,300	3,765
125	8.5			8,300	3,765
150	10.34			8,400	3,810
175	12			8,400	3,810
200	14			8,600	3,901
100	7	80	5.5	6,400	2,903
125	8.5			6,400	2,903
150	10.34			7,200	3,266
175	12			7,200	3,266
200	14			7,300	3,311

NOTE: Published capacities are based on the use of external check valves supplied by Armstrong.

Capacity Conversion Factors for Other Filling Heads

	Filling Head				
in	**0**	**6**	**12**	**24**	*** 24 or greater**
mm	**0**	**150**	**305**	**610**	*** 620 or greater**
Double Duty DD-12	.7	.85	1	1.08	* Consult Factory

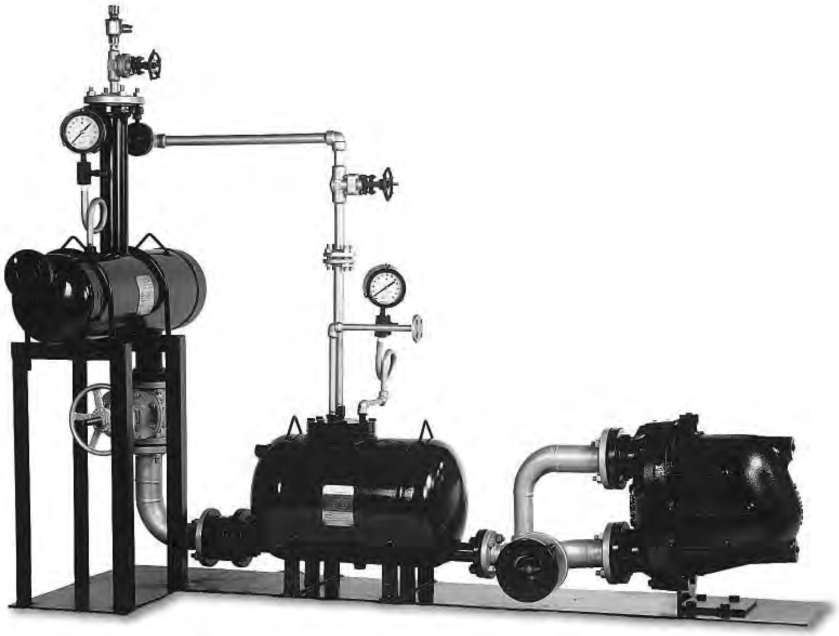
Double Duty® 12 Trap Capacities

Differential Pressure		Capactiy	
psi	bar	lb/hr	kg/hr
2	.14	21,500	9,752
5	.34	28,700	13,018
10	.7	35,900	16,284
25	1.7	52,100	23,632
50	3.5	59,600	27,034
75	5.2	72,000	32,659
100	6.9	81,000	36,741
150	10.3	93,000	42,184

NOTE: Fill head measured from drain to top of cap.
Weight in lb/kg: 348 (158)

Armstrong Packaged Solutions

Custom Fabrications



Armstrong can design and fabricate custom packages to fit your application needs.

ASME Packages

Armstrong can design and fabricate all ASME packages to meet your plant piping requirements.

Standard

Armstrong's standard simplex (shown), duplex, triplex or quadraplex packages are unparalleled in quality and craftsmanship.

Accessories

Pre-Piped PRV Station
PRV/Drip trap stations, pre-piped to single pumps or packages.

Horizontal ASME Reservoirs/Horizontal Flash Tanks
ASME stamped vessels designed for condensate collection or use as horizontal flash tanks. (Horizontal flash tanks with sparge tubes and drop legs are also available - consult factory)

Exhaust Heads
Eliminate water carryover in atmospheric vent pipe.

Digital Cycle Counters
- Open- or closed-loop designs
- Optional external dry contacts
- Intrinsically safe models available (consult factory)

Insulation Blankets
- Pumps
- Receivers (consult factory for models)

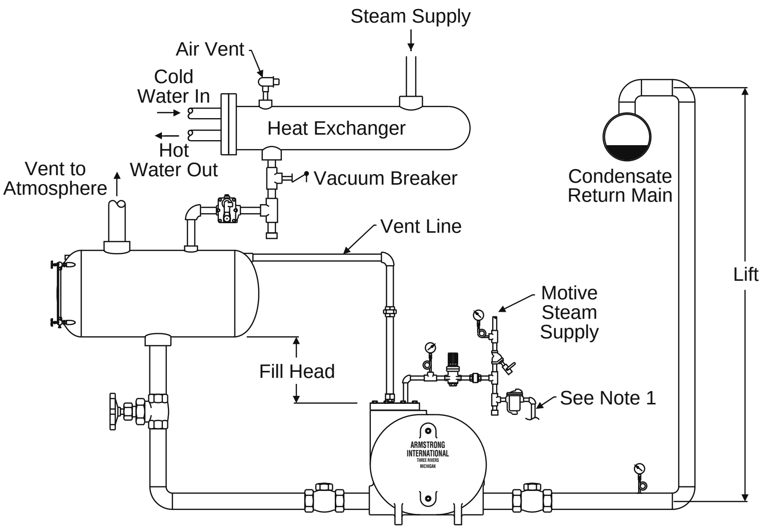
Options
Use of external check valves required for operation of pumping trap.
- Inlet Swing Check Valve
  NPT Bronze ASTM B 62
  Teflon® Disc
  Class 150 (Minimum)
- Outlet
  Stainless Steel Check Valve
  Class 150 (Minimum)
- In-line Check Valves
  Stainless Steel Non-Slam
  Check Valves
- Bronze Gauge Glass Assembly
- Steel Gauge Glass Assembly
- Removable Insulation Jacket
- Digital Cycle Counter

Check Valves
- Stainless steel in-line non-slam check valves
- Bronze/stainless steel (standard)
- Cast steel/stainless steel wafer-style (flanged pumps)
- Stainless steel/stainless steel wafer-style (flanged pumps)
- Bronze (standard)

Level Gauges
- Bronze glass gauge (standard)
- Carbon steel glass gauge
- Reflex gauge (HPI Service)—consult factory

Pump/Package Accessories
Low Boy™ packages enable you to utilize mechanical pump technology in limited height applications.

General Applications

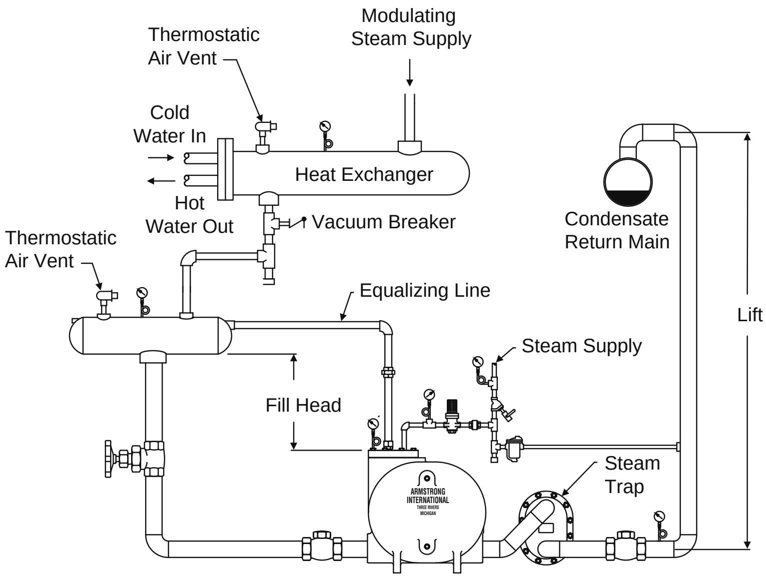


Multiple or single traps discharging to vented receiver.

OPEN SYSTEMS

For the majority of applications, a steam trap is recommended on each piece of heat exchange equipment. The steam trap, or traps, discharge to a vented receiver where flash steam will be vented to the atmosphere. The pump trap is located downstream and below the vented receiver, allowing for proper fill head height. See tables on page 215 and 218 for vented receiver and vent sizing for an open system.

Note 1: Drip trap may be discharged into the receiver, the return line or to the drain.



Draining steam coil or heat exchanger when steam pressure may exceed the return line pressure, a steam trap is required on the discharge side of the pump trap. Request installation and operation manual IB-100.

CLOSED SYSTEMS

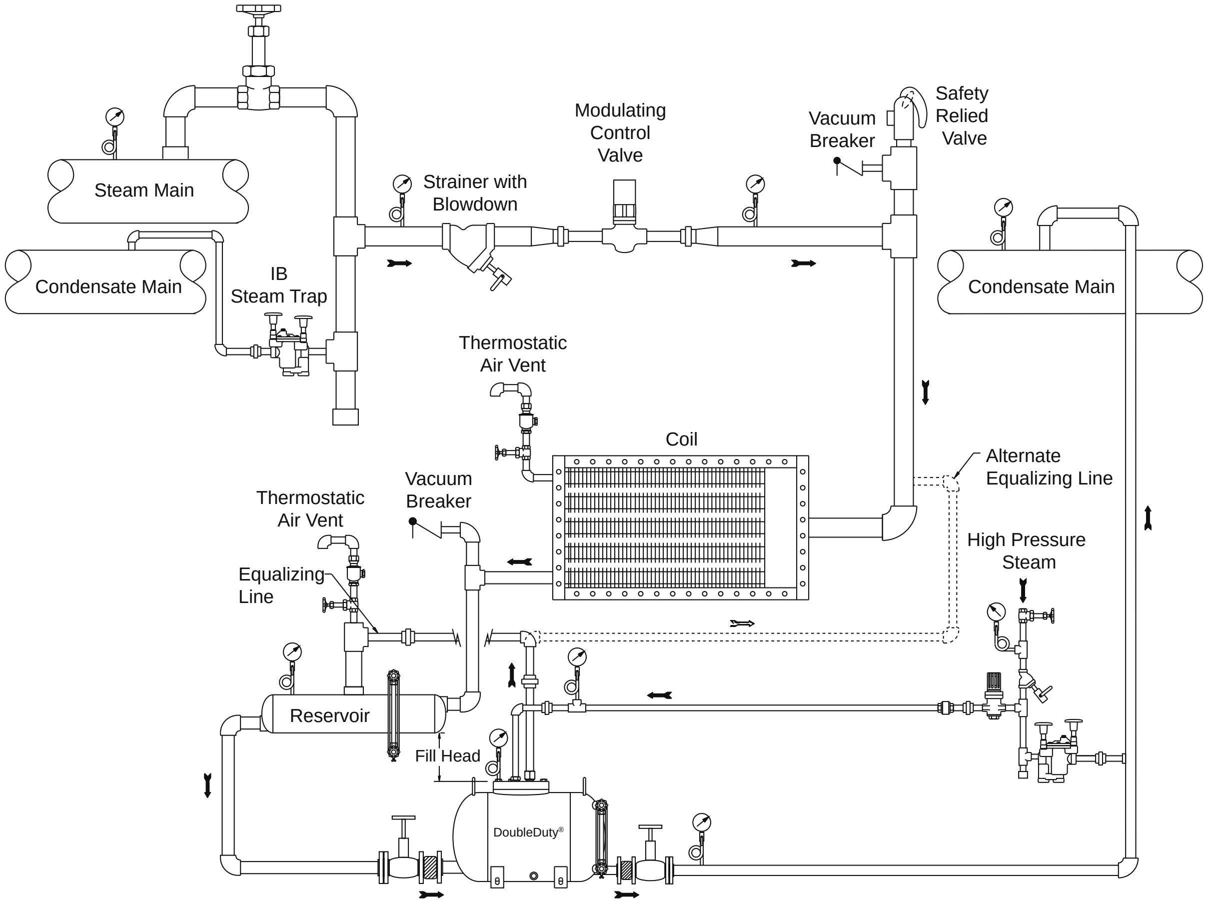
Applications exist where it is desirable to tie the vent line back into the heat exchange space, equalizing the pressure in the heat exchanger, reservoir/piping and the pump trap. This allows water to flow by gravity down to the pump where it can be returned. Valuable Btu's remain within the system due to no flash steam loss to the atmosphere through the vent. Closed system applications can also be used to drain liquid from the equipment under a vacuum. See installation and operation manual IB-100. See tables on pages 215 and 218 for reservoir pipe sizing.

Note 1: If steam motive is used, the drip trap may be discharged into the return line or to the drain.

Note 2: Vent piping from the pump trap can be connected to the inlet side of the equipment being drained if the pressure drop across the equipment is less than .5 psi (0.03 bar) and there is a minimum of 24" (609 mm) of fill head present.

Note 3: A vacuum breaker must be installed if the vent piping from the pump trap is connected to the receiver. If the equipment modulated down to a sub-atmospheric condition, the vacuum breaker will open to equalize the system and provide adequate drainage.

Double Duty® Typical Application

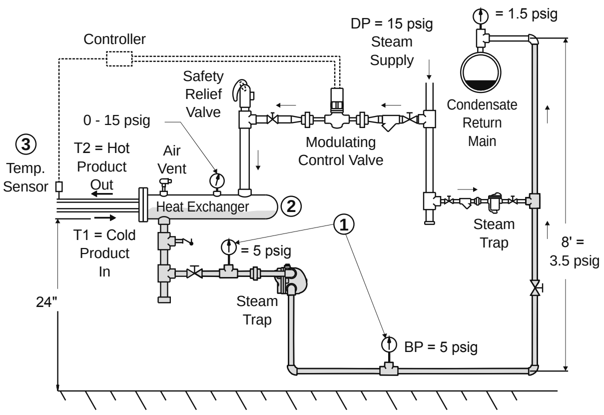


Common Applications for Condensate Armstrong Pump Traps

- Air Heating Coils
- Plate and Frame Heaters
- Jacketed Kettles
- Vacuum Space
- Flash Tanks
- Shell and Tube Heat Exchangers
- Absorption Chillers
- Low Pressure Applications

Any application using modulated control.

Condensate Drainage From Modulated Steam/Temperature Controlled Equipment



Problem: "Stall" Condition on Modulated Steam Control

Modulated steam controls are required to change steam pressure in the heat exchanger to control accurate product output temperature. Due to these varying steam pressure changes, a stall condition exists in all heat exchangers where condensate cannot flow through the steam trap due to insufficient pressure differential. Under the stall condition, partial or complete flooding will occur. Reference figure above noting the stall conditions and problems that can occur.

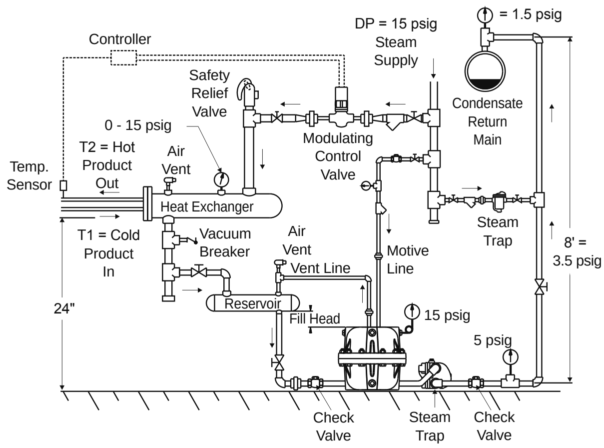
Problems

1. Stall condition—no condensate drainage due to insufficient pressure to move condensate through the steam trap
2. Heat exchange equipment floods causing equipment damage from:
   - Water hammer due to steam and condensate occupying the same space
   - Corrosion due to carbonic acid forming from sub-cooled condensate reabsorbing trapped carbon dioxide and non-condensable gases
3. Inaccurate temperature control

Stall Chart

Use of the stall chart on right will determine the point where flooding will occur.

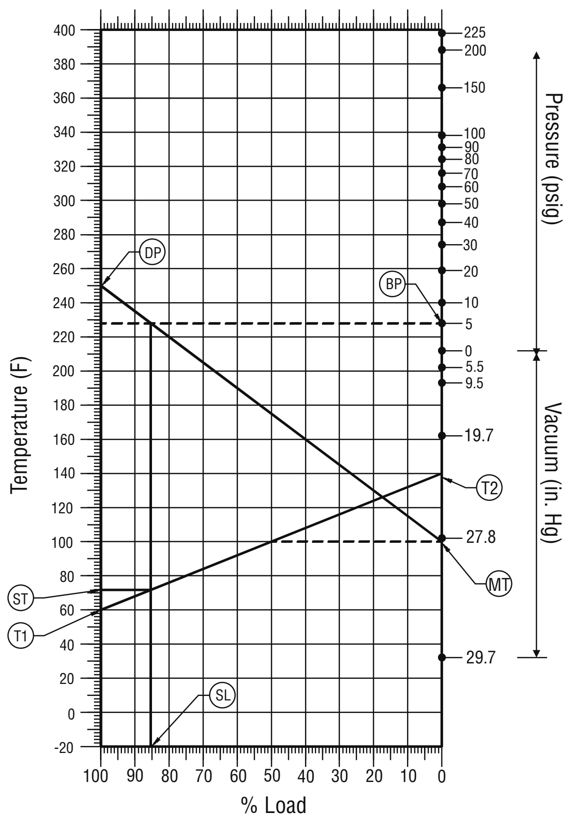
Application information required:	**Example**
DP = design pressure to heat exchanger	15 psig
BP = back pressure	5 psig
T1 = incoming temperature	60°F
T2 = exit temperature	140°F
MT = mean temperature	100°F
Stall Information:	
SL = stall load %	85%
ST = stall load temperature	72°F



Armstrong Solution

The Armstrong pump trap and steam trap combination is the total solution to the stall condition by removing condensate under all system conditions. When the steam system pressure is sufficient to overcome the back pressure, the steam trap operates normally. When the system pressure falls to the stall condition, the pump trap operates and pumps condensate through the steam trap. Temperature control and condensate drainage are assured under all system conditions.

NOTE: The pump trap is sized for the stall conditions.
NOTE: Closed-loop solution shown. See page 228 for vented system arrangement.



ARMSTRONG
FLOW CONTROL

Pressure & Temperature Control

Pressure Reducing Valves

Armstrong pressure reducing valves (PRVs) and temperature regulators help you manage steam, air and liquid systems safely and efficiently. And assure uninterrupted productivity—by maintaining constant pressure or temperature for process control. In short, Armstrong products make using resources safe and productive…as well as environmentally sound.

For decades, Armstrong has devoted itself to learning—and sharing—all it can about energy conservation as it relates to steam equipment. As part of our product/service network, PRVs and temperature regulators represent expanded options for a reliable Armstrong solution.

PRV Types

Steam, liquids and gases usually flow at high pressures to the points of final use. At these points, a pressure reducing valve lowers the pressure for safety and efficiency and to match the requirements of the application. There are three types of pressure reducing valves.

Direct Acting. The simplest of PRVs, the direct acting type operates with either a flat diaphragm or convoluted bellows. Since it is self-contained, it does not need an external sensing line downstream to operate. It is the smallest and most economical of the three types and designed for low to moderate flows. Accuracy of direct acting PRVs is typically +/-10% of the downstream set point.

Internally Piloted Piston-Operated. This type of PRV incorporates two valves—a pilot and main valve—in one unit. The pilot valve has a design similar to the direct acting valve. The discharge from the pilot valve acts on top of a piston, which opens the main valve. This design makes use of inlet pressure in opening a larger main valve than could otherwise be opened directly. As a result, there is a greater capacity per line size and greater accuracy (+/-5%) than with the direct acting valve. As with direct acting valves the pressure is sensed internally, eliminating the need for an external sensing line.

Externally Piloted. In this type, double diaphragms replace the piston operator of the internally piloted design. This increased diaphragm area can open a larger main valve, allowing a greater capacity per line size than the internally piloted valve. In addition, the diaphragms are more sensitive to pressure changes, and that means accuracy of +/-1%. This greater accuracy is due to the location, external of the valve, of the sensing line where there is less turbulence. This valve also offers the flexibility to use different types of pilot valves (i.e., pressure, temperature, air loaded, solenoid or combinations).

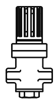
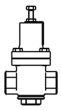
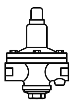
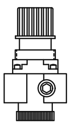
Selector Guide

Pressure Reducing Valve Selection

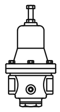
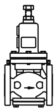
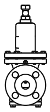
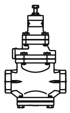
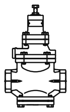
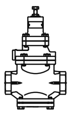
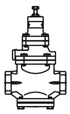
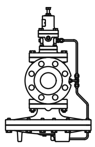
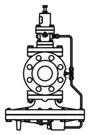
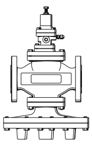
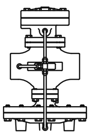
If Fluid Is	If Inlet Pressure Is		If Outlet Pressure Is		If Maximum Capacity Is Less Than		Look for Model	Find on Page
	psig	bar	psig	bar	lb/hr	kg/hr		
Steam	15 to 150	1 to 10	3 to 60	.21 to 4	425	193	GD-6N	276
	5 to 15	.3 to 1	2 to 12	.14 to .8	5,643	2,565	GP-2000L	291
	15 to 250	1 to 17	5 to 200	.34 to 13.8	18,024	8,175	GP-1000	285
	15 to 300	1 to 20	1.5 to 200	.10 to 14	134,534	61,024	GP-2000 Series	290
	15 to 300	1 to 20	3 to 140	.21 to 9.6	1,038	471	GD-30S/GD-45	272/274
	15 to 250	1 to 17	3 to 140	.21 to 9.6	3,471	1,575	GD-30	272
	15 to 425	1 to 30	1.5 to 248	.10 to 17	25,706	11,660	GP-2000CS	292
	15 to 150	1 to 10	5 to 125	.34 to 8.6	4,505	2,048	GP-1000 SS/AS	285
If Fluid Is	**If Inlet Pressure Is**		**If Outlet Pressure Is**		**If Maximum Capacity Is Less Than**		**Look for Model**	**Find on Page**
	psig	**bar**	**psig**	**bar**	**gpm**	**l/min**		
Water and Non-corrosive Liquids	20 to 230	1.4 to 16	7 to 80	.48 to 5.5	141	534	GD-24	279
	15 to 150	1 to 10	3 to 60	.21 to 4.1	18	68	GD-6	276
	15 to 150	1 to 10	7 to 100	.48 to 6.9	1,323	5,007	GD-200	280
	15 to 300	1 to 20	7 to 130	.48 to 9.0	1,323	5,007	GD-200H	280
If Fluid Is	**If Inlet Pressure Is**		**If Outlet Pressure Is**		**If Maximum Capacity Is Less Than**		**Look for Model**	**Find on Page**
	psig	**bar**	**psig**	**bar**	**scfm**	**m3/min**		
Air and Non-Corrosive Gases	15 to 150	1 to 10	5 to 125	.34 to 8.6	413	702	GD-10F	277
	15 to 300	1 to 20	5 to 125	.34 to 8.6	8,329	14,153	GD-10	277
	15 to 150	1 to 10	3 to 60	.21 to 4.1	153	260	GD-6	276
	15 to 150	1 to 10	5 to 125	.34 to 8.6	6,488	11,024	GP-1000A	285
	15 to 150	1 to 10	7 to 100	.48 to 6.9	20,614	35,028	GD-200	280
	15 to 300	1 to 20	7 to 130	.48 to 9.0	20,614	35,028	GD-200H	280
	15 to 300	1 to 20	3 to 140	.21 to 9.6	374	764	GD-45	274
	15 to 250	1 to 17	3 to 150	.21 to 9.6	1,249	2,122	GD-30	272

NOTE: GD models are direct acting; GP models are pilot controlled.

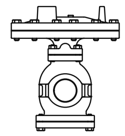
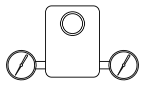
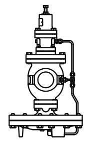
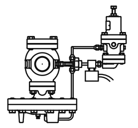
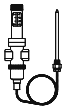
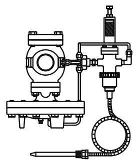
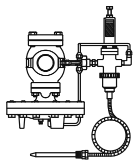
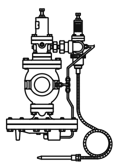
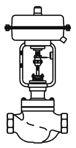
Pressure and Temperature Control ID Charts

Illustration	Type	Fluid	Conn. Type	Max. Allow. Press. psig	TMA °F	Body Material	Model	Max. Oper. Press. psig	Connection Size	Located on Page
	**GD-30** Direct Acting Valves	Steam, Air, Non-Corrosive Gases	NPT	250	410	Cast Bronze ASTM B584	GD-30	250	1/2", 3/4", 1", 1-1/2", 2"	272
				300	430	Stainless Steel AISI 316	GD-30S	300	1/2", 3/4", 1"	
	**GD-45** Direct Acting Valves	Steam, Air, Non-Corrosive Gases	NPT	300	450	Ductile Iron ASTM A536	GD-45	300	1/2", 3/4", 1"	274
	**GD-6** Direct Acting Valves	Steam	NPT	150	450	Cast Iron ASTM A278	GD-6N	150	3/8", 1/2", 3/4", 1"	276
		Liquid, Gas			175		GD-6			
	**GD-10** Direct Acting Valves	Air, Non-Corrosive Gases	NPT	300	175	Zinc and Aluminum	GD-10	300	1/4", 3/8", 1/2", 3/4", 1", 1-1/4", 1-1/2", 2"	277
				250			GD-10F	250	1/4", 3/8", 1/2", 3/4"	
							AF-10		1/4", 3/8", 1/2", 3/4", 1"	

Pressure and Temperature Control ID Charts

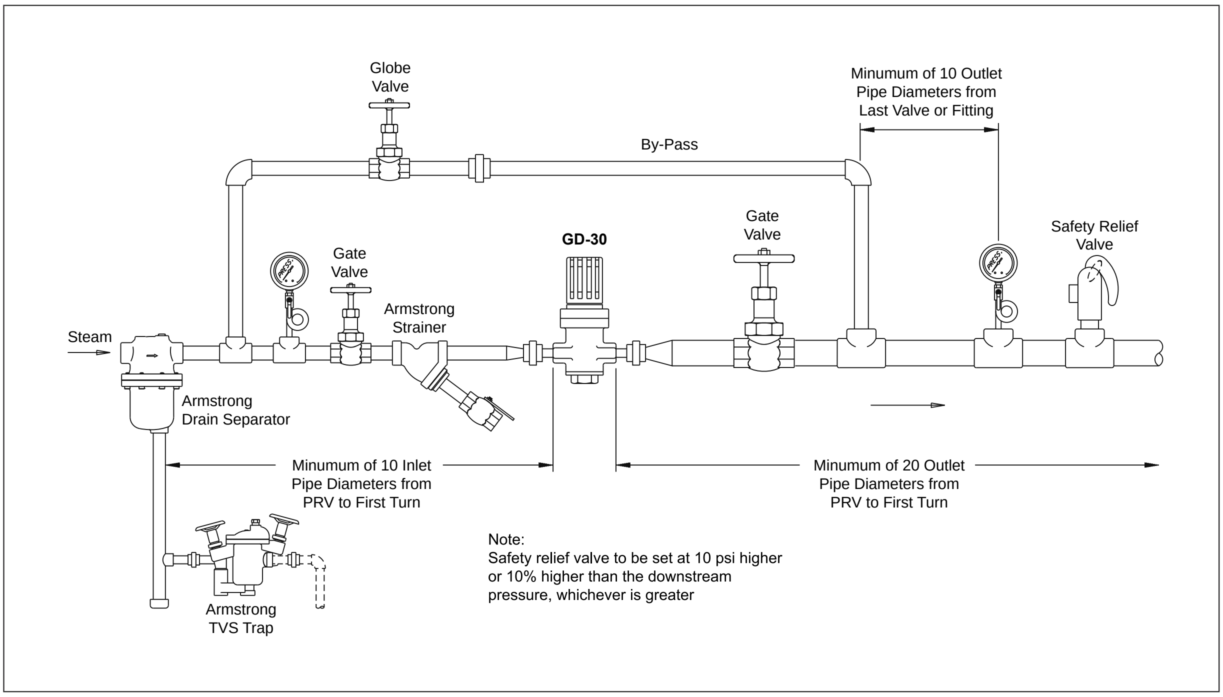
Illustration	Type	Fluid	Conn. Type	Max. Allow. Press. psig	TMA °F	Body Material	Model	Max. Oper. Press. psig	Connection Size	Located on Page
	**GD-24** Direct Acting Valves	Water	NPT	230	175 210 (Viton)	Cast Bronze ASTM B584	GD-24	230	1/2", 3/4", 1", 1-1/4", 1-1/2", 2"	279
	**GD-200** Direct Acting Valves	Air, Water, Non-Corrosive and Non-Viscous Liquids	Flanged ANSI 150#	150	175 210 (Viton)	Ductile Iron ASTM A536	GD-200	150	2", 2-1/2", 3", 4", 5", 6"	280
			Flanged ANSI 300#	300			GD-200H	300		
	**GD-20R** Direct Acting Valves	Water, Non-Corrosive Gases	Flanged ANSI 150#	150	175	Ductile Iron ASTM A536	GD-20R	150	1/2", 3/4", 1", 1-1/4", 1-1/2", 2", 2-1/2", 3", 4", 5", 6"	282
	**GP-1000** Internal Pilot Piston Operated	Steam	NPT	250	450	Ductile Iron ASTM A536	GP-1000	250	1/2", 3/4", 1", 1-1/4", 1-1/2", 2"	285
			Flanged ANSI 150#	150				150	2", 2-1/2", 3", 4"	
	**GP-1000 A** Internal Pilot Piston Operated	Air, Non-Corrosive Gases	NPT	150	175	Ductile Iron ASTM A536	GP-1000A	150	1/2", 3/4", 1", 1-1/4", 1-1/2", 2"	285
			Flanged ANSI 150#						2", 2-1/2", 3", 4"	
	**GP-1000 SS** Internal Pilot Piston Operated	Steam	NPT	150	450	Stainless Steel AISI 304	GP-1000SS	150	1/2", 3/4", 1", 1-1/4", 1-1/2", 2"	285
	**GP-1000 AS** Internal Pilot Piston Operated	Steam	NPT	150	450	Stainless Steel AISI 304	GP-1000AS	150	1/2", 3/4", 1", 1-1/4", 1-1/2", 2"	285
	**GP-2000** External Pilot Diaphragm Operated	Steam	NPT	300	450	Ductile Iron ASTM A536	GP-2000 Integral or Remote Pilot	300	1/2", 3/4", 1", 1-1/4", 1-1/2", 2"	290
			Flanged ANSI 150	185				185	2", 2-1/2", 3", 4", 6"	
			Flanged ANSI 300	300				300		
	**GP-2000 L** External Pilot Diaphragm Operated (low pressure)	Steam	NPT	150	450	Ductile Iron ASTM A536	GP-2000 L	15	1/2", 3/4", 1", 1-1/4", 1-1/2", 2"	291
			Flanged ANSI 150#						2", 2-1/2", 3", 4", 6"	
	**GP-2000CS** External Pilot Diaphragm Operated	Steam	NPT	450	600	Carbon Steel Grade WCB	GP-2000CS	450	1/2", 3/4", 1", 1-1/4", 1-1/2", 2", 2-1/2", 3", 4"	292
			Flanged ANSI 150	140				140		
			Flanged ANSI 300	450				450		
	**GP-2000K-1, GP-2000K-3, GP-2000K-6** External Pilot Diaphragm Operated	Steam	NPT	300	450	Ductile Iron ASTM A536	GP-2000K-1	300	1/2", 3/4", 1", 1-1/4", 1-1/2", 2"	293
			Flanged ANSI 150#	185			GP-2000K-3	185	2", 2-1/2", 3", 4", 6"	
			NPT	300			GP-2000K-6	300		

Pressure and Temperature Control ID Charts

Illustration	Type	Fluid	Conn. Type	Max. Allow. Press. psig	TMA °F	Body Material	Model	Max. Oper. Press. psig	Connection Size	Located on Page
	**GD-2000K** Direct Acting Diaphragm Operated	Steam	NPT	300	450	Ductile Iron ASTM A536	GD-2000K	300	1/2", 3/4", 1", 1-1/4", 1-1/2", 2"	294
			Flanged ANSI 150	185				185	2", 2-1/2", 3", 4"	
			Flanged ANSI 300	300				300		
	**OBK-2000** Pneumatic Temperature Pilot	Air	NPT	250 (Process) 25 (Air)	400	Brass	OBK-2000	250 (Process) 25 (Air)	1/2" Process 1/8" Air	297
	**GP-2000R** External Pilot Diaphragm Operated	Steam	NPT	200	450	Ductile Iron ASTM A536	GP-2000R	200	1/2", 3/4", 1", 1-1/4", 1-1/2", 2"	298
			Flanged ANSI 150	185				185	2", 2-1/2", 3", 4", 6"	
			Flanged ANSI 300	200				200		
	**GP-2000 On/Off** External Pilot Solenoid Operated Valve	Steam	NPT	150	366	Ductile Iron ASTM A536	GP-2000	150	1/2", 3/4", 1", 1-1/4", 1-1/2", 2"	301
			Flanged ANSI 150 Flanged ANSI 300						2", 2-1/2", 3", 4", 6"	
	**OB-30/31** Direct Acting Temperature Regulators	Water, Steam and Non-Corrosive Liquids	NPT	150	366	Bronze ASTM B584	OB-30 (Heating)	150	1/2", 3/4", 1"	304
				250			OB-31 (Cooling)	250		
	**OB-2000** Piloted Diaphragm Operated Temperature Regulator	Steam	NPT	300	450	Pilot Bronze ASTM B584 Valve Ductile Iron A536	OB-2000	300	1/2", 3/4", 1", 1-1/4", 1-1/2", 2"	306
			Flanged ANSI 150	185				185	2", 2-1/2", 3", 4", 6"	
			Flanged ANSI 300	300				300		
	**OB-2000 L** Piloted Diaphragm Operated Temperature Regulator (low pressure)	Steam	NPT	150	450	Pilot Bronze ASTM B584 Valve Ductile Iron A536	OB-2000 L	15	1/2", 3/4", 1", 1-1/4", 1-1/2", 2"	308
			Flanged ANSI 150						2", 2-1/2", 3", 4"	
	**OB-2000PT** Pressure/ Temperature Piloted Diaphragm Operated Temperature Regulator	Steam	NPT	300	450	Temp. Pilot Bronze ASTM B584 Valve and Pressure Pilot Ductile Iron A536	OB-2000PT	300	1/2", 3/4", 1", 1-1/4", 1-1/2", 2"	310
			Flanged ANSI 150	185				185	2", 2-1/2", 3", 4", 6"	
			Flanged ANSI 300	300				300		
	**Control Valve** Pnuematic Actuated Control Valve	Steam, Liquid	NPT	300	450	Carbon Steel A216 Gr. WCB	1100	300	1/2", 3/4", 1", 1-1/2", 2"	314
			Flanged ANSI 150	185				185	1/2", 3/4", 1", 1-1/2", 2", 2-1/2", 3, 4, 6, 8	
			Flanged ANSI 300	300				300		

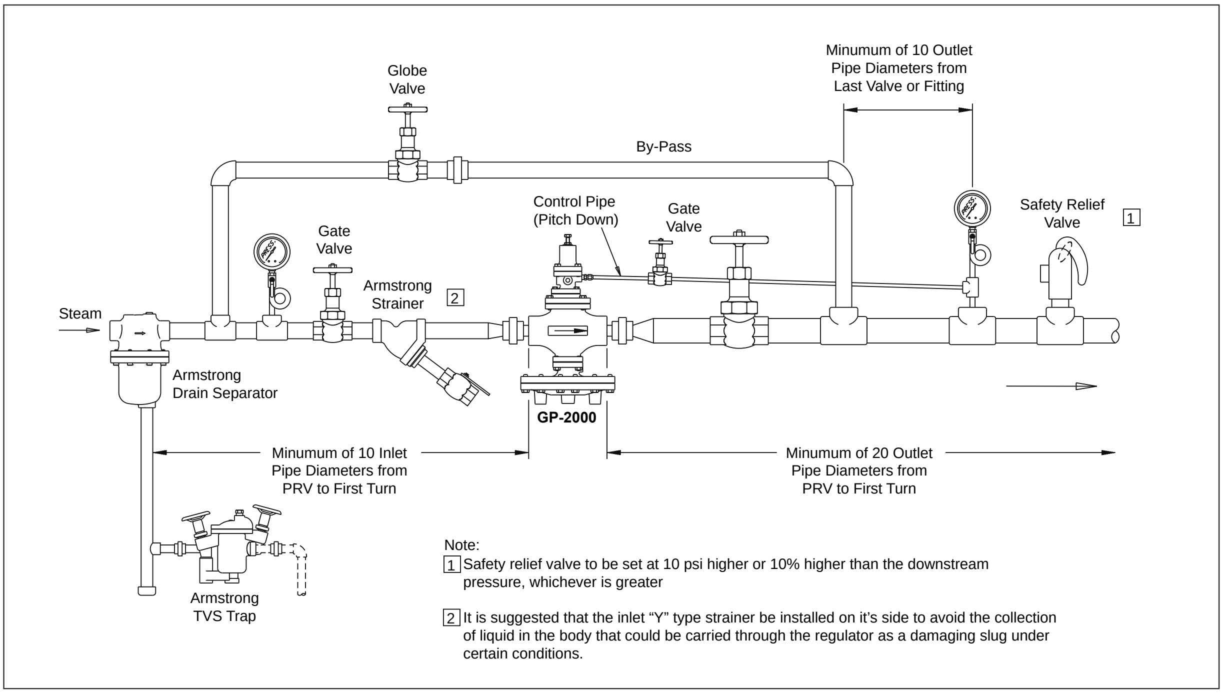
Application Data—Pressure Reducing Valves

Direct Acting Single Stage Reduction



Typical Direct Acting PRV Installation

External Pressure Pilot Single Stage Reduction

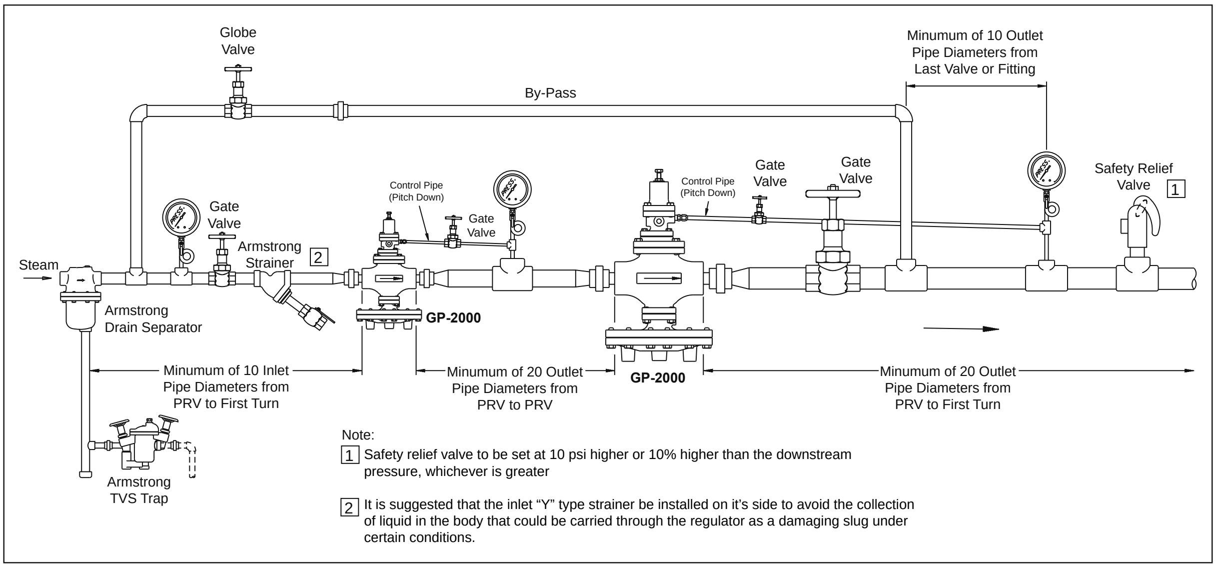


Typical External Pressure Pilot PRV Installation

Application Data—Pressure Reducing Valves

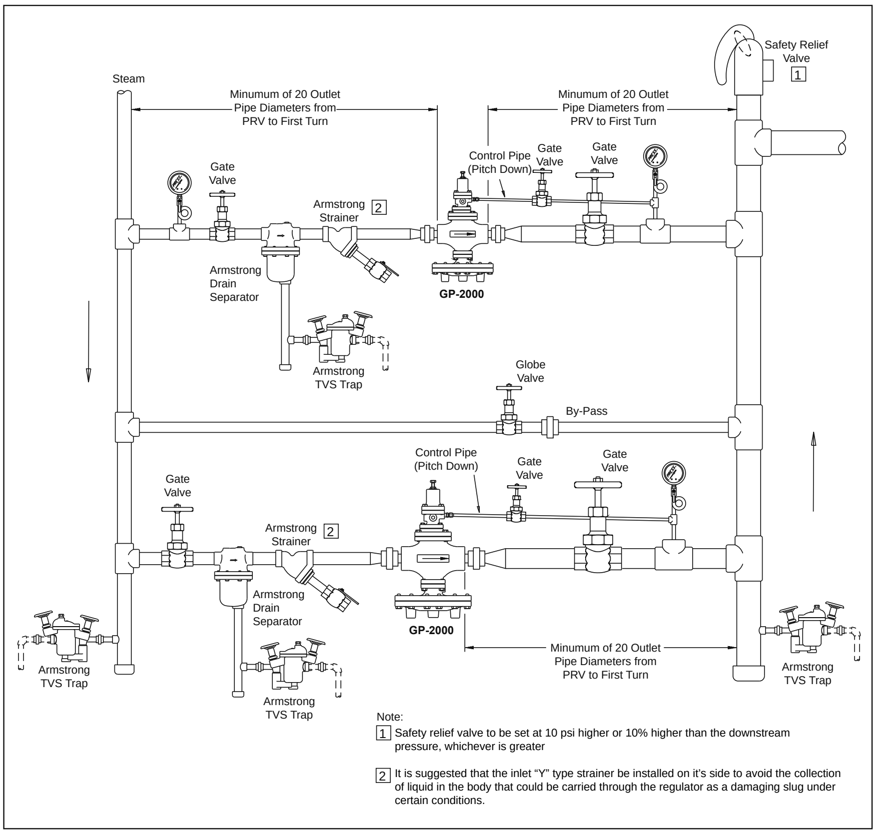
External Pressure Pilot Two Stage Reduction

This piping application is used when the pressure turndown ratio is greater than that of a single valve. Pressure reduction is accomplished by using two valves in series to reduce the pressure in stages. Depending on the volume of fluid required and pressure reduction, the second stage valve typically will be larger in size than the first stage valve. Unless a specific intermediate pressure of the fluid is required, this intermediate pressure is typically selected so as to keep the pressure turndown ratios of both valves as similar as possible. This will help equalize and maximize the service life of both valves.



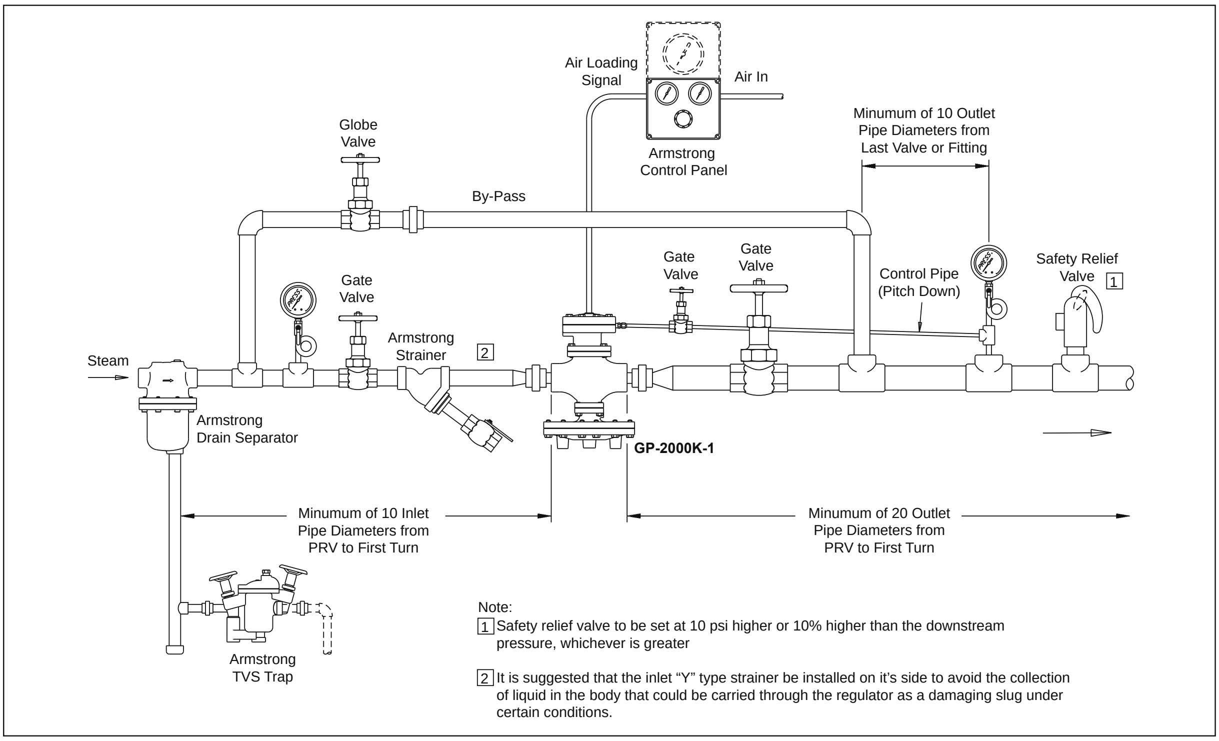
External Pressure Pilot One-Third to Two-Thirds Reduction Station

This piping application is used when the flow rangeability is greater than that of a single valve. Better control is achieved by piping two valves in parallel and sizing one to handle 1/3 the maximum load and the other 2/3 the maximum load. These two valves are staged by offsetting their pressure set points by 2-3 psig. The smaller valve is usually the lead valve and would have a pressure set point at the desired pressure. The larger valve is usually the lag valve and would have a pressure set point of 2-3 psig below the lead valve. This offset of set points will stage the valves so that the lag valve will remain closed until the lead valve can no longer pass the required flow and is wide open. This lack of flow will cause the set pressure to drop slightly until the lag valve opens and regulates at the higher demands of flow.



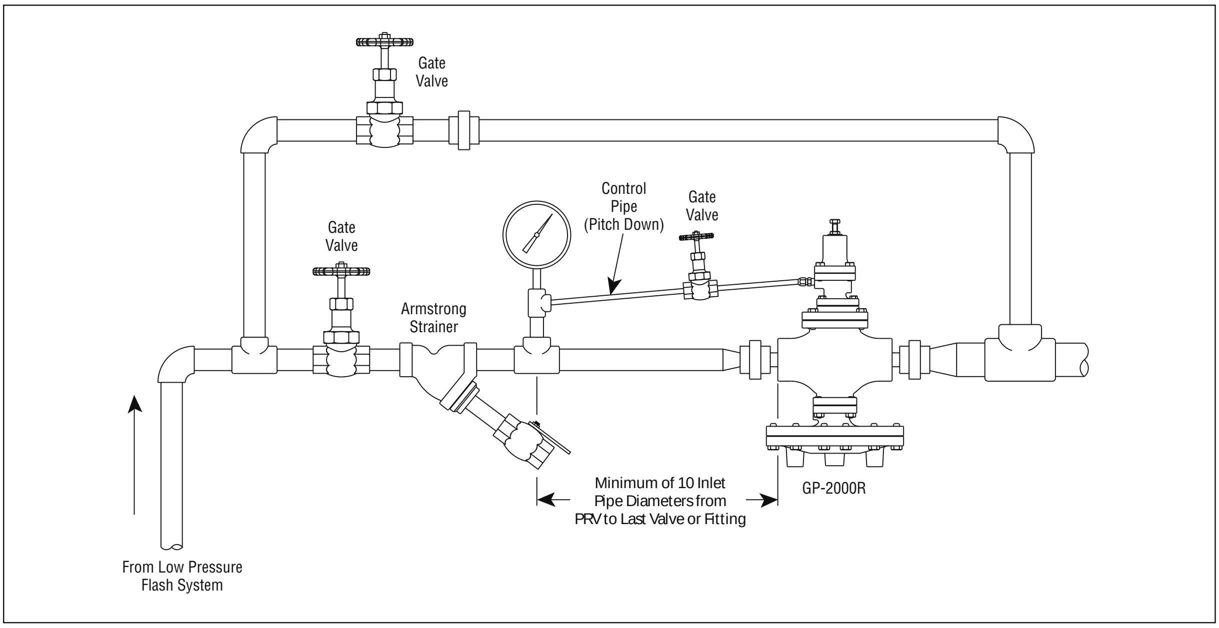
Application Data—Pressure Reducing Valves

Air Loaded External Pilot Single Stage Reduction



Typical Air Loaded External Pilot Reduction Station. Complete with remote located air loading control panel.

External Back Pressure Pilot Installation



Typical External Pilot Back Pressure Installation. Used to maintain a constant upstream pressure in the piping system.

Sizing Data

Selection Formulas

C_V Value and Calculations

1. For Steam:

When $P_2 > \frac{P_1}{2}$ $\quad C_v = \dfrac{W}{2.1\sqrt{\Delta P\,(P_1 + P_2)}}$

*When $P_2 \le \frac{P_1}{2}$ $\quad C_v = \dfrac{W}{1.71\,(P_1)}$

2. For Gas:

When $P_2 > \frac{P_1}{2}$ $\quad C_v = \dfrac{Q\sqrt{G\,(T+460)}}{963\sqrt{\Delta P\,(P_1 + P_2)}}$

When $P_2 \le \frac{P_1}{2}$ $\quad C_v = \dfrac{Q}{36.39\,(P_1)}$

3. For Liquid:

$$C_v = \frac{(GPM)\sqrt{G}}{\sqrt{\Delta P}}$$

Formula Key

W = Maximum flow capacity of steam, lbs/hr
P_1 = Inlet pressure, psia (psig + 14.7)
P_2 = Outlet pressure, psia (psig + 14.7)
ΔP = Pressure drop ($P_1 - P_2$) psi
Q = Maximum flow capacity of gas SCFH
G = Specific gravity
T = Fluid temperature °F
GPM = Maximum flow capacity of liquid GPM
C_v = Valve flow coefficient

* Formula applies only to piloted valves. With direct acting valves, at critical flow or sonic flow, capacities diminish with greater differential pressure.

Ordering Information

C_V Values for Each Product

Model	Connection Size													
	in 1/4 / mm 8	in 3/8 / mm 10	in 1/2 / mm 15	in 3/4 / mm 20	in 1 / mm 25	in 1-1/4 / mm 32	in 1-1/2 / mm 40	in 2 / mm 50	in 2-1/2 / mm 65	in 3 / mm 80	in 4 / mm 100	in 5 / mm 125	in 6 / mm 150
GD-10	1.4	1.4	1.4	2.6	5.8	5.8	5.8	43	—	—	—	—	—
GD-10F	1.4	1.4	1.4	2.6	5.8	—	—	—	—	—	—	—	—
GD-6/6N	—	.35	.5	1.0	1.5	—	—	—	—	—	—	—	—
GD-200/200H	—	—	—	—	—	—	—	16	28	36	68	75	108
GD-20R	—	—	1.5	2.7	4	8	11	14	23	32	48	75	108
GD-24	—	—	1.5	1.9	3	4	7	10	—	—	—	—	—
GD-30/GD-45	—	—	1.3	1.5	2.5	—	5.6*	8.5*	—	—	—	—	—
GP-2000 Series	—	—	5	7.2	10.9	14.3	18.8	32	60	78	120	—	250
GP-1000	—	—	1	2.3	4	6.5	9	16	25	36	64	—	—
OB-30/OB-31	—	—	3.7	4.6	5.8	—	—	—	—	—	—	—	—
OB-2000/OB-2000PT	—	—	5	7.2	10.9	14.3	18.8	32	60	78	120	—	—

NOTE: 50% reduced ports are available for all 2000 Series valves. Capacities and Cv are reduced by 1/2. GD-6/6N and GD-30/45 capacities cannot be determined with a formula—consult capacity tables. Reference note under formula key above.

*GD-30 only.

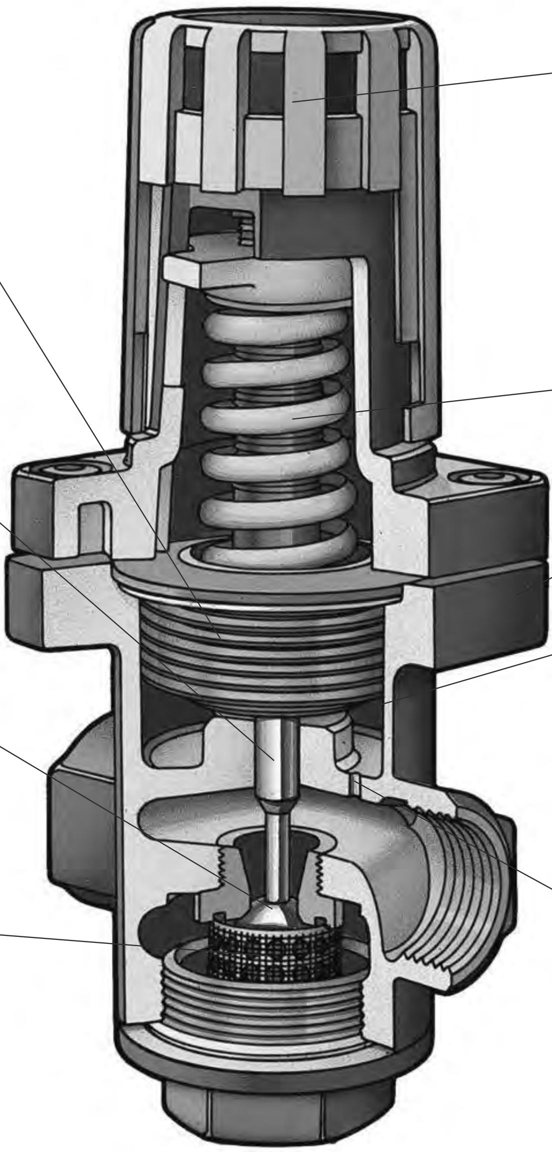
When ordering please specify:

1. Model number
2. Connection size and type
3. Quantity
4. Service fluid
5. Specific gravity (if other than steam, air, water)
6. Fluid temperature
7. Maximum inlet pressure
8. Desired delivered pressure (reduced pressure)
9. Flow rate
10. Special conditions (if any)

Direct Acting

For Steam, Air and Non-Corrosive Gas Service

The simplest of pressure reducing valves, the direct acting type operates with either a flat diaphragm or convoluted bellows. Since it is self-contained, it does not need an external sensing line downstream to operate. It is the smallest and most economical of the three types and is designed for low to moderate flows. Accuracy of direct acting PRVs is typically +/-10%.



GD-30/30S

For Steam, Air and Non-Corrosive Gases

The GD-30 is a compact, high performance direct acting valve. Economical to buy and use, it's ideal for those low to moderate flow applications where accuracy of +/-10% is acceptable. The GD-30 is well suited for laundry and dry cleaning equipment, hospital equipment, tire molds, humidifiers, small heaters and applications in food processing. It provides tight shutoff for dead-end service on steam. Turndown ratio is 10:1 and ANSI Class IV Shutoff.

For a fully detailed certified drawing, refer to:
GD-30 (bronze only) CDY #1038
GD-30S (stainless steel) CDY #1089

GD-30/30S Specifications

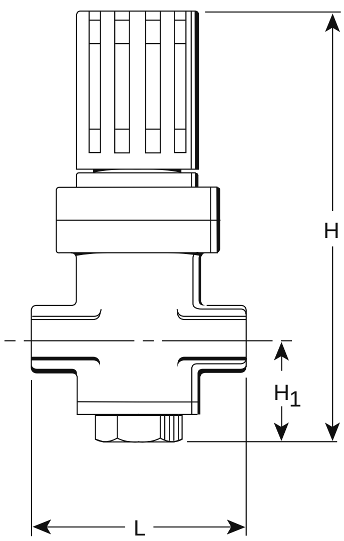
Model Number	Inlet Pressure psig (bar)	Reduced Pressure psig (bar)	Spring Color	Minimum Differential psig (bar)	Application	Maximum Temp. °F (°C)	Materials		
							Body	Valve/Seat	Bellows
GD-30	15 - 250 (1 - 17)	3 - 15 (.21 - 1.0) 7 - 80 (.48 - 5.5) 50 - 140 (3.4 - 9.6)	Yellow Blue Green	7 (.48)	Steam, Air, Non-Corrosive Gases	410 (210)	Cast Bronze ASTM B584	Stainless Steel AISI 440/304	Phosphor Bronze ASTM B103*
GD-30S	15 - 300 (1 - 20)				Steam	430 (220)	Stainless Steel AISI 316		Stainless Steel AISI 316L

*Stainless steel optional

GD-30/30S Dimensions and Weights

Symbol	Connection Size									
	in	mm	in	mm	in	mm	in	mm	in	mm
	1/2	**15**	**3/4**	**20**	**1**	**25**	**1-1/2***	**40**	**2***	**50**
L	3-1/8	80	3-3/8	85	3-3/4	95	5-1/2	140	5-7/8	150
H_1	2	47	2	47	2	47	3	77	3	77
H	7-1/2	191	7-1/2	191	7-1/2	191	12-1/8	307	12-1/8	307
Weight lb (kg)	4-1/4 (1.9)		4-1/4 (1.9)		4-1/2 (2.0)		21-3/8 (9.7)		22 (10)	
C_v	1.3		1.5		2.5		5.6		8.5	

NOTE: GD-30 capacities cannot be determined with a formula—consult capacity tables. Reference note under formula key on page 269.
*GD-30S available in 1/2", 3/4", and 1" only.



GD-30/30S

GD-30 Capacities—Steam

lb/hr

	Inlet	Outlet	Connection Size (in) 1/2	3/4	1	1-1/2	2
	psig		1/2	3/4	1	1-1/2	2
	C_v Factor		1.3	1.5	2.5	5.6	8.5
	15	7	49	56	92	198	297
	20	13	53	61	105	216	331
		7	42	55	63	180	264
	30	23	62	71	112	242	408
		15	53	60	101	209	309
		3	33	40	60	139	216
	40	32	99	121	187	407	617
		20	79	97	159	330	517
		4	40	55	77	159	264
	50	40	130	143	242	539	837
		20	99	115	187	407	628
		5	48	62	88	193	297
	60	48	137	154	265	584	899
		40	150	165	289	617	969
		18	90	104	170	374	584
		6	55	73	99	220	331
	80	64	176	205	342	738	1,168
		54	187	225	353	782	1,201
		23	121	137	220	489	749
		8	60	77	108	231	363
	100	80	203	242	397	863	1,355
		66	225	262	437	958	1,465
		40	198	231	375	837	1,278
		10	68	79	132	297	473
	120	96	231	276	452	991	1,520
		70	276	311	518	1,168	1,818
		45	240	267	450	980	1,509
		12	110	121	198	462	705
	150	120	287	333	551	1,212	1,862
		85	364	421	705	1,531	2,369
		55	298	353	595	1,278	2,005
		15	132	165	254	562	848
	180	140	408	485	794	1,719	2,677
		115	430	507	860	1,829	2,832
		70	386	430	739	1,619	2,501
		18	165	187	309	683	1,035
	200	140	461	518	871	1,983	3,063
		115	474	540	904	2,005	3,085
		80	430	496	827	1,818	2,810
		20	209	242	386	848	1,300
	225	140	485	573	948	2,060	3,195
		115	496	584	961	2,071	3,207
		85	463	540	904	1,983	3,063
		23	254	298	496	1,079	1,675
	250	140	525	606	1,014	2,226	3,438
		120	551	584	1,038	2,248	3,471
		70	463	529	893	1,939	2,997
		25	276	320	529	1,146	1,796
GD-30S Only	275	140	529	613	1,023	–	–
		120	529	613	1,023	–	–
		70	470	542	902	–	–
		28	295	344	562	–	–
	300	140	529	613	1,023	–	–
		100	529	613	1,023	–	–
		70	478	551	926	–	–
		30	309	359	595	–	–

kg/hr

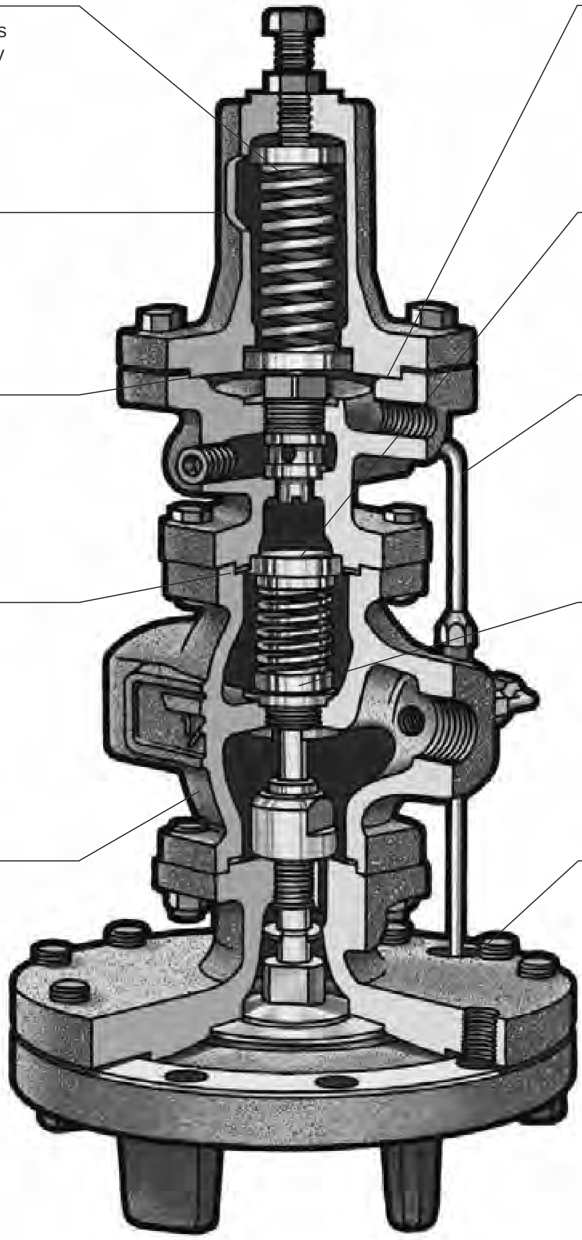
Inlet	Outlet	Connection Size (mm) 15	20	25	40	50
bar		15	20	25	40	50
C_v Factor		1.3	1.5	2.5	5.6	8.5
1.0	.5	22	25	42	90	135
1.4	.9	24	28	48	98	150
	.5	19	25	35	82	120
2.0	1.6	28	32	51	110	185
	1.0	24	27	46	95	140
	.2	15	18	27	63	98
2.8	2.2	45	55	85	185	280
	1.4	36	44	72	150	235
	.3	18	25	35	72	120
3.4	2.8	59	65	110	245	380
	1.4	45	52	85	185	285
	.3	22	28	40	88	135
4.0	3.3	62	70	120	265	408
	2.8	68	75	131	280	440
	1.2	41	47	77	170	265
	.4	25	33	45	100	150
5.5	4.4	80	93	155	335	530
	3.7	85	102	160	355	545
	1.6	55	62	100	222	340
	.5	27	35	49	105	165
6.9	5.5	92	110	180	392	615
	4.5	102	119	198	435	665
	2.8	90	105	170	380	580
	.7	31	36	60	135	215
8.3	6.6	105	125	205	450	690
	4.8	125	141	235	530	825
	3.1	109	121	204	445	685
	.8	50	55	90	210	320
10.3	8.3	130	151	250	550	845
	5.9	165	191	320	695	1,075
	3.8	135	160	270	580	910
	1.0	60	75	115	255	385
12.4	9.7	185	220	360	780	1,215
	8.0	195	230	390	830	1,285
	4.8	175	195	335	735	1,135
	1.2	75	85	140	310	470
13.8	9.7	209	235	395	900	1,390
	8.0	215	245	410	910	1,400
	5.5	195	225	375	825	1,275
	1.4	95	110	175	385	590
15.5	9.7	220	260	430	935	1,450
	8.0	225	265	436	940	1,455
	5.9	210	245	410	900	1,390
	1.6	115	135	225	490	760
17.2	9.7	238	275	460	1,010	1,560
	8.3	250	265	471	1,020	1,575
	4.8	210	240	405	880	1,360
	1.7	125	145	240	520	815
18.9	9.7	240	278	464	–	–
	8.3	240	278	464	–	–
	4.8	213	246	409	–	–
	1.9	134	156	255	–	–
20.0	9.7	240	278	464	–	–
	6.9	240	278	464	–	–
	4.8	217	250	420	–	–
	2.7	140	163	270	–	–

NOTE: For air capacities scfm, multiply steam capacities (lb/hr) by 0.36. For air capacities m3/hr, multiply steam capacities (kg/hr) by 1.35.
Maximum pressure reduction ratio 10:1.

Externally Piloted

For Steam Service

This type is similar to the internally piloted piston-operated valve in that a pilot and main valve are utilized. However, double diaphragms replace the piston. This increased diaphragm area can open a larger main valve, allowing a greater capacity per line size than the internally piloted piston-operated valve. In addition, the diaphragms are more sensitive to pressure changes, which results in accuracy of ±1%. This greater accuracy is due to the positioning of the sensing line downstream, where there is less turbulence. This valve also offers the flexibility to use different types of pilot valves (i.e., pressure, temperature, air loaded, solenoid or combination).



GP-2000

For Steam Service

The GP-2000 is a high performance, externally piloted reducing valve for large capacity requirements. Typical use is on intermittent service, including applications such as heat exchangers, steam coils, rotating dryers, process equipment and heating systems. With a 20:1 rangeability and high C_V, the GP-2000 is reliable and accurate (+/-1% of pressure set point from 5% to 100% of flow) over a long, trouble-free service life. Hardened stainless steel working parts are renewable in-line. Single seated for dead-end service. Available with both NPT (1/2" - 2") and flanged connections in 1/2" - 6" sizes. ANSI Class IV Shutoff.

For a fully detailed certified drawing, refer to:
GP-2000 **CDY #1008**
GP-2000 Flanged **CDY #1007**

GP-2000 Specifications

Application	Inlet Pressure psig (bar)	Reduced Pressure psig (bar)	Spring Color	Maximum Temperature °F (°C)	Minimum Differential psig (bar)	Materials				
						Body	Main Valve/Seat	Pilot Valve/Seat	Diaphragm	Color
Steam	NPT 15 - 300 (1 - 20)	*1.5 - 3 (.10 - .21)	Yellow	450 (232)	7 (.48)	Ductile Iron ASTM A536	Stainless Steel AISI 420		Stainless Steel AISI 301	Dark Gray
	15 - 185 (1 - 13) 150 lb. Flanged	3 - 21 (.21 - 1.4)	Yellow							
	15 - 300 (1 - 20) 300 lb. Flanged	15 - 200 (1 - 13.8)	Green							

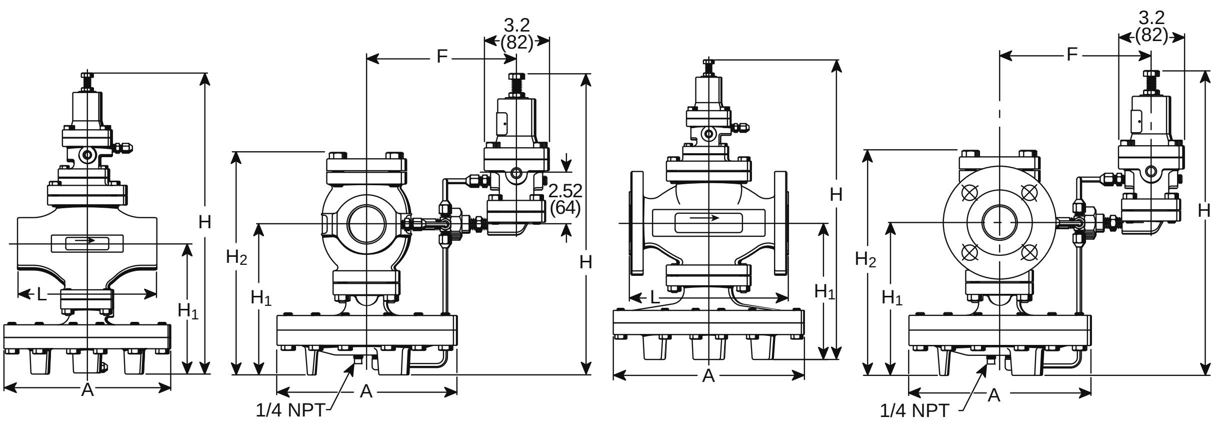
*NOTE: When using this spring range, remove one (1) pilot diaphragm. Capacities are reduced by 1/2 of capacity chart when this spring is being used.

GP-2000 Dimensions and Weights

Size		Face-to-Face "L"						A		F		H Integral		H Remote		H_1		H_2		Weight						C_V*
		NPT		150#		300#														NPT		150#		300#		
in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	lb	kg	lb	kg	lb	kg	
1/2	15	5-15/16	150	5-9/16	141	5-3/4	147	7-15/16	200	6-7/8	176	15-3/4	398	14-1/4	362	6-3/4	170	9-5/8	244	34	14	36	15	42	19	5.0
3/4	20	5-15/16	150	5-1/2	140	5-3/4	147	7-15/16	200	6-7/8	176	15-3/4	398	14-1/4	362	6-3/4	170	9-5/8	244	34	14	36	15	42	19	7.2
1	25	6-5/16	160	5-3/4	147	6-1/4	159	8-15/16	226	7-1/16	179	15-15/16	404	14-7/16	367	6-15/16	175	10	254	44	19	48	20	54	23	10.9
1-1/4	32	7-1/8	180	6-1/2	166	7-1/16	179	8-15/16	226	7-7/16	188	17-1/8	434	15-1/8	384	7-5/8	192	11-1/8	283	51	22	53	22	59	25	14.3
1-1/2	40	7-1/8	180	7-7/16	189	7-15/16	202	8-15/16	226	7-7/16	188	17-1/8	434	15-1/8	384	7-5/8	192	11-1/8	283	51	22	55	23	61	26	18.8
2	50	9-1/8	230	8-9/16	217	9-1/8	232	10-15/16	276	7-11/16	195	19-5/8	498	16	406	8-1/2	216	12-5/8	321	75	33	81	36	84	36	32
2-1/2	65	–	–	10-15/16	278	11-1/2	292	13-13/16	352	8-5/16	211	21-3/4	552	17-5/16	440	9-13/16	251	14-3/4	375	–	–	142	65	150	65	60
3	80	–	–	11-3/4	298	12-7/16	315	13-13/16	352	8-3/4	222	22-5/8	575	17-15/16	456	10-7/16	264	15-3/4	400	–	–	155	69	166	72	78
4	100	–	–	13-1/2	343	14-1/8	359	15-13/16	401	9-7/16	239	25-15/16	658	20-1/8	511	12-5/8	321	19-1/4	489	–	–	247	112	264	119	120
6	150	–	–	18-1/8	460	19	483	19-3/4	502	–	–	31-3/4	806	–	–	16-1/4	414	26-1/2	673	–	–	507	230	553	252	250

*50% reduced port available for sizes 1/2" - 4". The C_V value should be divided by 2 to get reduced port C_V.

For capacities see page 299.



GP-2000L

For Steam Service

The GP-2000L is a high performance, externally piloted reducing valve for large capacity and low inlet pressure requirements. The GP-2000L is reliable and accurate (+/-1% of pressure set point from 5% to 100% of flow) over a long, trouble-free service life. Hardened stainless steel working parts are renewable in-line. Single seated for dead-end service. Available with both NPT (1/2" - 2") and flanged connections in 1/2" - 4" sizes. ANSI Class IV Shutoff.

GP-2000L Specifications

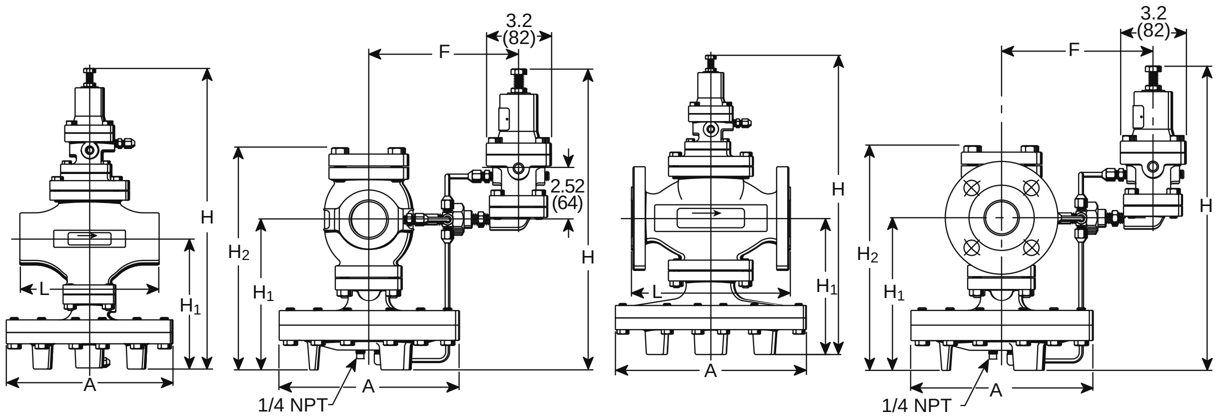
Application	Inlet Pressure psig (bar)	Reduced Pressure psig (bar)	Spring Color	Maximum Temperature °F (C)	Minimum Differential psig (bar)	Materials				
						Body	Main Valve/ Seat	Pilot Valve/ Seat	Diaphragm	Color
Steam	5 - 15 (.3 - 1)	2 - 12 (.13 - .8)	Yellow	450 (232)	3 (.21)	Ductile Iron ASTM A536	Stainless Steel AISI 420		Stainless Steel AISI 301	Dark Gray

GP-2000L Dimensions and Weights

Size		Face-to-Face "L"						A		F		H Integral		H Remote		H_1		H_2		Weight						C_V*
		NPT		150#		300#														NPT		150#		300#		
in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	lb	kg	lb	kg	lb	kg	
1/2	15	5-15/16	150	5-9/16	141	5-3/4	147	7-15/16	200	6-7/8	176	15-3/4	398	14-1/4	362	6-3/4	170	9-5/8	244	34	14	36	15	42	19	5.0
3/4	20	5-15/16	150	5-1/2	140	5-3/4	147	7-15/16	200	6-7/8	176	15-3/4	398	14-1/4	362	6-3/4	170	9-5/8	244	34	14	36	15	42	19	7.2
1	25	6-5/16	160	5-3/4	147	6-1/4	159	8-15/16	226	7-1/16	179	15-15/16	404	14-7/16	367	6-15/16	175	10	254	44	19	48	20	54	23	10.9
1-1/4	32	7-1/8	180	6-1/2	166	7-1/16	179	8-15/16	226	7-7/16	188	17-1/8	434	15-1/8	384	7-5/8	192	11-1/8	283	51	22	53	22	59	25	14.3
1-1/2	40	7-1/8	180	7-7/16	189	7-15/16	202	8-15/16	226	7-7/16	188	17-1/8	434	15-1/8	384	7-5/8	192	11-1/8	283	51	22	55	23	61	26	18.8
2	50	9-1/8	230	8-9/16	217	9-1/8	232	10-15/16	276	7-11/16	195	19-5/8	498	16	406	8-1/2	216	12-5/8	321	75	33	81	36	84	36	32
2-1/2	65	–	–	10-15/16	278	11-1/2	292	13-13/16	352	8-5/16	211	21-3/4	552	17-5/16	440	9-13/16	251	14-3/4	375	–	–	142	65	150	65	60
3	80	–	–	11-3/4	298	12-7/16	315	13-13/16	352	8-3/4	222	22-5/8	575	17-15/16	456	10-7/16	264	15-3/4	400	–	–	155	69	166	72	78
4	100	–	–	13-1/2	343	14-1/8	359	15-13/16	401	9-7/16	239	25-15/16	658	20-1/8	511	12-5/8	321	19-1/4	489	–	–	247	112	264	119	120

*50% reduced port available for sizes 1/2" - 4". The C_V value should be divided by 2 to get reduced port C_V.

For capacities see page 309.



GP-2000CS Carbon Steel Body

For Steam Service

The GP-2000CS is a high performance, externally piloted reducing valve for large capacity requirements. Typical use is on intermittent service, including applications such as heat exchangers, steam coils, rotating dryers, process equipment and heating systems. With a 20:1 rangeability and high C_V, the GP-2000CS is reliable and accurate (+/-1% of pressure set point from 5% to 100% of flow) over a long, trouble-free service life. Stellited stainless steel working parts are renewable in-line. Single seated for dead-end service. Available with both NPT (1/2" - 2") and flanged connections in 2" - 4" sizes.

For a fully detailed certified drawing, refer to:
GP-2000 **CDY #1008**
GP-2000 Flanged **CDY #1007**

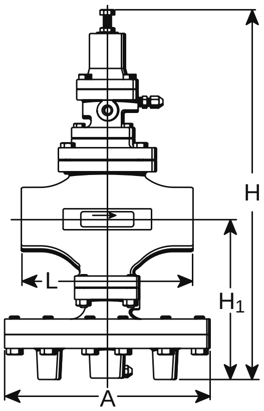
GP-2000GP-2000CS Specifications

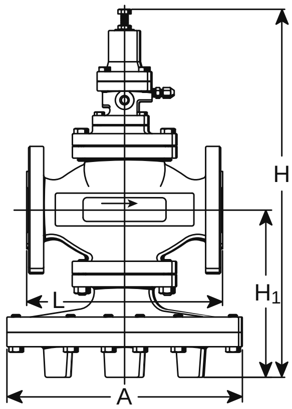
Application	Inlet Pressure psig (bar)	Reduced Pressure psig (bar)	Spring Color	Maximum Temperature °F (°C)	Minimum Differential psig (bar)	Materials				
						Body	Main Valve/Seat	Pilot Valve/Seat	Diaphragm	Color
Steam	NPT 15 - 450 (1 - 31)	3 - 21 (.21 - 1.4)	Yellow	600°F (315°C)	7 (.48)	Carbon Steel WCB ASTM216 A216M-08	Stainless Steel 304 Stainless Steel Stellite	420 Stainless Steel	Stainless Steel AISI 301	Silver
	150 lb Flanged 15 - 140 (1 - 9.6)	15 - 200 (1 - 13.6)	Green							
	300 lb Flanged 15 - 450 (1 - 31)	190 - 300 (13.1 - 20.6)	Brown							

GP-2000CS Dimensions and Weights

Size		L						A		F		H Integral		H_1		H_2		Weight						C_V
		NPT		150#		300#												NPT		150#		300#		
in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	lb	kg	lb	kg	lb	kg	
1/2	15	5-15/16	150	–	–	–	–	7-15/16	200	6-7/8	176	15-3/4	398	6-3/4	170	9-5/8	244	35	16	–	–	–	–	5.0
3/4	20	5-15/16	150	–	–	–	–	7-15/16	200	6-7/8	176	15-3/4	398	6-3/4	170	9-5/8	244	35	16	–	–	–	–	7.2
1	25	6-5/16	160	–	–	–	–	8-15/16	226	7-1/16	179	15-15/16	404	6-15/16	175	10	254	49	22	–	–	–	–	10.9
1-1/4	32	7-1/8	180	–	–	–	–	8-15/16	226	7-7/16	188	17-1/8	434	7-5/8	192	11-1/8	283	53	24	–	–	–	–	14.3
1-1/2	40	7-1/8	180	–	–	–	–	8-15/16	226	7-7/16	188	17-1/8	434	7-5/8	192	11-1/8	283	53	24	–	–	–	–	18.8
2	50	9-1/8	230	8-9/16	217	9-1/8	232	10-15/16	276	7-11/16	195	19-5/8	498	8-1/2	216	12-5/8	321	62	37	88	40	92	42	32
2-1/2	65	–	–	10-15/16	278	11-1/2	292	13-13/16	352	8-5/16	211	21-3/4	552	9-13/16	251	14-3/4	375	–	–	159	72	168	76	60
3	80	–	–	11-3/4	298	12-7/16	315	13-13/16	352	8-3/4	222	22-5/8	575	10-7/16	264	15-3/4	400	–	–	174	79	185	84	78
4	100	–	–	13-1/2	343	14-1/8	359	15-13/16	401	9-7/16	239	25-15/16	658	12-5/8	321	19-1/4	489	–	–	276	125	293	133	120

For capacities see page 299.





GP-2000, 2000K-1, 3 & 6, GD-2000K, GP-2000R, GP- 11S

Capacities for Steam

GP-2000, GP-2000K-1, GP-2000K-3, GP-2000K-6, GD-2000K, GP-2000R Capacities—Steam lb/hr

Inlet	Outlet	lb/hr Connection Size in									
psig		1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	6
C_V Factor		5	7.2	10.9	14.3	18.8	32	60	78	120	250
15	8	201	290	438	575	756	1,287	2,413	3,137	4,826	10,055
	3	250	361	546	716	942	1,603	3,005	3,907	6,010	12,521
20	13	219	316	478	628	825	1,404	2,633	3,423	5,267	10,972
	3	313	451	683	896	1,178	2,006	3,761	4,889	7,521	15,669
25	18	236	340	515	676	889	1,513	2,837	3,688	5,673	11,819
	3 - 5	339	489	740	971	1,276	2,172	4,073	5,295	8,146	16,972
30	23	252	363	550	721	948	1,614	3,026	3,934	6,052	12,609
	3 - 7	382	550	833	1,093	1,437	2,446	4,586	5,962	9,172	19,109
40	33	281	405	613	804	1,057	1,799	3,373	4,385	6,747	14,056
	25	395	569	861	1,130	1,486	2,529	4,741	6,164	9,483	19,756
	3 - 12	468	673	1,020	1,338	1,758	2,993	5,612	7,296	11,224	23,384
50	42	327	471	713	936	1,230	2,094	3,927	5,105	7,853	16,361
	30	491	707	1,071	1,405	1,847	3,143	5,894	7,662	11,788	24,557
	3 - 17	553	797	1,206	1,582	2,080	3,540	6,638	8,630	13,276	27,659
60	51	373	537	814	1,067	1,403	2,389	4,479	5,823	8,958	18,662
	45	471	679	1,028	1,348	1,773	3,017	5,657	7,355	11,315	23,572
	35	586	843	1,277	1,675	2,202	3,748	7,027	9,135	14,053	29,278
	3 - 22	639	920	1,392	1,827	2,401	4,088	7,664	9,963	15,328	31,934
75	63	471	678	1,026	1,346	1,769	3,012	5,647	7,341	11,295	23,530
	55	593	854	1,292	1,696	2,229	3,794	7,114	9,249	14,229	29,643
	45	703	1,012	1,532	2,010	2,643	4,499	8,435	10,966	16,871	35,148
	4 - 30	767	1,104	1,672	2,193	2,884	4,908	9,203	11,964	18,406	38,347
100	85	595	857	1,298	1,703	2,239	3,811	7,145	9,289	14,291	29,773
	75	751	1,081	1,636	2,147	2,822	4,804	9,007	11,709	18,014	37,529
	60	914	1,316	1,992	2,614	3,436	5,849	10,967	14,257	21,934	45,696
	5 - 42	981	1,412	2,138	2,805	3,687	6,276	11,768	15,299	23,536	49,034
125	106	739	1,064	1,610	2,112	2,777	4,727	8,863	11,522	17,725	36,928
	100	837	1,206	1,825	2,395	3,149	5,359	10,048	13,063	20,097	41,869
	75	1,125	1,619	2,451	3,216	4,228	7,197	13,494	17,543	26,989	56,226
	7 - 55	1,194	1,720	2,604	3,416	4,491	7,644	14,333	18,633	28,666	59,722
150	127	881	1,269	1,922	2,521	3,314	5,641	10,577	13,751	21,155	44,072
	100	1,241	1,787	2,705	3,549	4,666	7,943	14,893	19,360	29,785	62,052
	8 - 67	1,408	2,028	3,070	4,027	5,295	9,012	16,898	21,968	33,796	70,409
175	148	1,024	1,475	2,233	2,929	3,851	6,555	12,291	15,978	24,581	51,211
	125	1,348	1,940	2,938	3,854	5,067	8,624	16,170	21,021	32,341	67,376
	100	1,587	2,285	3,459	4,537	5,965	10,154	19,038	24,750	38,076	79,325
	9 - 80	1,622	2,336	3,536	4,639	6,098	10,380	19,463	25,302	38,926	81,097
200	170	1,149	1,655	2,506	3,287	4,322	7,356	13,792	17,930	27,585	57,468
	150	1,446	2,083	3,153	4,136	5,438	9,256	17,354	22,560	34,708	72,309
	125	1,712	2,465	3,732	4,896	6,437	10,956	20,542	26,705	41,085	85,593
	10 - 92	1,836	2,643	4,002	5,250	6,902	11,748	22,028	28,637	44,056	91,784
225	191	1,292	1,861	2,817	3,695	4,858	8,270	15,505	20,157	31,011	64,606
	175	1,539	2,215	3,354	4,400	5,785	9,847	18,462	24,001	36,925	76,926
	150	1,829	2,633	3,986	5,230	6,876	11,703	21,944	28,527	43,887	91,431
	12 - 105	2,049	2,951	4,468	5,861	7,706	13,116	24,593	31,971	49,186	102,472
250	200	1,626	2,341	3,544	4,649	6,112	10,404	19,508	25,360	39,015	81,282
	175	1,938	2,791	4,226	5,544	7,288	12,406	23,261	30,239	46,521	96,919
	150	2,176	3,133	4,743	6,223	8,181	13,925	26,110	33,943	52,219	108,790
	13 - 117	2,263	3,259	4,934	6,473	8,510	14,484	27,158	35,306	54,316	113,159
275	200	2,042	2,941	4,452	5,841	7,679	13,070	24,507	31,859	49,014	102,112
	175	2,299	3,311	5,012	6,575	8,644	14,714	27,588	35,864	55,176	114,950
	14 - 130	2,477	3,567	5,400	7,084	9,313	15,852	29,723	38,640	59,446	123,847
300	200	2,416	3,479	5,267	6,910	9,084	15,462	28,991	37,688	57,982	120,796
	175	2,637	3,797	5,748	7,540	9,913	16,874	31,638	41,130	63,277	131,826
	15 - 142	2,691	3,875	5,866	7,695	10,117	17,220	32,288	41,975	64,576	134,534
GP-2000CS Only: 350	248	2,656	3,825	5,791	7,597	9,987	17,000	31,864	41,423	63,728	—
	225	2,886	4,156	6,292	8,254	10,852	18,471	34,629	45,017	69,258	—
	200	3,095	4,457	6,748	8,853	11,639	19,811	37,135	48,276	74,270	—
	18 - 160	3,118	4,490	6,798	8,918	11,724	19,956	39,890	51,856	79,779	—
GP-2000CS Only: 425	248	3,702	5,331	8,071	10,588	13,921	23,695	44,415	57,740	88,830	—
	225	3,870	5,574	8,438	11,070	14,553	24,771	46,439	60,370	92,877	—
	22 - 195	4,000	5,578	8,719	11,439	15,038	25,595	48,096	62,525	96,192	—

NOTE: Maximum pressure reduction 20:1, except for GD-2000K 10:1. Minimum pressure reduction is 85% of inlet pressure.
For 50% reduced port capacities, divide the capacity by 2.
50% reduced port available for sizes 1/2" - 4".

GP-2000, 2000K-1, 3 & 6, GD-2000K, GP-2000R

Capacities for Steam continued

GP-2000, GP-2000K-1, GP-2000K-3, GP-2000K-6, GD-2000K, GP-2000R Capacities—Steam (kg/hr)

Inlet	Outlet	Connection Size (kg/hr, mm)									
bar		15	20	25	32	40	50	65	80	100	150
C_V Factor		5	7.2	10.9	14.3	18.8	32	60	78	120	250
1.03	0.55	91	131	199	261	343	584	1,095	1,423	2,189	4,561
	0.21	114	164	248	325	427	727	1,363	1,772	2,726	5,679
1.38	0.90	100	143	217	285	374	637	1,194	1,553	2,389	4,977
	0.21	142	205	310	407	534	910	1,706	2,218	3,412	7,108
1.72	1.24	107	154	234	307	403	686	1,287	1,673	2,573	5,361
	.21 - .34	154	222	336	440	579	985	1,848	2,402	3,695	7,698
2.07	1.59	114	165	249	327	430	732	1,373	1,784	2,745	5,719
	.21 - .48	173	250	378	496	652	1,109	2,080	2,704	4,161	8,668
2.76	2.28	128	184	278	365	479	816	1,530	1,989	3,060	6,376
	1.72	114	165	249	327	430	732	1,373	1,784	2,745	5,719
	.21 - .83	173	250	378	496	652	1,109	2,080	2,704	4,161	8,668
3.45	2.90	128	184	278	365	479	816	1,530	1,989	3,060	6,376
	2.07	179	258	391	513	674	1,147	2,151	2,796	4,301	8,961
	.21 - 1.17	212	305	462	607	798	1,358	2,546	3,309	5,091	10,607
4.14	3.52	148	214	324	425	558	950	1,781	2,315	3,562	7,421
	3.10	148	214	324	425	558	950	1,781	2,315	3,562	7,421
	2.41	223	321	486	637	838	1,426	2,673	3,475	5,347	11,139
	.21 - 1.5	251	361	547	718	943	1,606	3,011	3,914	6,022	12,546
5.17	4.34	213	307	465	611	803	1,366	2,562	3,330	5,123	10,673
	3.79	269	387	586	769	1,011	1,721	3,227	4,195	6,454	13,446
	3.10	319	459	695	912	1,199	2,041	3,826	4,974	7,653	15,943
	.27 - 2.1	348	501	758	995	1,308	2,226	4,175	5,427	8,349	17,394
6.89	5.86	270	389	589	772	1,016	1,729	3,241	4,213	6,482	13,505
	5.17	340	490	742	974	1,280	2,179	4,086	5,311	8,171	17,023
	4.14	415	597	904	1,186	1,559	2,653	4,975	6,467	9,949	20,728
	.34 - 2.9	445	641	970	1,272	1,673	2,847	5,338	6,939	10,676	22,242
8.62	7.31	335	482	730	958	1,260	2,144	4,020	5,226	8,040	16,750
	6.89	380	547	828	1,086	1,428	2,431	4,558	5,925	9,116	18,991
	5.17	510	735	1,112	1,459	1,918	3,265	6,121	7,957	12,242	25,504
	.48 - 3.7	542	780	1,181	1,550	2,037	3,467	6,502	8,452	13,003	27,090
10.34	8.76	400	576	872	1,143	1,503	2,559	4,798	6,237	9,596	19,991
	6.89	563	811	1,227	1,610	2,117	3,603	6,755	8,782	13,510	28,147
	.55 - 4.6	639	920	1,392	1,827	2,402	4,088	7,665	9,964	15,330	31,937
12.07	10.20	465	669	1,013	1,329	1,747	2,973	5,575	7,247	11,150	23,229
	8.62	611	880	1,332	1,748	2,298	3,912	7,335	9,535	14,670	30,562
	6.89	720	1,036	1,569	2,058	2,706	4,606	8,636	11,226	17,271	35,982
	.62 - 5.5	736	1,059	1,604	2,104	2,766	4,709	8,828	11,477	17,657	36,785
13.79	11.72	521	751	1,137	1,491	1,960	3,337	6,256	8,133	12,512	26,067
	10.34	656	945	1,430	1,876	2,466	4,198	7,872	10,233	15,744	32,799
	8.62	776	1,118	1,693	2,221	2,920	4,970	9,318	12,113	18,636	38,825
	.68 - 6.3	833	1,199	1,815	2,381	3,131	5,329	9,992	12,990	19,984	41,633
15.51	13.17	586	844	1,278	1,676	2,204	3,751	7,033	9,143	14,066	29,305
	12.07	698	1,005	1,521	1,996	2,624	4,466	8,374	10,887	16,749	34,894
	10.34	829	1,194	1,808	2,372	3,119	5,309	9,954	12,940	19,907	41,473
	.82 - 7.24	930	1,339	2,027	2,659	3,495	5,950	11,155	14,502	22,311	46,481
17.24	13.79	737	1,062	1,607	2,109	2,773	4,719	8,849	11,503	17,697	36,869
	12.07	879	1,266	1,917	2,515	3,306	5,627	10,551	13,716	21,102	43,962
	10.34	987	1,421	2,152	2,823	3,711	6,316	11,843	15,396	23,687	49,347
	.89 - 8.06	1,027	1,478	2,238	2,936	3,860	6,570	12,319	16,015	24,638	51,329
18.96	13.79	926	1,334	2,019	2,649	3,483	5,929	11,116	14,451	22,233	46,318
	12.07	1,043	1,502	2,273	2,982	3,921	6,674	12,514	16,268	25,028	52,141
	.96 - 8.96	1,124	1,618	2,449	3,213	4,224	7,191	13,482	17,527	26,965	56,177
20.00	13.79	1,096	1,578	2,389	3,134	4,120	7,013	13,150	17,095	26,300	54,793
	12.07	1,196	1,722	2,607	3,420	4,497	7,654	14,351	18,656	28,702	59,796
	1.03 - 9.79	1,220	1,758	2,661	3,491	4,589	7,811	14,646	19,040	29,292	61,024
24.13 (GP-2000CS Only)	17.10	1,205	1,735	2,627	3,446	4,530	7,711	14,453	18,789	28,907	—
	15.51	1,309	1,885	2,854	3,744	4,922	8,379	14,668	20,419	31,415	—
	13.79	1,404	2,022	3,061	4,016	5,279	8,986	16,844	21,898	33,689	—
	1.24 - 11.02	1,414	2,037	3,083	4,045	5,318	9,052	18,094	23,521	36,187	—
29.30 (GP-2000CS Only)	17.10	1,679	2,418	3,661	4,803	6,314	10,748	20,146	26,190	40,293	—
	15.51	1,756	2,528	3,827	5,021	6,601	11,236	21,064	27,383	42,129	—
	1.52 - 13.4	1,814	2,530	3,955	5,189	6,821	11,610	21,816	28,361	43,632	—

NOTE: Maximum pressure reduction 20:1, except for GD-2000K 10:1. Minimum pressure reduction is 85% of inlet pressure.
For 50% reduced port capacities, divide the capacity by 2.
50% reduced port available for sizes 15 - 100 mm.

Temperature Regulators

For Steam, Water and Non-Corrosive Liquid Service

Armstrong self-actuated temperature regulators are compact, high performance units that are simple in design and operation—and suitable for a wide variety of applications.

Features including flexible mounting positions of the sensor, interchangeable capillaries and varied temperature ranges make installation, adjustment and maintenance quick and easy.

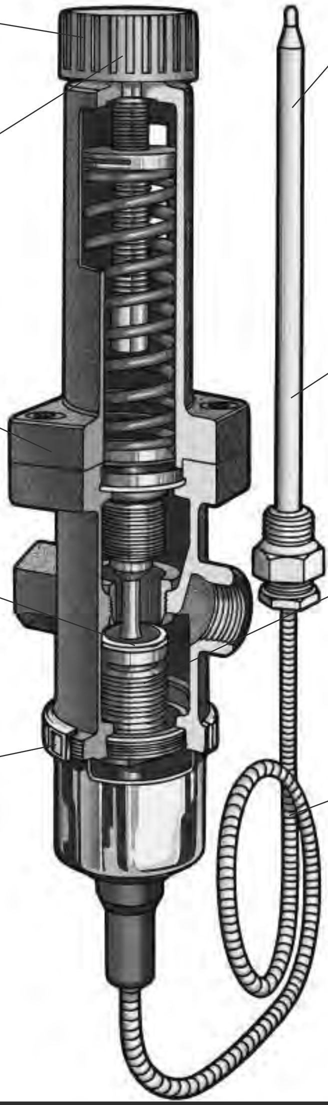
Color coded handles (red for heating and blue for cooling) make for easy identification in the field.

Easy no-tools temperature adjustment with a simple turn of the handle.

Cast bronze body permits liquid service to 250 psi and steam service to 150 psi.

Main valve seat materials are stainless steel and Teflon® for high durability and positive sealing.

Quick installation and removal of sensor from main body means easy temperature range changes.



Sensor temperature endurance—+72°F of the maximum value of the temperature regulation range. Gas-charged capillary eliminates chance of capillary charge mixing with process in case of breakage. Sensor can be mounted in any position.

Sensors are standard for both heating and cooling for all sizes (1/2" - 1"). Standard capillary units for heating or cooling are accurate to within ±7°F.

A single valve with bellows and balancing mechanism ensures stable regulation. Not affected by pressure fluctuation.

Braided stainless steel capillary protects against crimping.

Temperature Regulator Valve Selection

If the Service Is	If Inlet Pressure is psig (bar)	Type of Control	Temperature Ratings °F (°C)	Temperature Accuracy °F (°C)	If Maximum Capacity Is Less Than	Look for Model	Find on Page
Heating	5 to 150 (.34 to 10)	Self Contained Direct Acting	From 32 to 302 (0 to 150) 5 Ranges	±7 (±3) From set point	1,745 (792)	OB-30	304
	5 to 15 (.34 to 1)	Self Contained Pilot Operated	From 18 to 361 (-7 to 183) 6 Ranges	±2 (±1) From set point	5,643 (2,565)	OB-2000L	308
	10 to 300 (.69 to 20				58,032 (26,323)	OB-2000	306
						OB-2000PT	310
Cooling	5 to 250 (.34 to 17)	Self Contained Reverse Acting	From 32 to 302 (0 to 150) 5 Ranges	±7 (±3) From set point	70 gpm (308 m3/hr)	OB-31	304

OB-30/31

For Steam, Air and Non-Corrosive Liquids

The Armstrong OB-30/31 is a direct acting temperature regulator that requires no external source for operation. Simple and compact, the unit is suitable for a wide variety of heating/cooling applications. Installing, adjusting or maintaining the OB-30/31 is quick and easy because interchangeable capillaries mount in any position and disconnect by simply loosening the union nut. No stem packing so there's no leakage. Single composition seat for tight shutoff. The OB-30/31 comes in 1/2", 3/4" or 1" sizes and is available with a choice of five temperature ranges and three capillary lengths.

For a fully detailed certified drawing, refer to CDY #1036.

OB-30/31 Specifications

Model	Application	Service	Max. Inlet Pressure psig (bar)	Maximum Diff. psig (bar)	Temperature Ranges °F (°C)	Max. Temp. °F (°C)	Temperature Accuracy °F (°C)	Capillary Lengths feet (meters)
OB-30	Heating	Steam, Water	Steam 150 (10)	140 (9.6)	32 - 95 (0 - 35) 77 - 158 (25 - 70) 104 - 212 (40 - 100) 140 - 266 (60 - 130) 158 - 302 (70 - 150)	366 (185)	±7 (±3) From Set Point	*6-1/2 (2) 9-1/2 (3) 16-1/2 (5)
OB-31	Cooling	Water, Non-Corrosive Liquids	Liquid 250 (17)					

*Standard length.
NOTES: Capillary can withstand a maximum of 72°F (40°C) above rated range. If desired set temperature is in temperature range overlap, select lower range.

OB-30/31 Materials

Body Material	Seat Type & Material	Valve Material	Capillary Material	Bulb Material	Thermal Well Material
Bronze ASTM B584	Single Seat 304 Stainless Steel	Teflon	304 Stainless Steel Armor Shielded Capillary	Copper-Nickel Plated	*304 Stainless Steel or Brass

*Other materials available upon request.

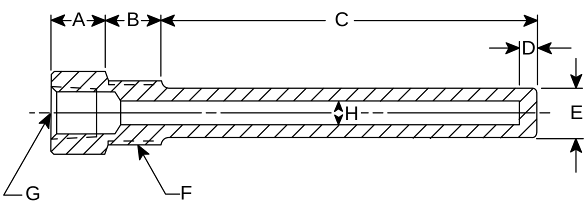
OB-30/31 Dimensions and Weights

Size		L		H_1		H		T		K		R		Weight		C_v
in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	lb	kg	
1/2	15	3	80	5-1/8	130	12-1/2	315	3/8	10	8	200	1/2	15	6	2.8	3.7
3/4	20	3-1/8	85	5-1/8	130	12-1/2	315	3/8	10	8	200	1/2	15	6	2.8	4.6
1	25	3-1/2	95	5-1/8	130	12-1/2	315	3/8	10	8	200	1/2	15	6-1/2	3.0	5.8

Thermal Well Dimensions

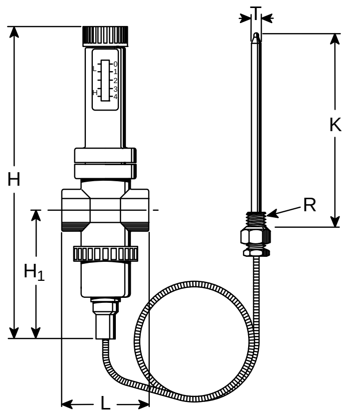
Model	A		B		C		D		E		F		G		H	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
OB-30/31	3/4	20	1	25	7-1/2	204	1/4	7	.765	20	3/4	20	1/2	15	.380	10
OB-2000/2000PT	1	25	3/4	20	7-3/4	197	1/4	7	.89	23	1	25	3/4	20	.630	16
OBK-2000	1	25	3/4	20	12-1/2	318	1/4	7	.765	20	3/4	20	1/2	15	.515	13

OB-30/31, OBK-2000 and OB-2000/2000PT Thermal Well



Standard Material: 304 stainless steel or brass. Other materials available upon request.

NOTE: When inserting sensor into thermal well, for best results, it is recommended that heat transfer medium be applied to sensor before installation.



OB-30/31

OB-30 Capacities—Steam

lb/hr					kg/hr				
Inlet	Outlet	Connection Size in			Inlet	Outlet	Connection Size mm		
psig		1/2	3/4	1	bar		15	20	25
C_V Factors		3.7	4.6	5.8	C_V Factors		3.7	4.6	5.8
5	3	67	83	105	.35	.20	30	38	48
	2	81	100	127		.14	37	45	58
	0	101	126	159		0	46	57	72
10	8	75	94	118	.7	.55	34	43	54
	6	104	130	164		.41	47	59	75
	4	125	155	196		.28	57	70	89
	0	154	191	241		0	70	87	110
15	12	101	125	158	1.0	.83	46	57	72
	9	139	172	218		.62	63	78	99
	6	165	205	259		.41	75	93	118
	0-5	200	249	314		0-.35	91	113	143
20	15	139	173	218	1.38	1.0	63	79	99
	10	181	235	296		.7	82	107	135
	5	221	275	347		.35	100	125	158
	0-2	234	290	367		0-.14	106	132	167
25	20	149	186	234	1.72	1.38	68	85	106
	15	204	254	320		1.0	93	115	145
	10	241	300	378		.7	110	136	172
	0-5	268	333	420		0-.35	122	151	191
30	25	159	198	250	2.0	1.72	72	90	114
	15	258	322	406		1.0	117	146	185
	0-7	302	375	473		0-.48	137	170	215
40	30	244	304	384	2.76	2.0	111	138	175
	20	328	408	515		1.38	149	185	234
	0-12	369	459	579		0-.83	168	209	263
50	40	268	333	420	3.45	2.76	122	151	191
	30	383	451	569		2.0	174	205	259
	0-17	437	543	685		0-1.2	199	247	311
60	50	290	360	454	4.0	3.45	132	164	206
	40	395	491	619		2.76	180	223	281
	0-22	504	627	791		0-1.5	229	285	360
70	60	310	385	486	4.83	4.0	141	175	221
	50	328	424	665		3.45	149	193	302
	40	502	624	787		2.76	228	284	358
	0-27	572	711	897		0-1.9	260	323	408
80	70	329	409	616	5.52	4.83	150	186	280
	60	452	562	708		4.0	205	255	322
	50	537	668	842		3.45	244	304	383
	0-32	640	795	1,003		0-2.2	291	361	456
90	80	346	431	543	6.0	5.52	157	196	247
	70	478	694	749		4.83	217	315	340
	60	570	708	893		4.0	259	322	406
	50	639	795	1,002		3.45	290	361	455
	0-37	707	879	1,109		0-2.6	321	400	504
100	90	363	452	570	6.9	6.0	165	205	259
	80	502	625	788		5.52	228	284	358
	70	600	747	942		4.83	273	340	428
	60	676	840	1,060		4.0	307	382	482
	0-42	776	963	1,215		0-2.9	353	438	552
125	110	489	608	767	8.62	7.59	222	276	349
	100	619	770	971		6.9	281	350	441
	80	798	992	1,250		5.52	363	451	568
	70	863	1,073	1,353		4.83	392	488	615
	0-55	944	1,174	1,480		0-3.8	429	534	673
150	130	611	759	958	10.0	8.97	278	345	435
	120	736	915	1,154		8.28	335	416	525
	100	918	1,141	1,439		6.9	417	519	654
	0-63	1,113	1,384	1,745		0-4.3	506	629	793

NOTE: Where it is not possible to calculate pressure drop, 35% - 40% of gauge supply pressure can be used as a reasonable approximation.

Temperature Regulator Selection Example

Parameters:

- Fluid .... Steam
- Maximum inlet pressure .... 100 psi
- Outlet pressure .... 90 psi
- Maximum flow rate .... 500 lbs/hr
- Temperature required .... 150°F
- Distance from regulator to sensing point .... 5'

To Locate Proper Model:

- Enter inlet column at .... 100 psi
- Move to outlet pressure of .... 90 psi
- Locate capacity of 570 lbs/hr under connection size .... 1"
- Find capillary temperature range .... 77-158°F
- Select capillary length .... 6-1/2'

Application Will Require:

OB-30, 1" with 77-158°F Temp. Range, Capillary Length 6-1/2'

OB-30/31 Capacities—Water

gpm				l/min			
Δ P	Connection Size in			Δ P	Connection Size mm		
psig	1/2	3/4	1	bar	15	20	25
5	8.1	10.1	12.3	.35	30	38	47
10	11.9	14.3	18.5	.70	45	55	70
15	14.3	17.6	22.0	1.00	55	67	83
20	16.7	20.7	26.4	1.40	63	78	100
25	18.5	22.0	28.2	1.80	70	83	107
30	20.3	25.6	31.7	2.00	77	97	120
50	26.4	33.5	41.4	3.50	100	127	157
75	32.6	39.6	49.3	5.20	123	150	187
100	37.9	46.2	57.2	7.00	143	175	217
125	42.2	52.0	65.6	8.70	160	197	248
150	46.3	57.25	70.5	10.00	175	217	267

Capillary Temperature Ranges

Temperature Ranges °F (°C)
32 - 95 (0 - 35)
77 - 158 (25 - 70)
104 - 212 (40 - 100)
140 - 266 (60 - 130)
158 - 302 (70 - 150)

NOTE: If desired set temperature is in temperature range overlap, select lower range.

OB-2000

For Steam

Armstrong's OB-2000 is a high performance externally piloted temperature regulator for large capacity applications such as heat exchangers, steam coils, steam dryers, plating tanks and parts washers. It is self-actuated and requires no external energy source. Capillary units mount in any position and can be easily disconnected and interchanged, offering easy installation and maximum application flexibility. Available in sizes 1/2" through 6" with six temperature ranges and three capillary lengths.

For a fully detailed certified drawing, refer to CDY #1013.

OB-2000L Specifications

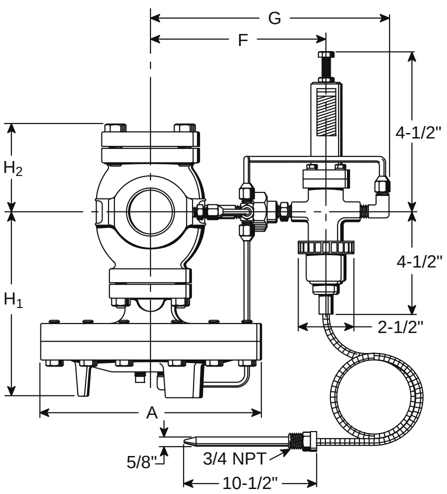
Application	Inlet Pressure psig (bar)	Reduced Pressure psig (bar)	Temperature Ranges °F (°C)	Temperature Accuracy °F (°C)	Capillary Lengths feet (meters)
Steam	NPT 10 - 300 (.69 - 20) 150 lb Flanged 10 - 185 (.69 - 13 300 lb Flanged 10 - 300 (.69 - 20)	7 (.48)	18 - 59 (-8 - 15) 50 - 97 (10 - 36) 86 - 144 (30 - 62) 131 - 201 (55 - 94) 176 - 260 (80 - 127) 239 - 361 (115 - 183)	±2 (±1) From Set Point	*6-1/2 (2) 9-1/2 (3) 16-1/2 (5)

*Standard length.
Note: If desired set temperature is in temperature range overlap, select lower range.

OB-2000 Dimensions and Weights

Size		Face-to-Face						H_1		H_2		A		F		G		Weight						C_V
		NPT		150#		300#												NPT		150#		300#		
in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	lb	kg	lb	kg	lb	kg	
1/2	15	5-15/16	150	5-9/16	141	5-3/4	147	6-3/4	170	2-15/16	74	7-15/16	200	6-5/8	169	8-3/4	222	31	15	33	15	39	18	5.0
3/4	20	5-15/16	150	5-1/2	140	5-3/4	147	6-3/4	170	2-15/16	74	7-15/16	200	6-5/8	169	8-3/4	222	31	15	33	15	39	18	7.2
1	25	6-15/16	160	5-3/4	147	6-1/4	159	6-15/16	175	3-1/16	76	8-15/16	226	6-7/8	174	8-7/8	226	39	19	41	20	47	21	10.9
1-1/4	32	7-1/8	180	6-1/2	166	7-1/16	179	7-5/8	192	3-9/16	90	8-5/16	226	7-1/8	182	9-1/4	235	47	22	49	23	54	24	14.3
1-1/2	40	7-1/8	180	7-7/16	189	7-15/16	202	7-5/8	192	3-9/16	90	8-15/16	226	7-1/8	182	9-1/4	235	47	22	49	23	54	24	18.8
2	50	9-1/8	230	8-9/16	217	9-1/8	232	8-1/2	216	4-1/16	103	10-15/16	276	7-7/16	189	9-1/2	242	71	33	77	36	78	36	32
2-1/2	65	-	-	10-15/16	278	11-1/2	292	9-13/16	251	4-7/8	122	13-13/16	352	8-1/8	206	10-1/8	259	-	-	138	63	140	64	60
3	80	-	-	11-3/4	298	12-7/16	315	10-7/16	264	5-3/8	135	13-13/16	352	8-9/16	217	10-5/8	270	-	-	149	69	155	71	78
4	100	-	-	13-1/2	343	14-1/8	359	12-5/8	321	6-9/16	167	15-13/16	401	9-1/4	234	11-1/4	287	-	-	234	107	243	110	120

NOTE: For 6" (150 mm) consult factory.
*50% reduced port available for sizes 1/2" - 4". The C_V value should be divided by 2 to get reduced port C_V.



OB-2000

For Steam

OB-2000 Sensor and Accessory Specifications

Capillary Material	Capillary Temperature Ranges °F (°C)	Bulb Material	Bulb Connection	Thermal Well Material	Thermal Well Connection
Copper Capillary Tube With 304 Stainless Steel Armor Shield	18 - 59 (-8 - 15) 50 - 97 (10 - 36) 86 - 144 (30 - 62) 131 - 201 (55 - 94) 176 - 260 (80 - 127) 239 - 361 (115 - 183)	Nickel Plated Copper Bulb	3/4" (20 mm) NPT	Brass* 304 Stainless Steel*	1" (25 mm) NPT

*Standard. Other material available upon request. See page 304 for dimensions of well.
NOTE: Capillary can withstand a maximum of 36°F (20°C) above rated range.
NOTE: If desired set temperature is in temperature range overlap, select lower range.

OB-2000 Materials

OB-2000	Body Material	Seat Type & Material	Valve Material	Connection	Maximum Temperature °F (°C)
Main Valve	Ductile Iron ASTM A536	Single Seat Stainless Steel AISI 420	Stainless Steel AISI 420	NPT 150 lb Flanged 300 lb Flanged	450 (232)
Temperature Pilot Valve	Bronze ASTM B584			1/4" (6 mm) NPT	

Valve Sizing

Proper valve selection requires the following information
• Steam capacity required for application
• Supply pressure of steam
• Allowable pressure drop across valve*

*Where it is not possible to calculate pressure drop, 35% - 40% of gauge supply pressure can be used as a reasonable approximation.

Temperature Regulator Selection Example

Parameters:

Fluid . . . . Steam
Maximum inlet pressure . . . . 100 psi
Outlet pressure . . . . 75 psi
Maximum flow rate . . . . 1,500 lbs/hr
Temperature required . . . . 180°F
Distance from regulator to sensing point . . . . 5'

To Locate Proper Model (refer to chart on page 311):

Enter inlet column at . . . . 100 psi
Move to outlet pressure of . . . . 75 psi
Locate capacity of
1,500 lbs/hr under . . . . 1" connection size
Find capillary temp. range . . . . 131-201°F
Select capillary length . . . . 6-1/2'

Application Will Require:

OB-2000, 1" with 131-201°F Temp. Range, Capillary Length 6-1/2'

OB-2000L

For Steam

Armstrong's OB-2000L is a high performance externally piloted temperature regulator for large capacity and low pressure applications. It is self-actuated and requires no external energy source. Capillary units mount in any position and can be easily disconnected and interchanged, offering easy installation and maximum application flexibility.

Available in sizes 1/2" through 4" with six temperature ranges and three capillary lengths.

For a fully detailed certified drawing, refer to CDY #2232.

OB-2000L Specifications

Application	Inlet Pressure psig (bar)	Reduced Pressure psig (bar)	Temperature Ranges °F (°C)	Temperature Accuracy °F (°C)	Capillary Lengths feet (meters)
Steam	5 - 15 (.3 - 1)	3 (.21)	18 - 59 (-8 - 15) 50 - 97 (10 - 36) 86 - 144 (30 - 62) 131 - 201 (55 - 94) 176 - 260 (80 - 127) 239 - 361 (115 - 183)	±2 (±1) From Set Point	*6-1/2 (2) 9-1/2 (3) 16-1/2 (5)

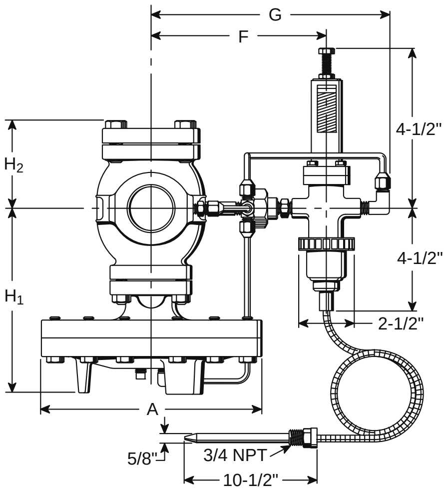
*Standard length.
Note: If desired set temperature is in temperature range overlap, select lower range.

OB-2000L Dimensions and Weights

Size		Face-to-Face "L"				H_1		H_2		A		F		G		Weight				C_V
		NPT		150#												NPT		150#		
in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	lb	kg	lb	kg	
1/2	15	5-15/16	150	5-9/16	141	6-3/4	170	2-15/16	74	7-15/16	200	6-5/8	169	8-3/4	222	31	15	33	15	6.5
3/4	20	5-15/16	150	5-1/2	140	6-3/4	170	2-15/16	74	7-15/16	200	6-5/8	169	8-3/4	222	31	15	33	15	9
1	25	6-5/16	160	5-3/4	147	6-15/16	175	3-1/16	76	8-15/16	226	6-7/8	174	8-7/8	226	39	19	41	20	12
1-1/4	32	7-1/8	180	6-1/2	166	7-5/8	192	3-9/16	90	8-15/16	226	7-1/8	182	9-1/4	235	47	22	49	23	19
1-1/2	40	7-1/8	180	7-7/16	189	7-5/8	192	3-9/16	90	8-15/16	226	7-1/8	182	9-1/4	235	47	22	49	23	22
2	50	9-1/8	230	8-9/16	217	8-1/2	216	4-1/16	103	10-15/16	276	7-7/16	189	9-1/2	242	71	33	77	36	38
2-1/2	65	—	—	10-15/16	278	9-13/16	251	4-7/8	122	13-13/16	352	8-1/8	206	10-1/8	259	—	—	138	63	66
3	80	—	—	11-3/4	298	10-7/16	264	5-3/8	135	13-13/16	352	8-9/16	217	10-5/8	270	—	—	149	69	78
4	100	—	—	13-1/2	343	12-5/8	321	6-9/16	167	15-13/16	401	9-1/4	234	11-1/4	287	—	—	234	107	116

*50% reduced port available for sizes 1/2" - 4". The C_v value should be divided by 2 to get reduced port C_v.

For capacities see page 48.



Designs, materials, weights and performance ratings are approximate and subject to change without notice. Visit www.armstronginternational.com for up-to-date information.

OB-2000L

For Steam

OB-2000L Sensor and Accessory Specifications

Capillary Material	Capillary Temperature Ranges °F (°C)	Bulb Material	Bulb Connection	Thermal Well Material	Thermal Well Connection
Copper Capillary Tube With 304 Stainless Steel Armor Shield	18 - 59 (-8 - 15) 50 - 97 (10 - 36) 86 - 144 (30 - 62) 131 - 201 (55 - 94) 176 - 260 (80 - 127) 239 - 361 (115 - 183)	Nickel Plated Copper Bulb	3/4" (20 mm) NPT	Brass* 304 Stainless Steel*	1" (25 mm) NPT

*Standard. Other material available upon request. See page 304 for dimensions of well.
NOTE: Capillary can withstand a maximum of 36°F (20°C) above rated range.
NOTE: If desired set temperature is in temperature range overlap, select lower range.

OB-2000L Materials

OB-2000	Body Material	Seat Type & Material	Valve Material	Connection	Maximum Temperature °F (°C)
Main Valve	Ductile Iron ASTM A536	Single Seat Stainless Steel AISI 420	Stainless Steel AISI 420	NPT 150 lb Flanged 300 lb Flanged	450 (232)
Temperature Pilot Valve	Bronze ASTM B584			1/4" (6 mm) NPT	

GP-2000L, OB-2000L

Capacities for Steam Service

GP-2000L and OB-2000L Steam Capacities

lb/hr											kg/hr										
Inlet	Outlet	Connection Size (in)									Inlet	Outlet	Connection Size (mm)								
psig		1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	bar		15	20	25	32	40	50	65	80	100
5	2	218	277	316	495	594	1,100	1,782	1,881	3,135	0.34	0.14	99	126	143	225	269	499	808	853	1,422
10	7	161	223	297	471	545	942	1,635	1,933	2,874	0.69	0.48	73	101	135	214	247	427	742	877	1,304
	3	356	435	475	812	920	1,518	2,574	2,772	4,598		0.21	161	197	215	368	417	689	1,168	1,257	2,086
15	12	178	246	328	519	601	1,038	1,803	2,131	3,169	1.03	0.83	81	112	149	235	273	471	818	966	1,437
	8	261	362	483	764	885	1,528	2,654	3,137	4,665		0.55	119	164	219	347	401	693	1,204	1,423	2,116
	3	416	482	594	970	1,168	1,694	3,069	3,366	5,643		0.21	189	219	269	440	530	768	1,392	1,527	2,560

Note: For reduced port capacity, please divide capacity by 2.

OB-2000PT

For Steam Service

The OB-2000PT is a diaphragm-operated externally piloted pressure/temperature combination regulator. It is used in applications where maximum pressure should be limited and the temperature of the heated medium is controlled using a single seated main valve. Temperature pilot and capillary unit disconnect, making repairs or temperature range changes quick and easy. Available in sizes 1/2" through 6" and with a choice of four spring ranges, six temperature ranges and three capillary lengths.

For a fully detailed certified drawing, refer to CDY #1006.

OB-2000PT Specifications

Application	Inlet Pressure psig (bar)	Minimum Differ. Pressure psig (bar)	Reduced Pressure & Spring Color psig (bar)	Temperature Ranges °F (°C)	Temperature Accuracy °F (°C)	Capillary Lengths feet (meters)
Steam	NPT 15 - 300 (1 - 20)	7 (.48)	1.5 - 3 (.10 - .21) Yellow 3 - 21 (.21 - 1.4) Yellow 15 - 200 (1.0 - 13.8) Green	18 - 59 (-8 - 15) 50 - 97 (10 - 36) 86 - 144 (30 - 62) 131 - 201 (55 - 94) 176 - 260 (80 - 127) 239 - 361 (115 - 183)	±2 (±1) From Set Point	6-1/2 (2)* 9-1/2 (3) 16-1/2 (5)
	150 lb Flanged 15 - 185 (1 - 13)					
	300 lb Flanged 15 - 300 (1 - 20)					

*Standard length.

OB-2000PT Sensor and Accessory Specifications

Capillary Material	Capillary Temperature Ranges °F (°C)	Bulb Material	Bulb Connection	Thermal Well Material	Thermal Well Connection
Copper Capillary Tube With 304 Stainless Steel Armor Shield	18 - 59 (-8 - 15) 50 - 97 (10 - 36) 86 - 144 (30 - 62) 131 - 201 (55 - 94) 176 - 260 (80 - 127) 239 - 361 (115 - 183)	Nickel Plated Copper Bulb	3/4" (20 mm) NPT	Brass* 304 Stainless Steel*	1" (25 mm) NPT

*Standard. Other material available upon request. See page 304 for dimensions of well.
NOTES: Capillary can withstand a maximum of 36°F (20°C) above rated range. If desired set temperature is in temperature range overlap, select lower range.

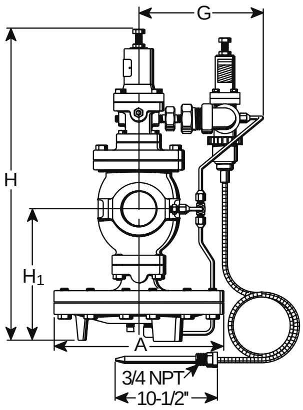
OB-2000PT Dimensions and Weights

Size		Face-to-Face						H		H_1		A		G		Weights						C_V
		NPT		150#		300#										NPT		150#		300#		
in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	lb	kg	lb	kg	lb	kg	
1/2	15	5-15/16	150	5-9/16	141	5-3/4	147	15-3/4	398	6-3/4	170	7-15/16	200	6-1/2	166	47	22	49	23	55	25	5.0
3/4	20	5-15/16	150	5-1/2	140	5-3/4	147	15-3/4	398	6-3/4	170	7-15/16	200	6-1/2	166	47	22	49	23	55	25	7.2
1	25	6-15/16	160	5-3/4	147	6-1/4	159	15-15/16	404	6-15/16	175	8-15/16	226	7	178	57	26	59	28	64	29	10.9
1-1/4	32	7-1/8	180	6-1/2	166	7-1/16	179	17-1/8	434	7-5/8	192	8-15/16	226	7-1/4	185	67	31	69	31	74	34	14.3
1-1/2	40	7-1/8	180	7-7/16	189	7-15/16	202	17-1/8	434	7-5/8	192	8-15/16	226	7-1/4	185	67	31	69	31	75	34	18.8
2	50	9-1/8	230	8-9/16	217	9-1/8	232	19-5/8	498	8-1/2	216	10-15/16	276	6-1/2	166	89	41	94	43	100	46	32
2-1/2	65	-	-	10-15/16	278	11-1/2	292	21-3/4	552	9-13/16	251	13-13/16	352	6-1/2	166	-	-	158	72	167	76	60
3	80	-	-	11-3/4	298	12-7/16	315	22-5/8	575	10-7/16	264	13-13/16	352	6-1/2	166	-	-	171	78	183	83	78
4	100	-	-	13-1/2	343	14-1/8	359	25-15/16	658	12-5/8	321	15-13/16	401	6-1/2	166	-	-	263	120	281	128	120

Note: For 6" (150 mm) consult factory.

OB-2000PT Materials

OB-2000PT	Body Material	Valve & Seat Material	Maximum Temperature °F (°C)
Main Valve	Ductile Iron ASTM A536	Stainless Steel AISI 420	450 (232)
Temperature Pilot Valve	Bronze ASTM B584		
Pressure Pilot	Ductile Iron ASTM A536		



OB-2000, OB-2000PT

Capacities for Steam Service

OB-2000, OB-2000PT Capacities—Steam

kg/hr											
Inlet	Outlet	Connection Size mm									
bar		15	20	25	32	40	50	65	80	100	150
C_V Factor		5	7.2	10.9	14.3	18.8	32	60	78	120	250
0.69*	0 - .21	96	138	209	274	360	613	1,150	1,494	2,299	4,790
1.03	0.55	91	131	199	261	343	584	1,095	1,423	2,189	4,561
	0 - .21	114	164	248	325	427	727	1,363	1,772	2,726	5,679
1.38	0.90	100	143	217	285	374	637	1,194	1,553	2,389	4,977
	0 - .21	142	205	310	407	534	910	1,706	2,218	3,412	7,108
1.72	1.24	107	154	234	307	403	686	1,287	1,673	2,573	5,361
	0 - .34	154	222	336	440	579	985	1,848	2,402	3,695	7,698
2.07	1.59	114	165	249	327	430	732	1,373	1,784	2,745	5,719
	0 - .48	173	250	378	496	652	1,109	2,080	2,704	4,161	8,668
2.76	2.28	128	184	278	365	479	816	1,530	1,989	3,060	6,376
	1.72	114	165	249	327	430	732	1,373	1,784	2,745	5,719
	0 - .83	173	250	378	496	652	1,109	2,080	2,704	4,161	8,668
3.45	2.90	128	184	278	365	479	816	1,530	1,989	3,060	6,376
	2.07	179	258	391	513	674	1,147	2,151	2,796	4,301	8,961
	0 - 1.17	212	305	462	607	798	1,358	2,546	3,309	5,091	10,607
4.14	3.52	148	214	324	425	558	950	1,781	2,315	3,562	7,421
	3.10	148	214	324	425	558	950	1,781	2,315	3,562	7,421
	2.41	223	321	486	637	838	1,426	2,673	3,475	5,347	11,139
	0 - 1.5	251	361	547	718	943	1,606	3,011	3,914	6,022	12,546
5.17	4.34	213	307	465	611	803	1,366	2,562	3,330	5,123	10,673
	3.79	269	387	586	769	1,011	1,721	3,227	4,195	6,454	13,446
	3.10	319	459	695	912	1,199	2,041	3,826	4,974	7,653	15,943
	0 - 2.1	348	501	758	995	1,308	2,226	4,175	5,427	8,349	17,394
6.89	5.86	270	389	589	772	1,016	1,729	3,241	4,213	6,482	13,505
	5.17	340	490	742	974	1,280	2,179	4,086	5,311	8,171	17,023
	4.14	415	597	904	1,186	1,559	2,653	4,975	6,467	9,949	20,728
	0 - 2.9	445	641	970	1,272	1,673	2,847	5,338	6,939	10,676	22,242
8.62	7.31	335	482	730	958	1,260	2,144	4,020	5,226	8,040	16,750
	6.89	380	547	828	1,086	1,428	2,431	4,558	5,925	9,116	18,991
	5.17	510	735	1,112	1,459	1,918	3,265	6,121	7,957	12,242	25,504
	0 - 3.7	542	780	1,181	1,550	2,037	3,467	6,502	8,452	13,003	27,090
10.34	8.76	400	576	872	1,143	1,503	2,559	4,798	6,237	9,596	19,991
	6.89	563	811	1,227	1,610	2,117	3,603	6,755	8,782	13,510	28,147
	0 - 4.6	639	920	1,392	1,827	2,402	4,088	7,665	9,964	15,330	31,937
12.07	10.20	465	669	1,013	1,329	1,747	2,973	5,575	7,247	11,150	23,229
	8.62	611	880	1,332	1,748	2,298	3,912	7,335	9,535	14,670	30,562
	6.89	720	1,036	1,569	2,058	2,706	4,606	8,636	11,226	17,271	35,982
	0 - 5.5	736	1,059	1,604	2,104	2,766	4,709	8,828	11,477	17,657	36,785
13.79	11.72	521	751	1,137	1,491	1,960	3,337	6,256	8,133	12,512	26,067
	10.34	656	945	1,430	1,876	2,466	4,198	7,872	10,233	15,744	32,799
	8.62	776	1,118	1,693	2,221	2,920	4,970	9,318	12,113	18,636	38,825
	0 - 6.3	833	1,199	1,815	2,381	3,131	5,329	9,992	12,990	19,984	41,633
15.51	13.17	586	844	1,278	1,676	2,204	3,751	7,033	9,143	14,066	29,305
	12.07	698	1,005	1,521	1,996	2,624	4,466	8,374	10,887	16,749	34,894
	10.34	829	1,194	1,808	2,372	3,119	5,309	9,954	12,940	19,907	41,473
	0 - 7.24	930	1,339	2,027	2,659	3,495	5,950	11,155	14,502	22,311	46,481
17.24	13.79	737	1,062	1,607	2,109	2,773	4,719	8,849	11,503	17,697	36,869
	12.07	879	1,266	1,917	2,515	3,306	5,627	10,551	13,716	21,102	43,962
	10.34	987	1,421	2,152	2,823	3,711	6,316	11,843	15,396	23,687	49,347
	0 - 8.06	1,027	1,478	2,238	2,936	3,860	6,570	12,319	16,015	24,638	51,329
18.96	13.79	926	1,334	2,019	2,649	3,483	5,929	11,116	14,451	22,233	46,318
	12.07	1,043	1,502	2,273	2,982	3,921	6,674	12,514	16,268	25,028	52,141
	0 - 8.96	1,124	1,618	2,449	3,213	4,224	7,191	13,482	17,527	26,965	56,177
20.00	13.79	1,096	1,578	2,389	3,134	4,120	7,013	13,150	17,095	26,300	54,793
	12.07	1,196	1,722	2,607	3,420	4,497	7,654	14,351	18,656	28,702	59,796
	0 - 9.79	1,220	1,758	2,661	3,491	4,589	7,811	14,646	19,040	29,292	61,024

*Minimum inlet pressure for OB-2000PT is 15 psi (1 bar) because of the pressure pilot.

OB-2000, OB-2000PT

Capacities for Steam Service

OB-2000, OB-2000PT Capacities—Steam

Inlet	Outlet	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	6
		lb/hr									
		Connection Size in									
psig		1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	6
C_V Factor		5	7.2	10.9	14.3	18.8	32	60	78	120	250
10*	0 - 3	211	304	460	604	794	1,352	2,534	3,294	5,068	10,559
15	8	201	290	438	575	756	1,287	2,413	3,137	4,826	10,055
	0 - 3	250	361	546	716	942	1,603	3,005	3,907	6,010	12,521
20	13	219	316	478	628	825	1,404	2,633	3,423	5,267	10,972
	0 - 3	313	451	683	896	1,178	2,006	3,761	4,889	7,521	15,669
25	18	236	340	515	676	889	1,513	2,837	3,688	5,673	11,819
	0 - 5	339	489	740	971	1,276	2,172	4,073	5,295	8,146	16,972
30	23	252	363	550	721	948	1,614	3,026	3,934	6,052	12,609
	0 - 7	382	550	833	1,093	1,437	2,446	4,586	5,962	9,172	19,109
40	33	281	405	613	804	1,057	1,799	3,373	4,385	6,747	14,056
	25	395	569	861	1,130	1,486	2,529	4,741	6,164	9,483	19,756
	0 - 12	468	673	1,020	1,338	1,758	2,993	5,612	7,296	11,224	23,384
50	42	327	471	713	936	1,230	2,094	3,927	5,105	7,853	16,361
	30	491	707	1,071	1,405	1,847	3,143	5,894	7,662	11,788	24,557
	0 - 17	553	797	1,206	1,582	2,080	3,540	6,638	8,630	13,276	27,659
60	51	373	537	814	1,067	1,403	2,389	4,479	5,823	8,958	18,662
	45	471	679	1,028	1,348	1,773	3,017	5,657	7,355	11,315	23,572
	35	586	843	1,277	1,675	2,202	3,748	7,027	9,135	14,053	29,278
	0 - 22	639	920	1,392	1,827	2,401	4,088	7,664	9,963	15,328	31,934
75	63	471	678	1,026	1,346	1,769	3,012	5,647	7,341	11,295	23,530
	55	593	854	1,292	1,696	2,229	3,794	7,114	9,249	14,229	29,643
	45	703	1,012	1,532	2,010	2,643	4,499	8,435	10,966	16,871	35,148
	0 - 30	767	1,104	1,672	2,193	2,884	4,908	9,203	11,964	18,406	38,347
100	85	595	857	1,298	1,703	2,239	3,811	7,145	9,289	14,291	29,773
	75	751	1,081	1,636	2,147	2,822	4,804	9,007	11,709	18,014	37,529
	60	914	1,316	1,992	2,614	3,436	5,849	10,967	14,257	21,934	45,696
	0 - 42	981	1,412	2,138	2,805	3,687	6,276	11,768	15,299	23,536	49,034
125	106	739	1,064	1,610	2,112	2,777	4,727	8,863	11,522	17,725	36,928
	100	837	1,206	1,825	2,395	3,149	5,359	10,048	13,063	20,097	41,869
	75	1,125	1,619	2,451	3,216	4,228	7,197	13,494	17,543	26,989	56,226
	0 - 55	1,194	1,720	2,604	3,416	4,491	7,644	14,333	18,633	28,666	59,722
150	127	881	1,269	1,922	2,521	3,314	5,641	10,577	13,751	21,155	44,072
	100	1,241	1,787	2,705	3,549	4,666	7,943	14,893	19,360	29,785	62,052
	0 - 67	1,408	2,028	3,070	4,027	5,295	9,012	16,898	21,968	33,796	70,409
175	148	1,024	1,475	2,233	2,929	3,851	6,555	12,291	15,978	24,581	51,211
	125	1,348	1,940	2,938	3,854	5,067	8,624	16,170	21,021	32,341	67,376
	100	1,587	2,285	3,459	4,537	5,965	10,154	19,038	24,750	38,076	79,325
	0 - 80	1,622	2,336	3,536	4,639	6,098	10,380	19,463	25,302	38,926	81,097
200	170	1,149	1,655	2,506	3,287	4,322	7,356	13,792	17,930	27,585	57,468
	150	1,446	2,083	3,153	4,136	5,438	9,256	17,354	22,560	34,708	72,309
	125	1,712	2,465	3,732	4,896	6,437	10,956	20,542	26,705	41,085	85,593
	0 - 92	1,836	2,643	4,002	5,250	6,902	11,748	22,028	28,637	44,056	91,784
225	191	1,292	1,861	2,817	3,695	4,858	8,270	15,505	20,157	31,011	64,606
	175	1,539	2,215	3,354	4,400	5,785	9,847	18,462	24,001	36,925	76,926
	150	1,829	2,633	3,986	5,230	6,876	11,703	21,944	28,527	43,887	91,431
	0 - 105	2,049	2,951	4,468	5,861	7,706	13,116	24,593	31,971	49,186	102,472
250	200	1,626	2,341	3,544	4,649	6,112	10,404	19,508	25,360	39,015	81,282
	175	1,938	2,791	4,226	5,544	7,288	12,406	23,261	30,239	46,521	96,919
	150	2,176	3,133	4,743	6,223	8,181	13,925	26,110	33,943	52,219	108,790
	0 - 117	2,263	3,259	4,934	6,473	8,510	14,484	27,158	35,306	54,316	113,159
275	200	2,042	2,941	4,452	5,841	7,679	13,070	24,507	31,859	49,014	102,112
	175	2,299	3,311	5,012	6,575	8,644	14,714	27,588	35,864	55,176	114,950
	0 - 130	2,477	3,567	5,400	7,084	9,313	15,852	29,723	38,640	59,446	123,847
300	200	2,416	3,479	5,267	6,910	9,084	15,462	28,991	37,688	57,982	120,796
	175	2,637	3,797	5,748	7,540	9,913	16,874	31,638	41,130	63,277	131,826
	0 - 142	2,691	3,875	5,866	7,695	10,117	17,220	32,288	41,975	64,576	134,534

*Minimum inlet pressure for OB-2000PT is 15 psi (1 bar) because of the pressure pilot.

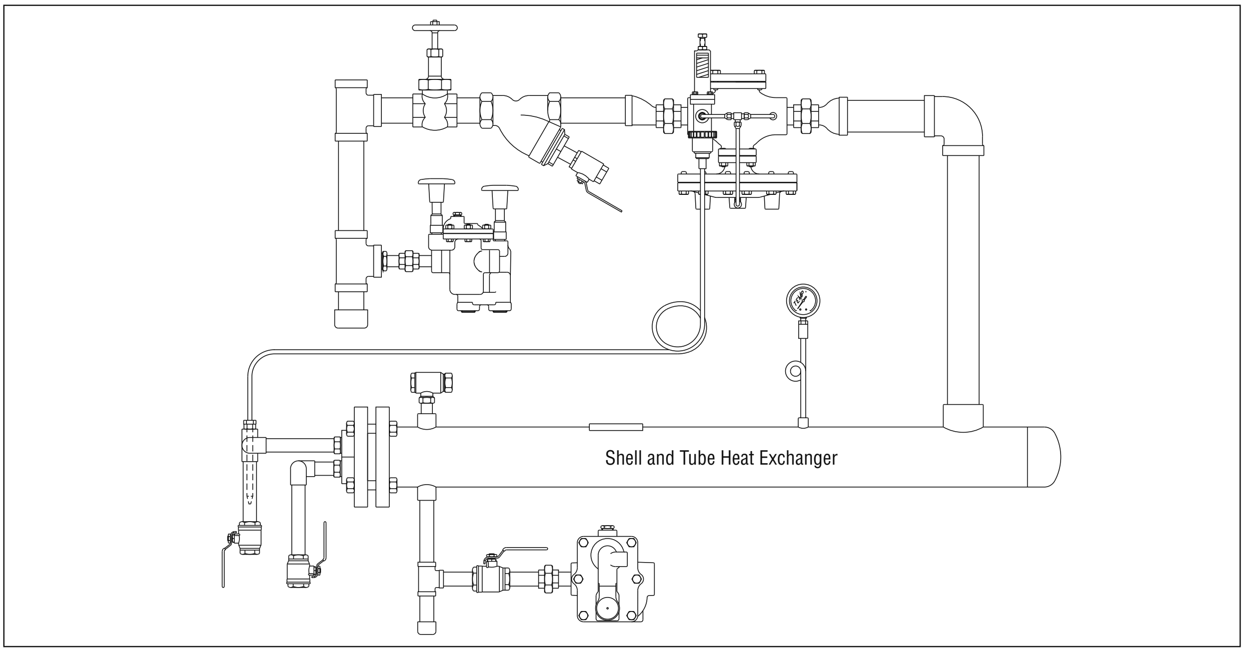
OB-30, OB-2000, OB-2000PT

For Steam Service

Points to Remember When Installing

- Drain condensate at inlet of pressure/temperature regulator with inverted bucket steam trap.
- Protect temperature regulating valve from dirt and scale by installing strainer with 100 mesh screen at inlet of valve.
- Install shutoff valves on either side of the regulating valve along with a by-pass line for maintenance purposes.
- Install vacuum breaker after the outlet of equipment and before the steam trap.
- Install sensor so it is fully immersed in the fluid being heated.
- If temperature well is used, apply heat transfer medium to sensor before insertion into well.
- Place thermometer into system in close proximity to temperature sensor for accurate valve adjustment.
- If possible, do not elevate condensate after steam trap.
- Determine pressure setting before temperature setting (OB-2000PT only).

Typical Installation—OB-30, OB-2000



Load Calculations

Heating oil with steam

$$\text{lb/hr steam} = \frac{GPM}{4} \times \Delta T \times 1.1$$

Heating water with steam

$$\text{lb/hr steam} = \frac{GPM}{2} \times \Delta T \times 1.1$$

Heating air with steam

$$\text{lb/hr steam} = \frac{CFM}{900} \times \Delta T \times 1.1$$

Jacketed kettles or tanks

$$\text{lb/hr steam} = \frac{Gal \times SG \times Cp \times \Delta T \times 8.3}{Lat \times T}$$

Where:

GPM = Gallons per minute
ΔT = Temperature rise (°F)
CFM = Cubic feet per minute
Cp = Specific heat of liquids (Btu/lb-°F)
T = Time (hours)
Lat = Latent heat of steam (Btu/lb)
Gal = Gallons of liquid to be heated
SG = Specific gravity
1.1 = Safety factor

PNEUMATIC CONTROL VALVES - PV16G

(V16G globe valves series with linear actuators PA series)

DESCRIPTION

The PV16G control valves are single seated, two-way body constructed with in-line straight connections. The PA pneumatic actuator is rubber diaphragm and multi-springs. Its action can be DA -direct action (air to close) or RA-reverse action (air to open). The PV16G valves have been designed to assure an accurate control in any process condition. Their wide application ranges allows the use of this valve with the most common process fluids such as water, superheated water, steam, air, gas and other non corrosive fluids.

MAIN FEATURES

Single seated, two ways, direct or reverse action valve.
Valve top flange permanently attached to the body, removal is unnecessary for replacing the actuator.
Soft sealing as standard.

OPTIONS:	Balanced plug (sizes DN125-DN200) Position transmitter 4-20 mA Pneumatic pilot positioner Electropneumatic pilot positioner Air filter regulator Top-work manual handwheel Stainless steel construction.
USE:	Saturated and superheated steam. Hot and superheated water. Air, gases and other noncorrosive fluids.
AVAILABLE MODELS:	PV16G-single seat unbalanced. PV16G2-single seat,pressure balanced.
VALVE SIZES:	DN15 to DN200
CONNECTIONS:	Flanged EN 1092-2 PN16
ACTUATORS:	PA-205; PA-280; PA-340; PA-435
ACTUATOR CONN:	1/4" NPT-F
CONTROL SIGNAL:	0,2 - 1 bar ; 0,4 - 1,2 bar ; 0,4 - 2 bar.

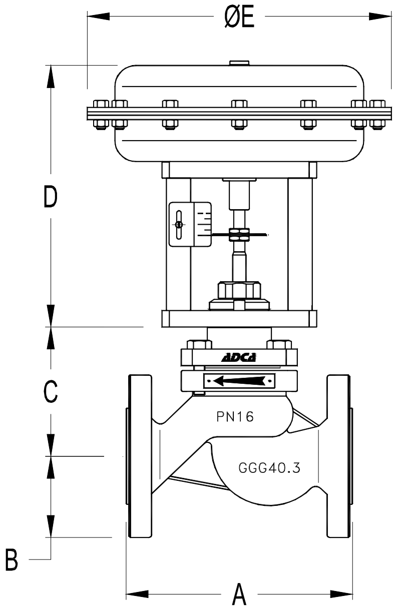
HOW TO SELECT: Never size the valve according to the pipe diameter in which it has to be fitted but according to the required actual flow of steam or water.Refer to valve calculation data sheet or consult the factory.

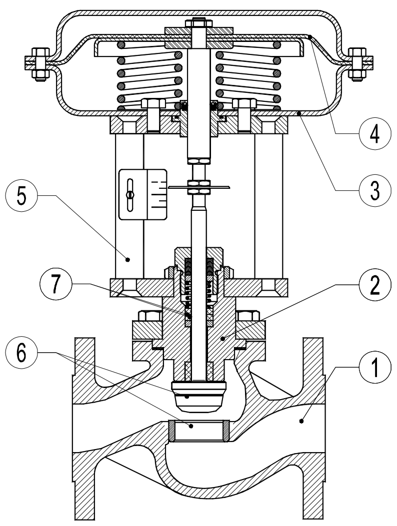
VALVE LIMITING CONDITIONS:	Body design conditions: PN16 16 bar at 120ºC 14,7 bar at 200ºC Min.working temperature: -10ºC
MAX. AIR SUPPLY PRESSURE:	3,5 bar
AMBIENT TEMPERATURE:	-20ºC ...+70ºC
BONNET :	From -5ºC to +220ºC (standard)
STEM SEALING:	PTFE/GR V-Rings - up to 220ºC (Standard bonnet) Graphite - up to 400ºC (Standard on valves DN125-200)
PLUG CHARACT.:	EQP - Equal percentage PT - On-off
PLUG DESIGN:	Contoured
PORT :	Full port

CE MARKING (PED - European Directive 97/23/EC)	
PN 16	**Category**
DN15 to DN50	SEP - art. 3, paragraph3
DN65 to DN200	1 (CE Marked)

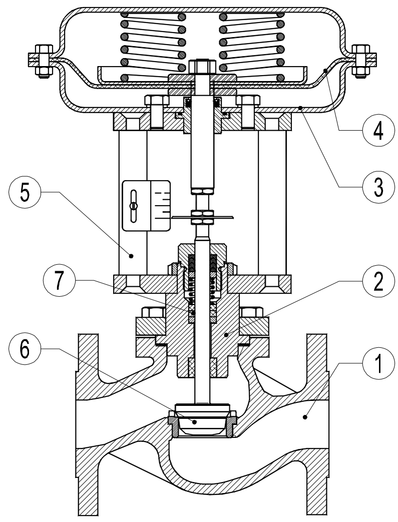
PNEUMATIC CONTROL VALVES - PV16G

(V16G globe valves series with linear actuators PA series)





PV16 DA – Direct action



PV16 RA – Reverse action

DIMENSIONS - VALVE BODY

DN	A (mm)	B (mm)	C (mm)	WEIGHT Kgs
15	130	48	80	3
20	150	53	80	3,7
25	160	58	85	4,4
32	180	70	90	6,8
40	200	75	105	9,5
50	230	83	105	11,7
65	290	93	165	18,5
80	310	100	175	20,3
100	350	110	190	30
125	400	125	240	-
150	480	142	290	-
200	600	170	315	-

PV16 DA - Direct action from DN15 to DN200
PV16 RA - Reverse action from DN15 to DN100

MATERIALS

POS.	DESIGNATION	MATERIAL
1	Valve Body	GJS-400-18-LT / 0.7043
2	Bonnet	CF8 / 1.4308
3	Actuator (Steel)	S235JRG2 / 1.0038
	Actuator (Stainless steel)	AISI304 / 1.4301
4	Diaphragm	NBR 70
5	Yoke (Steel)	C45E / 1.1191
	Yoke (Stainless steel)	AISI304 / 1.4301
6	Valve Seal	PTFE/GR
7	Standard packing	PTFE/GR

DIMENSIONS - ACTUATOR

Type	ø E (mm)	D (mm) DN15-100 DA/RA	D (mm) DN125-200 DA	WEIGHT Kgs
PA-205	210	235	—	5,7
PA-280	275	240	—	8,8
PA-340	335	265	—	14,3
PA-435	430	295	—	24,5

FLOW RATE COEFFICIENTS

	DN15	DN20	DN25	DN32	DN40	DN50	DN65	DN80	DN100	DN125	DN150	DN200
Kvs	3,8	5,1	9,4	15,4	22,2	40,1	63,4	89,7	136,7	230,6	316,1	555,3

Kvs in m3/h , see data sheet IS PV10.00 E ; For conversion Kvs = Cv(US) x 0,855

ACTUATOR STROKE IN mm

	DN15	DN20	DN25	DN32	DN40	DN50	DN65	DN80	DN100	DN125	DN150	DN200
Stroke	20	20	20	20	20	20	30	30	30	40	40/50	50

PNEUMATIC CONTROL VALVES - PV16G

(V16G globe valves series with linear actuators PA series)

MAX. PERMISSIBLE PRESS.DROP IN bar - Normally closed valve (fluid to open) -Reverse action actuator (air signal to open)

ACTUATOR	CONTROL SIGNAL	SIZES											
		DN15	DN20	DN25	DN32	DN40	DN50	DN65	DN80	DN100	DN125	DN150	DN200
PA-205	0,2 ÷ 1 bar	6	6	5	—	—	—	—	—	—	—	—	—
	0,4 ÷ 1,2 bar	10	10	7	—	—	—	—	—	—	—	—	—
	0,4 ÷ 2 bar	12	12	9	—	—	—	—	—	—	—	—	—
PA-280	0,2 ÷ 1 bar	28	26	16	8	6	3,5	—	—	—	—	—	—
	0,4 ÷ 1,2 bar	40	38	20	12	10	5	—	—	—	—	—	—
	0,4 ÷ 2 bar	50	45	25	16	12	6,5	—	—	—	—	—	—
PA-340A	0,2 ÷ 1 bar	60	60	50	20	12	10	—	—	—	—	—	—
	0,4 ÷ 1,2 bar	80	80	60	30	16	13	—	—	—	—	—	—
	0,4 ÷ 2 bar	100	100	80	40	20	18	—	—	—	—	—	—
PA-340B	0,2 ÷ 1 bar	—	—	—	—	—	—	4	2,5	1	—	—	—
	0,4 ÷ 1,2 bar	—	—	—	—	—	—	5	3,5	1,5	—	—	—
	0,4 ÷ 2 bar	—	—	—	—	—	—	6	4	2	—	—	—
PA435A	0,2 ÷ 1 bar	—	—	—	—	40	25	—	—	—	*	*	*
	0,4 ÷ 1,2 bar	—	—	—	—	48	30	—	—	—	*	*	*
	0,4 ÷ 2 bar	—	—	—	—	55	45	—	—	—	*	*	*
PA435B	0,2 ÷ 1 bar	—	—	—	—	—	—	6	5	3	*	*	*
	0,4 ÷ 1,2 bar	—	—	—	—	—	—	8	7	5	*	*	*
	0,4 ÷ 2 bar	—	—	—	—	—	—	10	8	6	*	*	*
	0,4 ÷ 2,5 bar	—	—	—	—	—	—	16	15	12	*	*	*

* For valve size DN125 and above please consult.
The pressure drop values are referred to closed valves. They have been verified by a control signal coming from an electro-pneumatic converter with an enduring minimum signal of 0,2 bar.
The actuator press. drops given with closed valve for the actuator signal 0,4 - 2 bar are also valid for ON-OFF service with air supply at 2,5 bar.
Special spring drops available on request.
The pressure drop values must be used within the body rating limits.
For electric actuator selection please consult catalogue IS EL.20.00 E or our technical department.

MAX.PERMISSIBLE PRESS.DROP IN bar - Normally open valve (fluid to open) - Direct action actuator (air signal to close)

ACTUATOR	CONTROL SIGNAL	SIZES											
		DN15	DN20	DN25	DN32	DN40	DN50	DN65	DN80	DN100	DN125	DN150	DN200
PA-205	0,2 ÷ 1 bar	16	16	12	5	—	—	—	—	—	—	—	—
	0,4 ÷ 2 bar	25	24	16	7,5	—	—	—	—	—	—	—	—
PA-280	0,2 ÷ 1 bar	—	—	19	10	8	4	—	—	—	—	—	—
	0,4 ÷ 2 bar	—	—	25	20	16	7	—	—	—	—	—	—
PA-340A	0,2 ÷ 1 bar	—	—	—	17	16	10	—	—	—	—	—	—
	0,4 ÷ 2 bar	—	—	—	28	26	25	—	—	—	—	—	—
PA-340B	0,2 ÷ 1 bar	—	—	—	—	—	—	5	3,5	1,5	—	—	—
	0,4 ÷ 2 bar	—	—	—	—	—	—	8	7	3	—	—	—
PA435B	0,2 ÷ 1 bar	—	—	—	—	—	—	8	5	3	*	*	*
	0,4 ÷ 2 bar	—	—	—	—	—	—	16	10	7,5	*	*	*

* For valve size DN125 and above please consult.
The actuator pressure drops given with closed valve, are obtained with the following air pressures supply :
Actuator signal 0,2 to 1 bar : air supply 1,2 bar
Actuator signal 0,4 to 2 bar : air supply 2,5 bar
The actuator press. drops given with closed valve for the actuator signal 0,4- 2 bar are also valid for ON-OFF service with air supply at 2,5 bar.
Special spring drops available on request.
The pressure drop values must be used within the body rating limits.
For electric actuator selection please consult catalogue IS EL.20.00 E or our technical department.

PNEUMATIC CONTROL VALVES - PV16G

(V16G globe valves series with linear actuators PA series)

ORDERING CODES V16

VALVE CODES	V .16 G . . . . .X. .
Actuator Type (1)	
Pneumatic Actuator	P
Electric Actuator	E
Group Designation	
Globe valve, two way, straight body	V
Valve Model	
Class PN16, GJS-400-18-LT body, stainless steel trim	.16 G
Class PN16, CF8M body, stainless steel trim	.16 I
Stem Sealing	
PTFE/GR-V-Rings / Standard bonnet	1
Virgin PTFE V-Rings / Standard bonnet	2
Graphite / Standard bonnet	3
Valve Plug	
EQP (equal percentage) - Soft (PTFE/GR)	1
Pipe Connection	
Flanged EN1092-2 PN16	L
Size	
DN15	15
DN20	20
...	
Actuator	(1)
Extras (3)	E

ACTUATOR CODES (pneumatic)	P.
Group Designation	
Multi-spring , pneumatic linear actuator	P.
Actuator Size	
205	1
280	3
340 A - From DN15 to DN50	5
340 B - From DN65 to DN100	6
435 A - From DN15 to DN50	7
435 B - From DN65 to DN100	8
Actuator	
Direct Action	D
Reverse Action	R
Actuator Constrution	
Steel construction (painted) - standard	(2)
Stainless steel construction	I
Control Signal	
0,2 - 1 bar (3/15 psi)	15
0,4 - 1,2 bar (6/18 psi)	18
0,4 - 2 bar (6/30 psi)	30

To be introduced on ".X.", if supplied in combination with the valve.

Example:
V16G valve model EQP soft plug, PTFE/GR stem sealing DN50 complete with reverse action actuator signal 0,4-1,2bar, size340A steel.

Code: PV.16G.11L50.5R18

REMARKS:
(1)- Indicate actuator type.
(2)- Omitted if the standard actuator is selected.
(3)- To be used only when a non-standard combination valve is supplied.
ADCATROL control valves are identified by a serial number on a nameplate, located on the actuator yoke.
Always order spares by using that serial number. If the valve has non-standard extras the serial number has also an E (extras).

PNEUMATIC CONTROL VALVES - PV25 (ANSI)

V25S globe control valves with linear actuators PA series

DESCRIPTION

The PV25 control valves are single seated, two-way body constructed with in-line straight connections. The PA pneumatic actuator is rubber diaphragm and multi-springs. Its action can be DA -direct action (air to close) or RA-reverse action (air to open). The PV25 valves have been designed to assure an accurate control in any process condition. Their wide application ranges allows the use of this valve with the most common process fluids such as water, superheated water, steam, air, gas and other non corrosive fluids (group 1).

MAIN FEATURES

Single seated, two way, direct or reverse action valve. Valve top flange permanently attached to the body, removal is unnecessary for replacing the actuator.
Metal to metal sealing as standard.

OPTIONS:	Position transmitter 4-20 mA Pneumatic pilot positioner Electropneumatic pilot positioner Air filter regulator Top-work manual handwheel Stainless steel construction. Soft sealing and stellite seat and plug.
USE:	Saturated and superheated steam. Hot and superheated water. Air, gases and other noncorrosive fluids.
AVAILABLE MODELS:	PV25S Cast steel
VALVE SIZES:	1/2" to 6"
CONNECTIONS:	Flanged ANSI B16.5 150# and 300#
ACTUATORS:	PA-205; PA-280; PA-340; PA-435
ACTUATOR CONN:	1/4" NPT-F
CONTROL SIGNAL:	0,2 - 1 bar ; 0,4 - 1,2 bar ; 0,4 - 2 bar.

HOW TO SELECT: Never size the valve according to the pipe diameter in which it has to be fitted but according to the required actual flow of steam or water. Refer to valve calculation data sheet or consult the factory.

CE MARKING (PED - European Directive 97/23/EC)		
ANSI 150	ANSI 300	Category
1" - 2" (DN25-50)	1" (DN25)	SEP - art. 3, paragraph3
3"-6" (DN80-150)	11/2"-4" (DN40-100)	1 (CE Marked)
/	11/2"-6" (DN40-150)	2 (CE Marked)

Note: classification for gases - Group 2, for others see IMI

MAX. AIR SUPPLY PRESSURE:	3,5 bar
AMBIENT TEMPERATURE:	-20ºC ...+70ºC
BONNET :	From -5ºC to +220ºC (standard) Finned for temperature >220ºC
STEM SEALING:	PTFE/GR V-Rings - up to 220ºC (Standard bonnet) Graphite - up to 400ºC (Finned bonnet) Stainless steel bellows
PLUG CHARACT.:	EQP - Equal percentage PL - Linear PT - On-Off
PLUG DESIGN :	Contoured V-ported Perforated (Low noise, anti-cavitation) Microflow
PORT :	Full port or reduced on request
COMPLEMENTARY INFORMATION :	See IS PV10.00 E

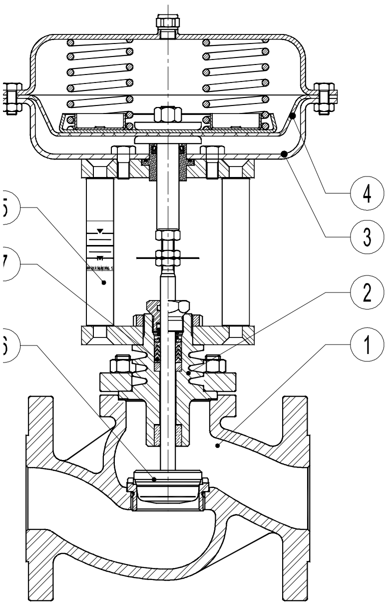
PNEUMATIC CONTROL VALVES - PV25 (ANSI)

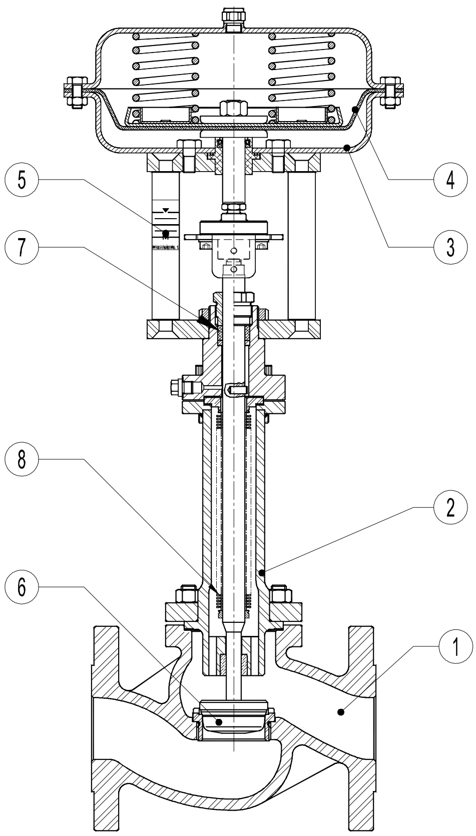
V25S globe control valves with linear actuators PA series

VALVE BODY LIMITING CONDITIONS			
PV25S - ANSI 150		PV25S - ANSI 300	
ALLOWABLE PRESSURES	RELATED TEMP.	ALLOWABLE PRESSURES	RELATED TEMP.
19,3 bar	-10 /50º C	50 bar	-10 /50º C
15,8 bar	150 ºC	43,9 bar	200 ºC
12,1 bar	250 ºC	36,9 bar	350 ºC
8,4 bar	350 ºC	34,6 bar	400 ºC

MATERIALS		
POS.	***DESIGNATION***	***MATERIAL V25S***
1	Valve Body	ASTM A216WCB / 1.0619 ; GP240GH / 1.0619
2	Bonnet	CF8 / 1.4308 **
3	Actuator (Steel)	S235JRG2 / 1.0038
	Actuator (Stainless steel)	AISI304 / 1.4301
4	*Diaphragm	NBR 70
5	Yoke (Steel)	C45E / 1.1191
	Yoke (Stainless steel)	AISI304 / 1.4301
6	*Valve plug	PTFE/GR ; St.Steel
7	*Standard packing	PTFE/GR
8	*Metal bellows	AISI316Ti / 1.4571

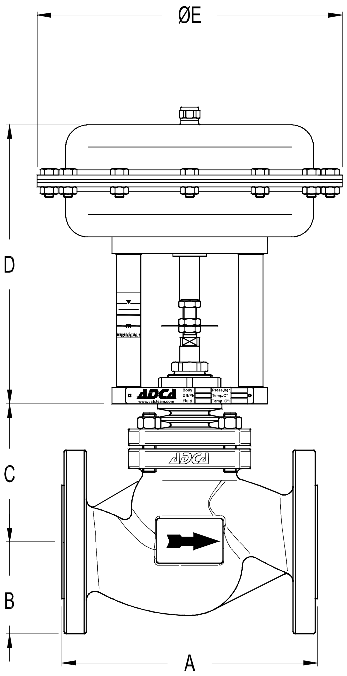
* Available spare parts **Except DN6", totaly in cast steel.

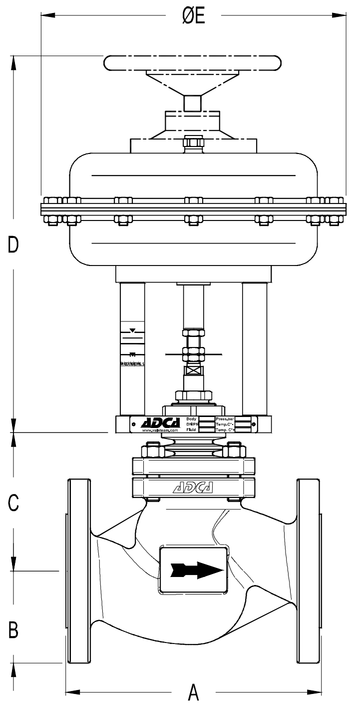


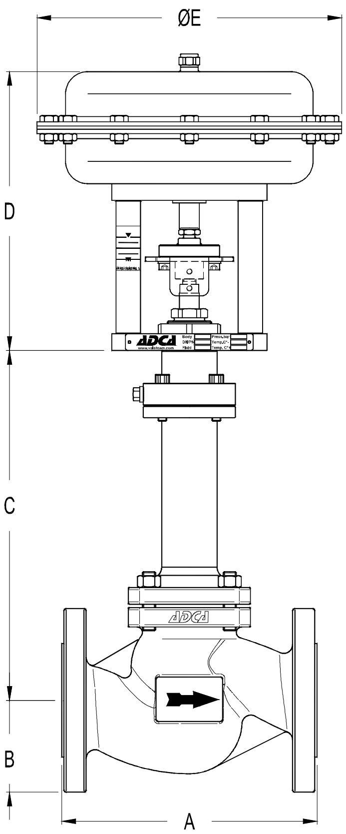


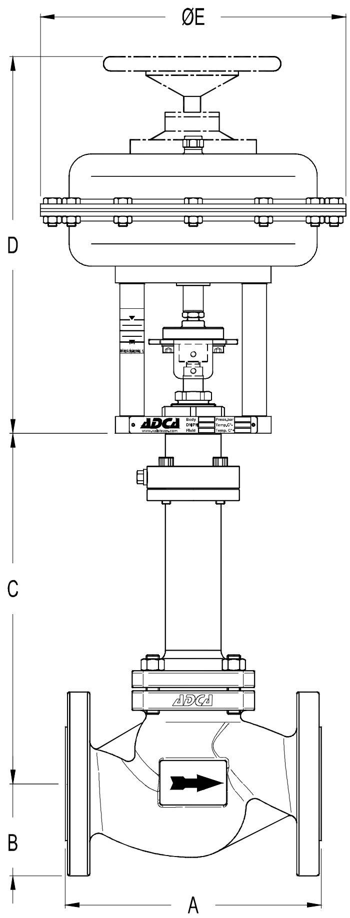
PNEUMATIC CONTROL VALVES - PV25 (ANSI)

V25S globe control valves with linear actuators PA series









PNEUMATIC CONTROL VALVES - PV25 (ANSI)

V25S globe control valves with linear actuators PA series

DIMENSIONS (mm) - VALVE BODY							
SIZE	A * ANSI 300	B ANSI 150	B ANSI 300	C BONNET			
				STANDARD	FINNED	EXTENDED	BELLOWS
1/2"	190	44,5	47,5	85	150	150	290
3/4"	194	49	58,5	85	150	150	290
1"	197	54	62	90	170	170	295
11/2"	235	63,5	78	115	195	195	285
2"	267	76	82,5	125	215	215	285
3"	317	95	105	175	275	275	392
4"	368	114,5	127	190	310	310	400
6"	470	140	159	210	390	390	480

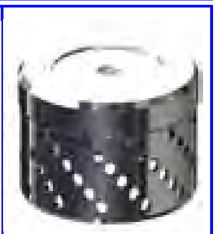
* ANSI 150 is drilled with the same lenght

DIMENSIONS - ACTUATOR			
Type	ø E (mm)	D (mm) DN1/2" - 4" DA/RA	WEIGHT Kgs
PA-205	210	235	5,7
PA-280	275	240	8,8
PA-340	335	265	14,3
PA-435	430	295	24,5

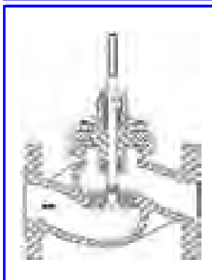
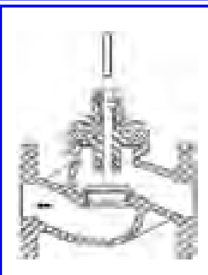
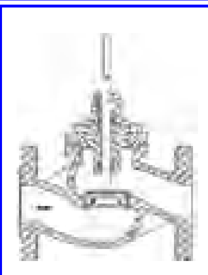
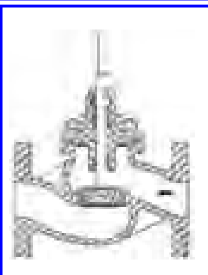
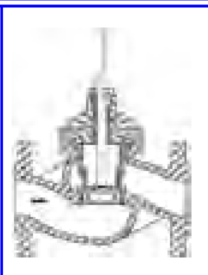
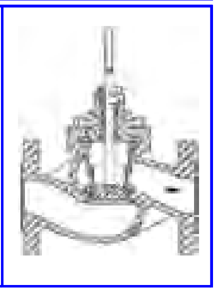
FLOW RATE COEFFICIENTS & VALVE STROKE										
	SIZES									
	1/2"	3/4"	1"	11/4"	11/2"	2"	21/2"	3"	4"	6"
Kvs (m3/h)	3,8	5,1	9,4	-	22,2	40,1	-	89,7	136,7	316,1
Stroke (mm)	20	20	20	-	20	20	-	30	30	40

Kvs in m3/h , for conversion Kvs = Cv(US) x 0,855

Perforated plugs has different flow rates, see data sheet IS PV10.00 E .

PLUG DESIGN					
Microflow Linear PL	Contoured Equal % or Linear EQP - PL	V - Ported Equal percentage EQP	V - Ported Linear PL	Perforated Equal percentage EQP	Perforated Linear PL
					

V-Ported and perforated plugs are also available in balanced pressure version.

VALVE DESIGN - FLOW DIRECTION					
Microflow Linear PL	Contoured Equal % or Linear EQP - PL	V - Ported EQP - PL	V - Ported Perforated EQP - PL	V-Ported Balanced EQP - PL	Perforated Balanced EQP - PL
					

PNEUMATIC CONTROL VALVES - PV25 (ANSI)

V25S globe control valves with linear actuators PA series

MAX. PERM.PRESS.DROP IN bar - N.C.(fluid to open) -Reverse action actuator (air signal to open)								
ACTUATOR	*CONTROL SIGNAL*	*SIZES*						
		1/2"	*3/4"*	*1"*	*11/2"*	*2"*	*3"*	*4"*
PA-205	**0,2 ÷ 1 bar**	6	6	5	—	—	—	—
	0,4 ÷ 1,2 bar	10	10	7	—	—	—	—
	0,4 ÷ 2 bar	12	12	9	—	—	—	—
PA-280	**0,2 ÷ 1 bar**	28	26	16	6	3,5	—	—
	0,4 ÷ 1,2 bar	40	38	20	10	5	—	—
	0,4 ÷ 2 bar	50	45	25	12	6,5	—	—
PA-340A	**0,2 ÷ 1 bar**	60	60	50	12	10	—	—
	0,4 ÷ 1,2 bar	80	80	60	16	13	—	—
	0,4 ÷ 2 bar	100	100	80	20	18	—	—
PA-340B	**0,2 ÷ 1 bar**	—	—	—	—	—	2,5	1
	0,4 ÷ 1,2 bar	—	—	—	—	—	3,5	1,5
	0,4 ÷ 2 bar	—	—	—	—	—	4	2
PA435A	**0,2 ÷ 1 bar**	—	—	—	40	25	—	—
	0,4 ÷ 1,2 bar	—	—	—	48	30	—	—
	0,4 ÷ 2 bar	—	—	—	55	45	—	—
PA435B	**0,2 ÷ 1 bar**	—	—	—	—	—	5	3
	0,4 ÷ 1,2 bar	—	—	—	—	—	7	5
	0,4 ÷ 2 bar	—	—	—	—	—	8	6
	0,4 ÷ 2,5 bar	—	—	—	—	—	15	12

* For valve size DN 6" please consult .
The pressure drop values are referred to closed valves. They have been verified by a control signal coming from an electro-pneumatic converter with an enduring minimum signal of 0,2 bar.
The actuator press. drops given with closed valve for the actuator signal 0,4 - 2 bar are also valid for ON-OFF service with air supply at 2,5 bar.
Special spring drops available on request.
The pressure drop values must be used within the body rating limits.
For electric actuator selection please consult catalogue IS EL.20.00 E or our technical department.
If higher differential pressures are required please consult PA45 pneumatic actuators catalogue.

MAX. PERM.PRESS.DROP IN bar - N.O.(fluid to open) -Direct action actuator (air signal to close)								
ACTUATOR	*CONTROL SIGNAL*	*SIZES*						
		1/2"	*3/4"*	*1"*	*11/2"*	*2"*	*2"*	*4"*
PA-205	**0,2 ÷ 1 bar**	16	16	12	—	—	—	—
	0,4 ÷ 2 bar	25	24	16	—	—	—	—
PA-280	**0,2 ÷ 1 bar**	—	—	19	8	4	—	—
	0,4 ÷ 2 bar	—	—	25	16	7	—	—
PA-340A	**0,2 ÷ 1 bar**	—	—	—	16	10	—	—
	0,4 ÷ 2 bar	—	—	—	26	25	—	—
PA-340B	**0,2 ÷ 1 bar**	—	—	—	—	—	3,5	1,5
	0,4 ÷ 2 bar	—	—	—	—	—	7	3
PA435B	**0,2 ÷ 1 bar**	—	—	—	—	—	5	3
	0,4 ÷ 2 bar	—	—	—	—	—	10	7,5

* For valve size DN 6" please consult.
The actuator pressure drops given with closed valve, are obtained with the following air pressures supply:
Actuator signal 0,2 to 1 bar :air supply 1,2 bar ; Actuator signal 0,4 to 2 bar : air supply 2,5 bar
The actuator press. drops given with closed valve for the actuator signal 0,4- 2 bar are also valid for ON-OFF service with air supply at 2,5 bar.
Special spring drops available on request.
The pressure drop values must be used within the body rating limits.
For electric actuator selection please consult catalogue IS EL.20.00 E or our technical department.

PNEUMATIC CONTROL VALVES - PV25 (ANSI)

V25S globe control valves with linear actuators PA series

ORDERING CODES V25

VALVE CODES		V	.25 S					.X.	
Actuator Type (1)									
Pneumatic Actuator	P								
Electric Actuator	E								
Group Designation									
Globe valve, two way, straight body		V							
Valve Model									
ASTM A216 WCB body, stainless steel trim			.25 S						
Stem Sealing									
PTFE/GR-V-Rings / Standard bonnet				1					
Virgin PTFE V-Rings / Standard bonnet				2					
Graphite / Standard bonnet				3					
Graphite / Finned bonnet				4					
Bellows				8					
Valve Plug									
EQP (equal percentage) - Soft (PTFE-GR)					1				
EQP (equal percentage) - Metal AISI316 / 1.4401					3				
EQP (equal percentage) - Stellite					4				
PL (linear) - Soft (PTFE/GR)					6				
PL (linear) - Metal AISI316 / 1.4401					7				
PT (on-off) - Soft (PTFE/GR)					9				
PT (on-off) - Metal AISI316 / 1.4401					10				
Pipe Connection									
Flanged ANSIB16.5 150#						U			
Flanged ANSIB16.5 300#						V			
Size									
1/2"							15		
3/4"							20		
…									
Actuator								(1)	
Extras (3)									E

ACTUATOR CODES (pneumatic)	P.				
Group Designation					
Multi-spring , pneumatic linear actuator	P.				
Actuator Size					
205		1			
280		3			
340 A - From DN15 to DN50		5			
340 B - From DN65 to DN100		6			
435 A - From DN15 to DN50		7			
435 B - From DN65 to DN100		8			
Actuator					
Direct Action			D		
Reverse Action			R		
Actuator Constrution					
Steel construction (painted) - standard				(2)	
Stainless steel construction				I	
Control Signal					
0,2 - 1 bar (3/15 psi)					15
0,4 - 1,2 bar (6/18 psi)					18
0,4 - 2 bar (6/30 psi)					30

To be introduced on ".X.", if supplied in combination with the valve.

Example:
V25G valve model EQP soft plug, PTFE/GR stem sealing DN 2" ANSI 150#complete with reverse action actuator signal 0,4-1,2bar, size340A steel.

Code: PV.25G.11U50.5R18

REMARKS:
(1)- Indicate actuator type.
(2)- Omitted if the standard actuator is selected.
(3)- To be used only when a non-standard combination valve is supplied.
ADCATROL control valves are identified by a serial number on a nameplate, located on the actuator yoke.
Always order spares by using that serial number. If the valve has non-standard extras the serial number has also an E (extras).

PNEUMATIC CONTROL VALVES - PV40

(V40 globe valves series with linear actuators PA or EL series)

DESCRIPTION

The PV40 control valves are single seated, two-way body constructed with in-line straight connections. The PA pneumatic actuator is rubber diaphragm and multi-springs. Its action can be DA -direct action (air to close) or RA-reverse action (air to open). The PV40 valves have been designed to assure an accurate control in any process condition. Their wide application ranges allows the use of this valve with the most common process fluids such as water, superheated water, steam, air, gas and other non corrosive fluids.

MAIN FEATURES

Single seated, two way, direct or reverse action valve.
Valve top flange permanently attached to the body, removal is unnecessary for replacing the actuator.
Metal to metal sealing as standard.

OPTIONS:	Soft sealing Position transmitter Pneumatic pilot positioner Air filter regulator Top-work manual handwheel
USE:	Saturated and superheated steam Hot and superheated water Diathermic oil Air, gases and other no corrosive fluids
AVAILABLE MODELS:	PV40S-EV40S – steel construction PV40I-EV40I – stainless steel
VALVE SIZES:	DN15 to DN50
CONNECTION:	Flanged EN 1092-1 or ANSI Threaded connections on request
PNEUMATIC ACTUATORS:	PA-205,PA-280,PA-340,PA-435
ACTUATOR CONN:	¼" NPT-F
CONTROL SIGNAL:	0,2 – 1bar; 0,4 – 1,2 bar ; 0,4 – 2 bar
ELECTRIC ACT.:	Consult catalogue IS EL20.00 E

MAX.AIR SUPPLY:	3,5 bar
AMBIENT TEMPERATURE:	-20ºC ….+70ºC
STEM SEALING:	PTFE/GR V-Rings-220ºC (Standard bonnet) Graphite – 300ºC (Extended bonnet)
PLUG CHARACT.:	EQP – Equal percentage PL – Linear PT – On-off
PLUG DESIGN:	Contoured Perforated (Low noise, anti-cavitation) Microflow
PORT:	Full or reduced on request

HOW TO SELECT: Never size the valve according to the pipe diameter in which it has to be fitted, but according to the required actual flow of steam or water. Refer to the valve calculation data sheet or consult the factory.

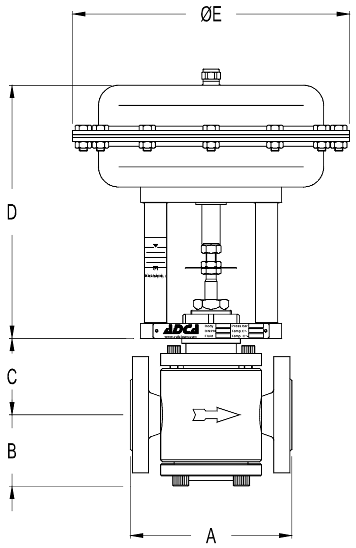
VALVE LIM. CONDITIONS V40S		VALVE LIM. CONDITIONS V40I	
PRESSURE/TEMPERATURE *		PRESSURE/TEMPERATURE *	
40 bar	-10/50ºC	40 bar	-10/100ºC
33,3 bar	200 ºC	33,7 bar	200 ºC
30,4 bar	250 ºC	31,8 bar	250 ºC
27,6 bar	300 ºC	29,7 bar	300 ºC

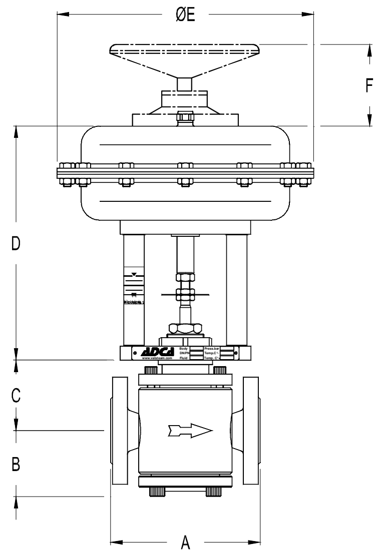
Maximum temperature limited to the valve packing selected
Valves with soft seat , maximum allowable temperature: 200ºC
*** PN63 and PN100 design on request**

CE MARKING (PED - European Directive 97/23/EC)	
PN 40	Category
DN15 to DN32	SEP - art. 3, paragraph3
DN40 to DN50	1 (CE Marked)

PNEUMATIC CONTROL VALVES - PV40

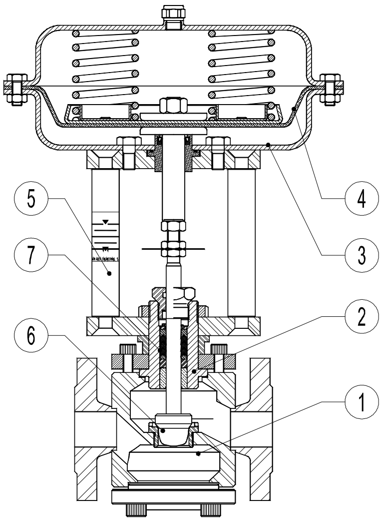
(V40 globe valves series with linear actuators PA or EL series)





DIMENSIONS - VALVE BODY							
DN	EN FLANGES A (mm)	ANSI 150 FLANGES A (mm)	ANSI 300 FLANGES A (mm)	B (mm)	C (mm) BONNET		
					STAND.	FINNED	EXTEND.
15 - 1/2"	150	184	190	71	75	140	140
20 - 3/4"	150	184	194	71	75	140	140
25 - 1"	160	184	197	71	75	140	140
32	180	-	-	75	83	163	163
40 - 11/2"	200	222	235	82	96	163	163
50 - 2"	230	254	267	97	100	182	182

Note: welded-on flanges EN 1092-1 PN40 or ANSI B16.5 Cl.150 and 300 lbs. RF



DIMENSIONS - ACTUATOR			
Type	ø E (mm)	D (mm) DN15-50 DA/RA	WEIGHT Kgs
PA-205	210	235	5,7
PA-280	275	240	8,8
PA-340	335	265	14,3
PA-435	430	295	24,5

MATERIALS			
POS.	DESIGNATION	PV40S - EV40S	PV40I - EV40I
1	Valve Body	S355 J2 G3 / 1.0570	AISI 316 / 1.4401
2	Bonnet	CF8 / 1.4308	CF8 / 1.4308
3	* Actuator (Steel)	S235JRG2 / 1.0038	S235JRG2 / 1.0038
	* Actuator (St.steel)	AISI304 / 1.4301	AISI304 / 1.4301
4	Diaphragm	NBR70	NBR70
5	Yoke (steel)	C45E / 1.1191	C45E / 1.1191
	Yoke (st. steel)	AISI304 / 1.4301	AISI304 / 1.4301
6	Valve plug	St.Steel - PTFE/GR	St.Steel - PTFE/GR
7	Standard packing	PTFE/GR	PTFE/GR

*** Electric actuator : see IS EL20.00 E**

PNEUMATIC CONTROL VALVES - PV40

(V40 globe valves series with linear actuators PA or EL series)

FLOW RATE COEFFICIENTS						
	SIZES					
	DN15	DN20	DN25	DN32	DN40	DN50
Kvs	3,8	5,1	9,4	15,4	22,2	40,1

Kvs in m3/h , see data sheet IS PV10.00 E ;
For conversion Kvs = Cv(US) x 0,855

ACTUATOR STROKE IN mm						
	SIZES					
	DN15	DN20	DN25	DN32	DN40	DN50
Stroke	20	20	20	20	20	20

MAX. PERM.PRESS.DROP IN bar - N.C.(fluid to open) -Reverse action actuator (air signal to open)										
ACTUATOR	CONTROL SIGNAL	SIZES								
		DN15	DN20	DN25	DN32	DN40	DN50	DN65	DN80	DN100
PA-205	0,2 ÷ 1 bar	6	6	5	—	—	—	—	—	—
	0,4 ÷ 1,2 bar	10	10	7	—	—	—	—	—	—
	0,4 ÷ 2 bar	12	12	9	—	—	—	—	—	—
PA-280	0,2 ÷ 1 bar	28	26	16	8	6	3,5	—	—	—
	0,4 ÷ 1,2 bar	40	38	20	12	10	5	—	—	—
	0,4 ÷ 2 bar	50	45	25	16	12	6,5	—	—	—
PA-340A	0,2 ÷ 1 bar	60	60	50	20	12	10	—	—	—
	0,4 ÷ 1,2 bar	80	80	60	30	16	13	—	—	—
	0,4 ÷ 2 bar	100	100	80	40	20	18	—	—	—
PA435A	0,2 ÷ 1 bar	—	—	—	—	40	25	—	—	—
	0,4 ÷ 1,2 bar	—	—	—	—	48	30	—	—	—
	0,4 ÷ 2 bar	—	—	—	—	55	45	—	—	—

The pressure drop values are referred to closed valves. They have been verified by a control signal coming from an electro-pneumatic converter with an enduring minimum signal of 0,2 bar.
The actuator press. drops given with closed valve for the actuator signal 0,4 - 2 bar are also valid for ON-OFF service with air supply at 2,5 bar.
Special spring drops available on request.
The pressure drop values must be used within the body rating limits.
For electric actuator selection please consult catalogue IS EL.20.00 E or our technical department.

MAX. PERM.PRESS.DROP IN bar - N.O.(fluid to open) -Direct action actuator (air signal to close)										
ACTUATOR	CONTROL SIGNAL	SIZES								
		DN15	DN20	DN25	DN32	DN40	DN50	DN65	DN80	DN100
PA-205	0,2 ÷ 1 bar	16	16	12	5	—	—	—	—	—
	0,4 ÷ 2 bar	25	24	16	7,5	—	—	—	—	—
PA-280	0,2 ÷ 1 bar	—	—	19	10	8	4	—	—	—
	0,4 ÷ 2 bar	—	—	25	20	16	7	—	—	—
PA-340A	0,2 ÷ 1 bar	—	—	—	17	16	10	—	—	—
	0,4 ÷ 2 bar	—	—	—	28	26	25	—	—	—

The actuator pressure drops given with closed valve, are obtained with the following air pressures supply:
Actuator signal 0,2 to 1 bar : air supply 1,2 bar
Actuator signal 0,4 to 2 bar : air supply 2,5 bar
The actuator press. drops given with closed valve for the actuator signal 0,4- 2 bar are also valid for ON-OFF service with air supply at 2,5 bar.
Special spring drops available on request.
The pressure drop values must be used within the body rating limits.
For electric actuator selection please consult catalogue IS EL.20.00 E or our technical department.

PNEUMATIC CONTROL VALVES - PV40

(V40 globe valves series with linear actuators PA or EL series)

ORDERING CODES V40

VALVE CODES	Code
	V 40 S .X.
Actuator Type (1)	
Pneumatic Actuator	P
Electric Actuator	E
Group Designation	
Globe valve, two way, straight body	V
Valve Model	
PN40 steel body	.40 S
PN40 stainlesssteel body	.40 I
Stem Sealing	
PTFE/GR-V-Rings / Standard bonnet	1
Virgin PTFE V-Rings / Standard bonnet	2
Graphite / Standard bonnet	3
Graphite / Finned bonnet	4
Valve Plug	
EQP (equal percentage) - Soft (PTFE-GR)	1
EQP (equal percentage) - Metal AISI316 / 1.4401	3
EQP (equal percentage) - Stellite	4
PL (linear) - Soft (PTFE/GR)	6
PL (linear) - Metal AISI316 / 1.4401	7
PT (on-off) - Soft (PTFE/GR)	9
PT (on-off) - Metal AISI316 / 1.4401	10
Pipe Connection	
Threaded BSP ISO 7/1 Rp	A
Flanged EN1092-1 PN40	N
Flanged ANSI B16.5 300#	V
Size	
DN15	15
DN20	20
...	
Actuator	(1)
Extras (3)	E

ACTUATOR CODES (pneumatic)	Code
	P.
Group Designation	
Multi-spring , pneumatic linear actuator	P.
Actuator Size	
205	1
280	3
340 A - From DN15 to DN50	5
435 A - From DN15 to DN50	7
Actuator	
Direct Action	D
Reverse Action	R
Actuator Constrution	
Steel construction (painted) - standard	(2)
Stainless steel construction	I
Control Signal	
0,2 - 1 bar (3/15 psi)	15
0,4 - 1,2 bar (6/18 psi)	18
0,4 - 2 bar (6/30 psi)	30

To be introduced on ".X.", if supplied in combination with the valve.

Example:
V40S valve model EQP soft plug, PTFE/GR stem sealing DN50 complete with reverse action actuator signal 0,4-1,2bar, size340A steel.

Code: PV.40S.11N50.5R18

REMARKS:
(1)- Indicate actuator type.
(2)- Omitted if the standard actuator is selected.
(3)- To be used only when a non-standard combination valve is supplied.
ADCATROL control valves are identified by a serial number on a nameplate, located on the actuator yoke.
Always order spares by using that serial number. If the valve has non-standard extras the serial number has also an E (extras).

LINEAR PNEUMATIC ACTUATORS

PA205 – PA435

DESCRIPTION

Pneumatic multi-spring linear actuators PA series for modulating and open-close duty of a control and process technology to operate control valves.

MAIN FEATURES

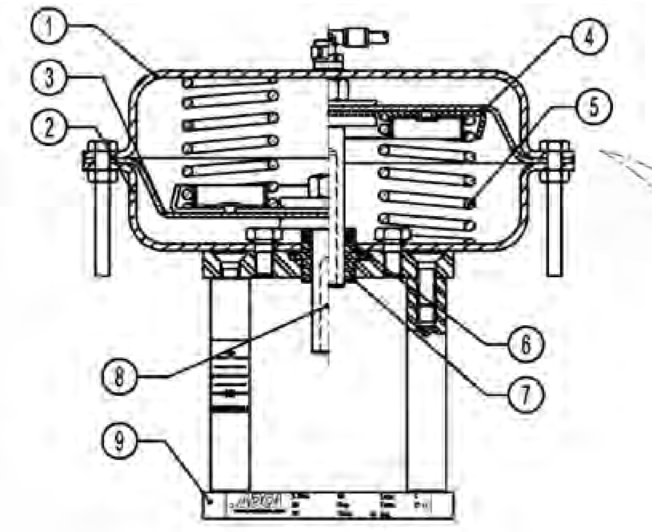
Direct and reverse action actuators for maximum 45mm valve stroke.
Operation with compressed air, nitrogen or clean water.

OPTIONS:	Limit switches Manual operating device Different kind of positioners Stainless steel construction
USE:	Actuating of V series Adcatrol control valves or others on request.
AIR SUPPLY:	Max. 3,5 bar
CONNECTION:	DN ¼”
AVAILABLE MODELS:	PA205, PA280, PA340, PA435
MAX.AMBIENT TEMPERATURE:	-20 ºC to 80 ºC

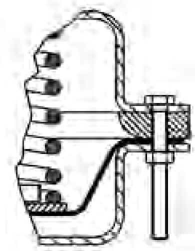
LINEAR PNEUMATIC ACTUATORS

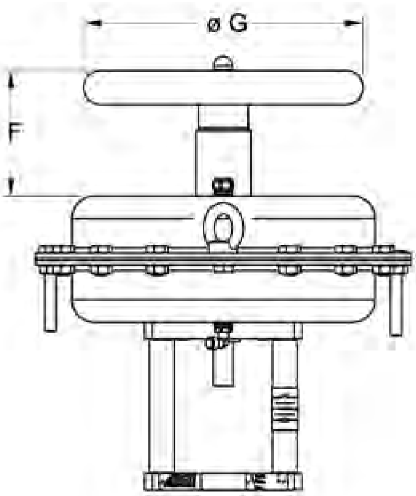
PA205 – PA435

PA205 – PA435
RA- Reverse action **DA – Direct action**



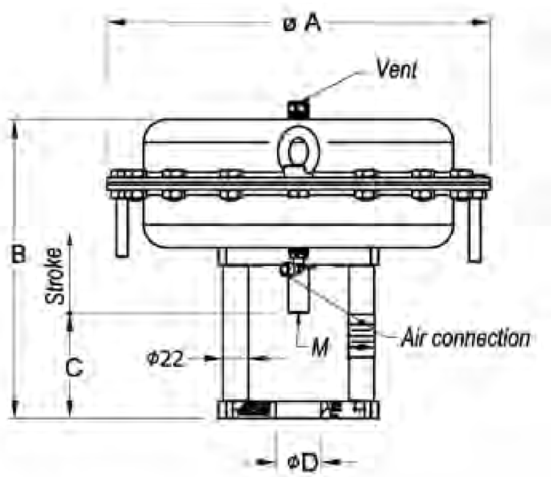
PA 435B





MATERIALS		
POS.	***DESIGNATION***	***MATERIAL***
1	Body (Steel)	S235JRG2 / 1.0038
	Body (Stainless steel)	AISI 304 / 1.4301
2	Body (Steel)	S235JRG2 / 1.0038
	Body (Stainless steel)	AISI 304 / 1.4301
3	*Diaphragm	NBR 70
4	Diaphragm plate	S235JRG2 / 1.0038
5	Spring	Spring steel
6	*Seal ring	NBR
7	Guide	Nylon
8	Rod	AISI316 / 1.4401
9	Yoke (Steel)	C45E / 1.1191
9	Yoke (Stainless steel)	AISI 304 / 1.4301

* Available spare parts



DIMENSIONS (mm)						
DIMENSIONS	**ACTUATOR MODEL**					
	PA205	**PA280**	**PA340A**	**PA340B**	**PA435A**	**PA435B**
Ø A	210	275	335	335	430	430
B	235	245	265	265	295	315
C	92	92	82	92	72	82
Ø D	40	40	40	45	40	45
M	M10	M10	M10	M10	M10	M10
Ø G	250	250	350	350	350	350
F	100	100	110	110	120	140
STROKE (mm)	20	20	20	30	40	45
WEIGHT (Kgs)	6	10	15	15	25	27

LINEAR ELECTRIC ACTUATORS - Type EL

EL12, EL20, EL45, EL80, EL120, EL250

DESCRIPTION

Electric linear actuators EL series for modulating and open-close duty of control and process technology to operate control valves.
The self-locking stem/stem nut is driven by an electric motor via a gearing. Load and limit switches define the stops for the end positions.

MAIN FEATURES

- Valve protection against excessive force due to load-dependent seating.
- Comfortable manual operation when disengaging the actuator motor.
- Mounting to valve made via yoke or mounting flange DIN 3358. The design enables easy connection to all types of valves. Standard version is suitable for Adcatrol valves.
- Generating a defined closing force in the end position leads to constantly tight shut-off of the valve.
- A robust metal cover protects efficiently against external contamination and manipulation.
- The actuators are in enclosure protection IP 65 (EL12 IP43) and are designed for rugged industrial use.
- Stall proof synchronous motors (or brake motors for higher positioning forces) ensure highest positioning accuracy.
- Mechanical stroke indication via anti-rotation bar.
- Exact, backlash-free measurement of actual valve stroke by direct coupling to the valve stem.
- Universally usable actuators due to control via 3-point-step controllers, analogue input signals (0…10 V, 0 (4)…20 mA), or fieldbus systems.
- Easy supplement to actuator with optional devices due to modular design.
- Limit switches, easily adjustable, for stroke limitation (not necessary for Adcatrol valves) or as signal for intermediate positions.
- Integrated, adjustable stroke setting to nominal stroke over the complete stroke range (without exchanging pinions, …).

LINEAR ELECTRIC ACTUATORS - Type EL

EL12, EL20, EL45, EL80, EL120, EL250

TECHNICAL DATA					
Type	EL 12	EL 20	EL 45	EL 45.1	EL 45.2
Positioning force kN	1,2	2,0	4,5		
Positioning speed [1] mm/min (mm/s)	8 (0,14)	15 (0,25)	17 (0,28)	25 (0,4)	50 (0,8)
Power consumption (230 V) A	4	6,6	28	28	32
Nominal current (230 V) A	0,017	0,029	0,135	0,135	0.160
Type of motor [3]	syn	syn	syn	syn	syn
Motor protection [4]	B	B	B	B	B
Max. stroke mm	35 mm	75 (standard 55mm)			
Supply voltages [2]	24 V / 115 V / 230 V / 400 V 50/60 Hz, 24 V DC				
Type of duty acc. to IEC 34-1	S1 – 100%		S4 – 30% c.d.f. 600 c/h		
Cable entry	3 x M16 x 1,5	2 x M16x1.5 and 1 dummy plug M16x1.5			
Electrical connection	Inside terminal board, terminal configuration according to electrical connection wiring diagram				
Switch off in end position	2 load-dependent switches, max. 250 V AC, rating for resistive load, max. 5 A, for inductive load, max. 3 A				
Mounting position	as desired, however downward position not possible				
Ambient temperature	–20 °C to +60 °C				
Lubricant for gearing	Klüber Mickrolube GL 261 grease				
Position indicator	by anti-rotation bar				
Manual adjustment	crank handle	by means of lateral hand wheel			
Enclosure protection acc. to EN 60529	IP 43	IP 65			
Trapezoidal thread	Tr 8 x 1,5	Tr 14 x 3			
Connection type	EN ISO 5210 F05 (also refer to options)				
Weight kg	2,1	8,0			

TECHNICAL DATA						
Type	EL80	EL80.1	EL80.2	EL120	EL120.1	EL120.2
Positioning force kN	8,0			12		
Positioning speed [1] mm/min (mm/s)	13,5 (0,2)	25 (0,4)	50 (0,8)	13,5 (0,2)	25 (0,4)	50 (0,8)
Power consumption (230 V) A	25	34	152	25	34	152
Nominal current (230 V) A	0,11	0,15	0,78	0.11	0.15	0.78
Type of motor [3]	syn	syn	asyn	syn	syn	asyn
Motor protection [4]	B	B	T	B	B	T
Max. stroke mm	80					
Supply voltages [2]	24 V / 115 V / 230 V / 400 V 50/60 Hz, 24 V DC					
Type of duty acc. to IEC 34-1	S4 – 30% c.d.f. 600 c/h					
Cable entry	2 x M16x1.5 and 1 dummy plug M16x1.5					
Electrical connection	Inside terminal board, terminal configuration according to electrical connection wiring diagram					
Switch off in end position	2 load-dependent switches, max. 250 V AC, rating for resistive load, max. 5 A, for inductive load, max. 3 A					
Mounting position	as desired, however downward position not possible					
Ambient temperature	–20 °C to +60 °C					
Lubricant for gearing	Klüber Microlube GL 261 grease					
Position indicator	by anti-rotation bar					
Manual adjustment	by means of lateral hand wheel					
Enclosure protection according to EN 60529	IP 65					
Trapezoidal thread	Tr 20 x 4					
Connection type	DIN 3210 G0 (also refer to options)					
Weight kg	13,0					

LINEAR ELECTRIC ACTUATORS - Type EL

EL12, EL20, EL45, EL80, EL120, EL250

TECHNICAL DATA						
Type	**-**	**-**	**-**	**-**	**EL250.1**	**EL250.2**
Positioning force kN	-				25	
Positioning speed [1] mm/min (mm/s)	-	-	-	-	25 (0,4)	50 (0,8)
Power consumption (230 V) A	-	-	-	-	157	218
Nominal current (230 V) A	-	-	-	-	0.73	1.0
Type of motor [3]	-	-	-	-	asyn	asyn
Motor protection [4]	-	-	-	-	T	T
Max. stroke mm	100					
Supply voltages [2]	115 V / 230 V 50/60 Hz, 24 V DC					
Type of duty acc. to IEC 34-1	S4 – 30% c.d.f. 600 c/h					
Cable entry	2 x M20x1.5 and 1 dummy plug M20x1.5					
Electrical connection	Inside terminal board, terminal configuration according to electrical connection wiring diagram					
Switch off in end position	2 load-dependent switches, max. 250 V AC, rating for resistive load, max. 5 A, for inductive load, max. 3 A					
Mounting position	as desired, however downward position not possible					
Ambient temperature	–20 °C to +60 °C					
Lubricant for gearing	Klüber Microlube GL 261 grease					
Position indicator	by anti-rotation bar					
Manual adjustment	by means of lateral hand wheel					
60529	IP 65					
Trapezoidal thread	Tr 26 x 5					
Connection type	DIN 3210 G0 (also refer to options)					
Weight kg	19,0					

1) at 60 Hz, the positioning speeds and input power increase by 20%

2) other supply voltages on request

3) syn synchronous motor; asyn asynchronous motor

4) B stallproof motor; T thermoswitch for temperature monitoring

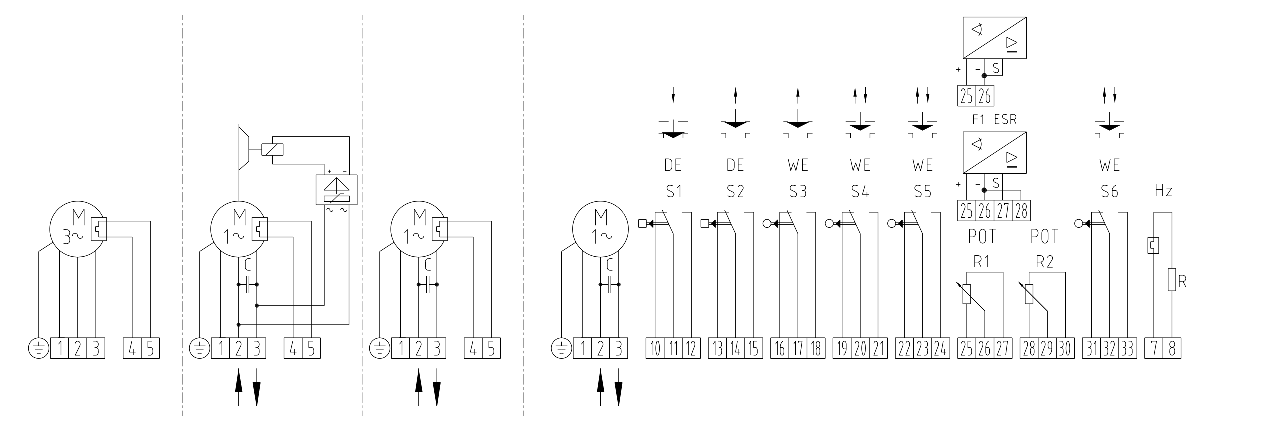
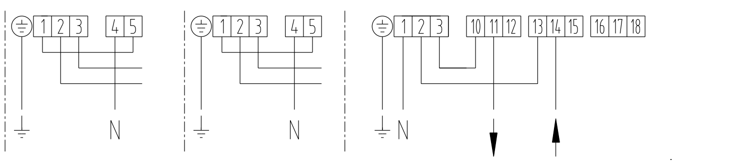
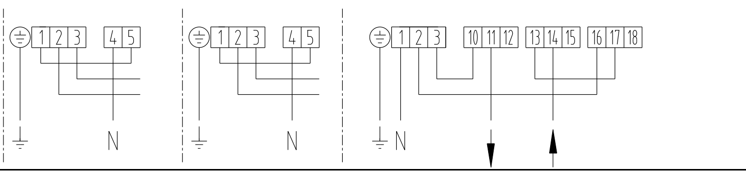
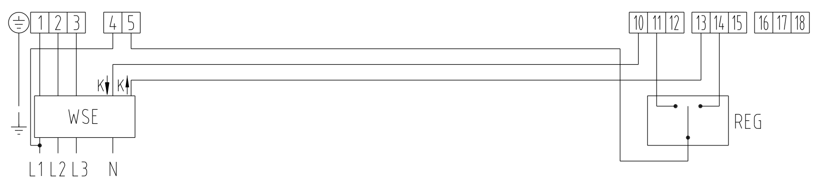
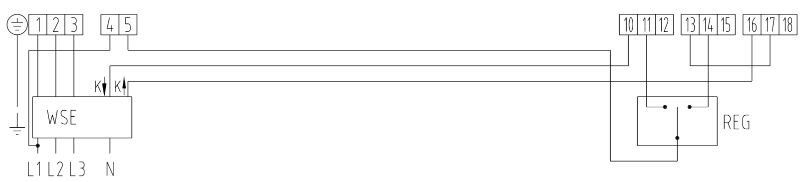
ACCESSORIES AND OPTIONS		
Accessories for actuators		
	Yoke for adaptation to valves refer to dimension sheet.	STALA/ FLA
	Mounting flange with central attachment Mxx refer to dimension sheet (thrust rod must be secured against revolving).	ZFLA
	Compact plug 10/24 poles with additional housing at actuator Voltages ≤ 500 V.	KS
	Special finish coating for use in the tropics "tropics coating".	LA-TR
	Version with bellows at thrust rod (for EL20, EL45, EL80, EL120).	A-FAB

Options for actuators		
	Additional limit switches for signalling end positions or intermediate positions, freely adjustable, max. 250 V AC, rating for resistive load max. 5 A, for inductive load max. 3 A, max. 2 switches for EL20 and EL45, max. 4 switches for EL80 and EL120.	WE
	Additional limit switches for signalling end positions or intermediate positions, freely adjustable, with gold-plated contacts for low voltage, max. 30 V AC, rating for resistive load max. 0.1 A, max. 2 switches for EL20 and EL45, max. 4 switches for EL80 and EL120.	WE-G
	Potentiometer 100/130/200/500/1000/5000 Ohms or 10 kOhms Linearity error ≤ 0.5 %, max. 1.5 W, contact current 30 mA max. 2 pieces	POT
	Electronic position feedback 2-/3-/4-wire system Inductive travel measuring, output 0 (4)…20 mA Connection 24 V DC	ESR
	Positioning electronics for actuator control Input 0…10 V, 0 (4)…20 mA, output 0…10 V, 0 (4)…20 mA Supply voltage 24, 115, 230 V 50/60 Hz	PEL
	Heating resistor with thermoswitch against moisture with automatic temperature regulation, max. 15 Watts Supply voltage 24, 115, 230 V 50/60 Hz	HZ/WP

LINEAR ELECTRIC ACTUATORS - Type EL

EL12, EL20, EL45, EL80, EL120, EL250

ELECTRICAL CONNECTION

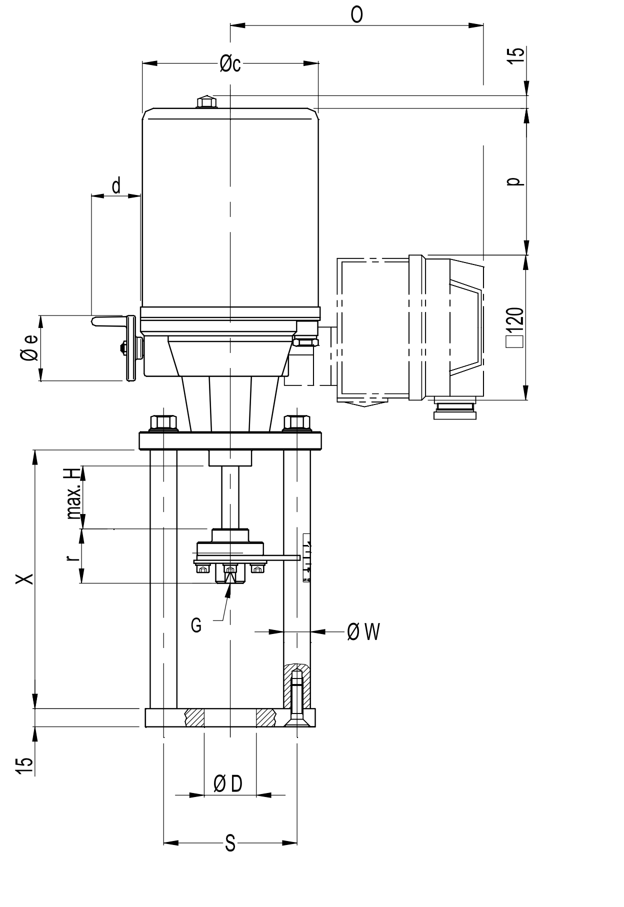
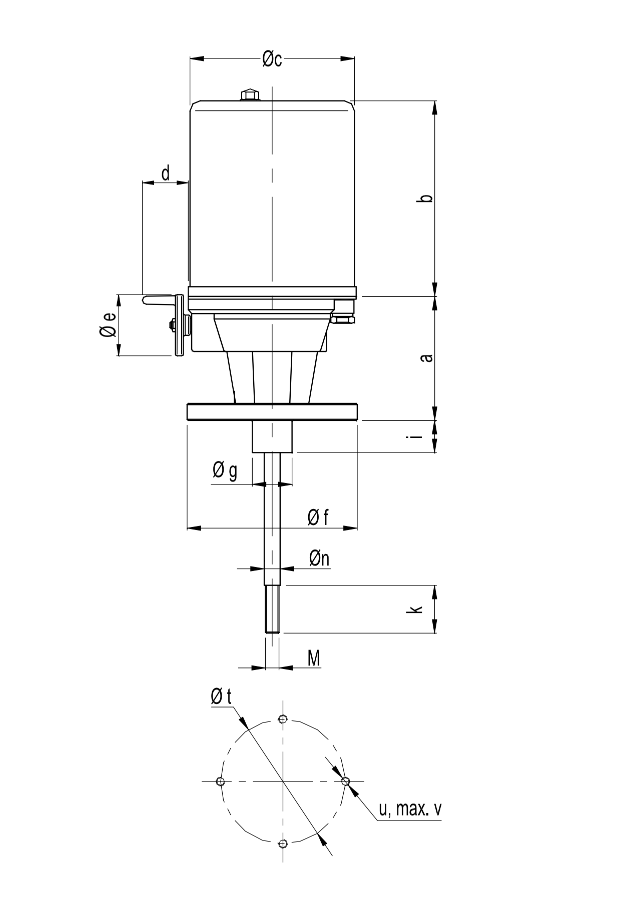
3 ~ asynchronous motor with brake and thermoswitch	1 ~ asynchronous motor with brake and thermoswitch	Synchronous motor with thermoswitch	synchronous motor	Basic wiring diagram including options
				
				Switch off in end postion via two load-dependant switches to control e.g. three-way mixing valves.
				Switch off in end position via a load-dependent switch and a limit switch to control e.g. full-way valves without upper stop. Monitoring blocking in OPEN direction.
				Control of three-phase actuators with thermoswitch. Switch off in end position via two load-dependant switches to control e.g. three-way mixing valves. For motors without thermoswitch, the wiring to terminal 4 and 5 is not applicable.
				Control of three-phase actuators with thermoswitch. Switch off in end position via a load-dependent switch and a limit switch to control e.g. full-way valves without upper stop. Monitoring blocking in OPEN direction. For motors without thermoswitch, the wiring to terminal 4 and 5 is not applicable.

WE	Limit switch
HZ	Heater with thermoswitch
POT	Potentiometer
ESR	Electronic position feedback
PEL	Positioning electronics
WSE	External reversing contactor unit
REG	Process controller

LINEAR ELECTRIC ACTUATORS - Type EL
EL12, EL20, EL45, EL80, EL120, EL250

DIMENSIONS

EL20 - EL45- EL80 – EL120

Mounting with yoke – for Adcatrol valves	Mounting according to EN ISO 5210 G0
	

DIMENSIONS							
Type	**EL20- EL45**	**EL80 - EL120**	**EL250**	**Type**	**EL20 - EL45**	**EL80 - EL120**	**EL250**
a	94.5	130	190	o	210	220	240
b	173	197	226	p	115	179	164
Ø c	145	188	216	r	45	45	51
d	42	69	70	Ø w	22	22	22
Ø e	54	100	100	M		M16x1,5	M20x1,5
Ø f	74	130	130	max. G	M20	M20	M20
Ø g	35 f8	60	60	Ø D	Ø 40, Ø 45	Ø 40, Ø 45	Ø 45, 65
i	3	26	3	G	M10	M10	M16
k		16	22	S	110 (100)	110 (100)	125
n	14	20	26	X	190 - 228		235
Ø t	50	102	102				
u	M6	M10	M10				
v							
H	Stroke actuators (see technical data)						

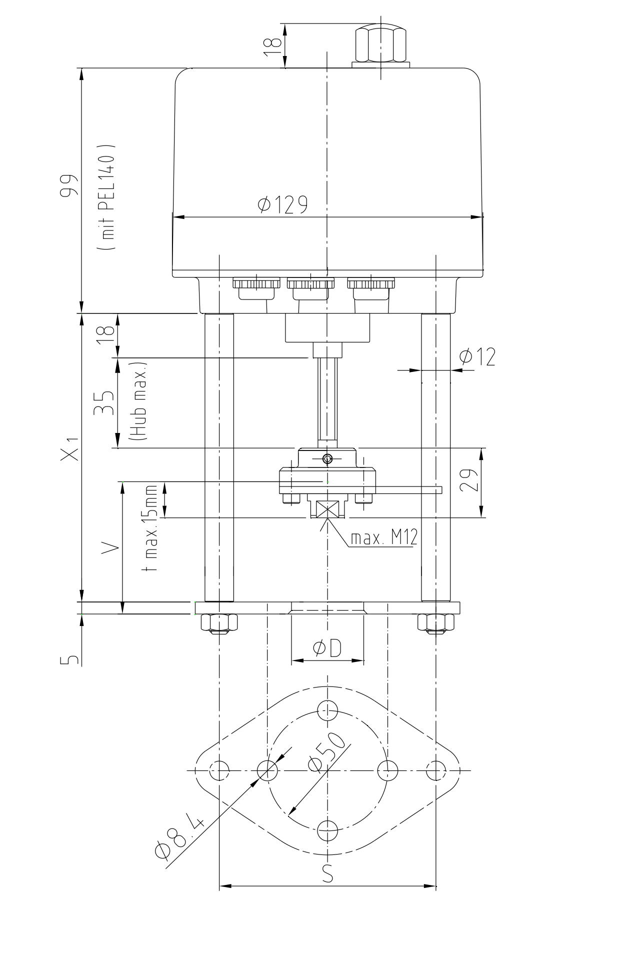
LINEAR ELECTRIC ACTUATORS - Type EL

EL12, EL20, EL45, EL80, EL120, EL250

DIMENSIONS

EL12

Mounting with yoke – for Adcatrol valves



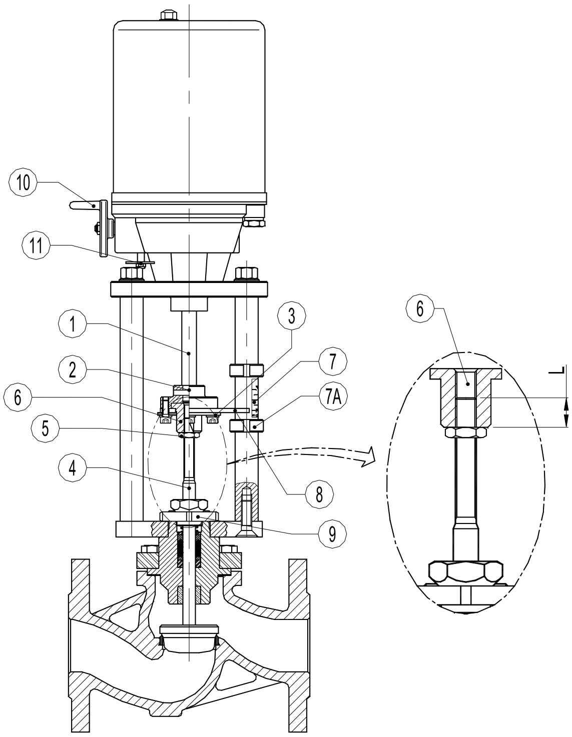
Type	EL 12
Ø D	40
S	100
X1	160
X2	55

LINEAR ELECTRIC ACTUATORS - Type EL

EL12, EL20, EL45, EL80, EL120, EL250

COMBINATION WITH A CONTROL VALVE
(short instruction)

On delivery the driving rod (1) is driven out to the bottom end limit (anti-rotation flange at bottom mark).
Further procedure:
-Insert valve stem (4) into the valve all the way to limit stop - Move the driving rod (1) up by rotating the hand wheel anti-clockwise by about 20 mm (see manual operation). -Lift the actuator and yoke over the valve stem, place onto the top of the valve and secure using the mounting nut (9) -Unscrew the locking plate (3) and the anti-rotation flange (8) in succession from the coupling flange (2) and allow it to fall over the stem.
-Remove the threaded socket (6) from the coupling flange and screw it onto the stem according to dimension L from table 1.
-Drive out the rod by rotating the hand wheel clockwise until the threaded socket (6) stops in the coupling flange (2).
Screw the anti-rotation flange (8) and the locking plate (3) onto the coupling flange
-Tighten the stem with the nut (5) against the threaded socket.
- When mounting pay attention that the valve plug is not pressed onto the seat and is not turned.
For electrical connections please report to IMI EL20.00



MANUAL OPERATION

The manual adjustment must not be disengaged or engaged while the motors is running.
Execute the manual adjustment only with motor being at standstill, hereto:
-With the left hand press the disengaging rod (11) with plate in direction of the outgoing driving rod toward the bottom
-Simultaneously turn the handwheel (10) with the right hand until the coupling-in has sensible been executed
-To actuate the linear actuator now turn the handwheel, hold the disengaging rod with the plate in engaged position

Turning crank handle to the right (clockwise), the driving rod moves out of the actuator
Turning crank handle to the left (anti-clockwise), the driving rod moves into the actuator

(The linear actuator is automatically switched back to motoric operation, as soon as the disengaging rod will be released).

(L) Dimensions in mm												
Valve Type	DN15	DN20	DN25	DN32	DN40	DN50	DN65	DN80	DN100	DN125	DN150	DN200
EV16G	18	18	18	13	12	14	25	25	19	-	-	-
EV40S	18	18	18	13	12	14	25	25	19	-	-	-

Table1

Actuator selection for two way valves type EV16G, EV25G and EV40S												
Actuator Type	Differential pressure (bar)											
	DN15	DN20	DN25	DN32	DN40	DN50	DN65	DN80	DN100	DN125	DN150	DN200
EL12	38	20	12	6,5	3,5	1,8	-	-	-	-	-	-
EL20	40	40	28	16	9,9	5,8	3	1,7	0,6	-	-	-
EL45	40	40	40	40	29,8	18,5	10,5	6,6	3,8	-	-	-
EL80	40	40	40	40	40	36,4	21	13,6	8,2	-	-	-
EL120	-	-	-	-	40	40	33,1	21,6	13,3	8,3	5,6	3
EL250	-	-	-	-	-	-	40	40	30,2	19,1	12,1	5,5

Remarks: V-rings stem packing.

Actuator selection for three way valves type EV253G and EV403S												
Actuator Type	Differential pressure (bar)											
	DN15	DN20	DN25	DN32	DN40	DN50	DN65	DN80	DN100	DN125	DN150	DN200
EL12	25	22	13,2	7,1	3,8	1,9	-	-	-	-	-	-
EL20	25	25	25	17,3	10,8	6,6	3,4	2	1,1	-	-	-
EL45	-	-	-	25	25	19,8	11,6	7,3	3,8	2,4	1,5	-
EL80	-	-	-	-	25	25	23,1	14,8	8.9	5,5	3,6	-
EL120	-	-	-	-	25	25	25	23,1	14,5	9,1	6,1	-
EL250	-	-	-	-	-	-	-	-	-	-	-	-

LINEAR ELECTRIC ACTUATORS - Type EL

EL12, EL20, EL45, EL80, EL120, EL250

ORDERING CODES EL - ELR

ACTUATOR CODES (Electric)	Code
Group Designation	
EL Series electric linear actuator	E.
Valve Model	
V16G, V16I	16
V25G, V25S, V25I	25
V40S, V40I, WV40I	40
V253G	23
Valve Size	
DN15 to DN50	D.
DN65 to DN100	J.
DN125 to DN200	M.
Actuator Type	
EL12	12
EL20	20
EL45	40
EL45.1	41
EL45.2	42
EL80	60
EL80.1	61
EL80.2	62
EL120	70
EL120.1	71
EL120.2	72
EL250	80
EL250.1	81
EL250.2	82
ELR2.1	2A
ELR2.2	2B
ELR2.3	2C
Actuator Voltage	
230 VAC	1
115 VAC	2
24 VAC	3
24 VDC	4
400 V3~	5
Control Signal	
Actuator without positioner (standard)	(2)
4 - 20 mA with positioner PEL (not for DC)	3
0 - 10 V with positioner PEL (not for DC)	4
Positioner PEL (DC)	5

To be introduced on ".X.", if supplied in combination with the valve.

Example:

V16G valve model EQP soft plug, PTFE/GR stem sealing DN50 complete with 230V electric actuator EL20 with positioner for 4-20mA signal.

Code: EV.16G11L50.2013

REMARKS:

(2)- Omitted if the standard actuator is selected.

ADCATROL control valves are identified by a serial number on a nameplate, located on the actuator yoke. Always order spares by using that serial number. If the valve has non-standard extras the serial number has also an E (extras).

PI991 Intelligent Positioner with HART, PROFIBUS PA, FOUNDATION Fieldbus H1 or FoxCom for EEx ia Intrinsically Safe Applications

DESCRIPTION

The microprocessor controlled positioner PI991 is designed to control pneumatic valve actuators and can be operated locally or by means of control systems. The advanced diagnostic can be partially shown on the local LCD of the positioner or fully on a PC or a DCS workstation with a DTM based software (VALcare or Valve Monitor). The positioner is available with different communication protocols. This includes versions with analog setpoint (4 to 20 mA) and superimposed HART- or FoxCom signal; digital with FoxCom protocol, or fieldbus communication according to PROFIBUS-PA and FOUNDATION fieldbus H1 according to IEC 1158-2 based on FISCO. The PI991 also has the capability to control a Partial Stroke Test (PST) that offers perators a tool to identify the trouble-proof function of ESD (Emergency Shut Down) valves.

Version "Intelligent"

- Autostart with self calibration
- Self diagnostic, status and diagnostic messages

Version "Intelligent with Communication"

- Communication HART, FOUNDATION Fieldbus H1, PROFIBUS-PA or FoxCom
- Configuration by means of local keys, Hand Held Terminal, PC or I/A Series system or with an infrared interface by means of IRCOM

Version "Intelligent without Communication"

- Input signal 4-20 mA

For all Versions

- Stroke range 8 to 260 mm (0.3 to 10.2 in)
- Angle range up to 95°
- Supply air pressure up to 6 bar (90 psig), with "Spool Valve" up to 7 bar (105 psig)
- Single or double acting
- Mounting on linear actuators according to NAMUR:
    - IEC 534 Part 6
    - VDI/VDE 3847
- Direct mounting on actuators FlowPak and FlowTop
- Mounting on rotary actuators acc. to VDI/VDE 3845
- Protection class IP 65, NEMA 4X
- Explosion protection:
    - II 2 G EEx i / II 2 G EEx n (intrinsic safety) according to ATEX
    - Intrinsic safety according to FM and CSA
- Ambient temperature –40 to 80°C (–40 to 176°F)
- Display and Local User Interface:
    - Multilingual Full-Text Graphic LCD or LEDs
    - Status- and Diagnostic-Messages displayed on LCD
    - Easy configuration by means of 3 pushbuttons

PI991 Intelligent Positioner with HART, PROFIBUS PA, FOUNDATION Fieldbus H1 or FoxCom for EEx ia Intrinsically Safe Applications

- Mechanical travel indicator
- Suitable for safety applications up to SIL 3
- Partial Stroke Test (PST) for Emergency Shut Down applications
- Infrared Interface for wireless communication
- Stainless Steel housing for Offshore or Food and Beverage applications
- Additional Inputs/outputs (optional):
  - 2 binary outputs (limits)
  - Position feedback 4 to 20 mA, 1 Alarm output
  - 2 binary inputs
  - Built-in independent inductive limit switches (2- 3-wire) or micro switches
  - Sensors for supply air pressure and output pressure
  - Binary Inputs/Outputs dedicated to SIS logic solvers
- Accessories
  • Booster relay to minimize stroke time
  • Gauge Manifold

Input

All “intelligent” versions are with micro controller

With HART communication

Two-wire system
Reverse polarity protection . . built-in standard feature
Signal range . . . . 4 to 20 mA
Operating range . . . . 3.6 to 21 mA
Voltage . . . . DC 12 to 36 V (unloaded circuit)
Max. load. . . . . 420 Ohms (8.4 V at 20 mA)
Communication signal . . . . . HART, 1200 Baud, FSK modulated on 4 to 20 mA

With Fieldbus communication (acc. to FISCO)

Input signal . . . . digital fieldbus
Supply voltage . . . . DC 9 to 32 V
Operating current . . . . 10.5 mA ±0.5 mA (base current)
Current amplitude. . . . . ±8 mA
Fault current . . . . base current +0 mA
(+4 mA by means of independent FDE-safety circuit)

PROFIBUS-PA

Data transfer . . . . acc. to PROFIBUS- PA
profileclass B based on EN
50170 and DIN 19245 part 4

FOUNDATION Fieldbus H1

Data transfer . . . . FF Specification Rev. 1.4, Link-Master (LAS)
Function blocks . . . . AO, PID, Transducer, Resource, 2xDI, DO

With FoxCom communication

Operating mode digital
Input signal . . . . digital
Supply voltage . . . . DC 13 to 36 V
Supply current . . . . ~ 9 mA at 24 V
Communication signal . . . . . FoxCom digital, 4800 Baud, FSK modulated on supply Voltage

PI991 Intelligent Positioner with HART, PROFIBUS PA, FOUNDATION Fieldbus H1 or FoxCom for EEx ia Intrinsically Safe Applications

Without communication 4 to 20 mA

Two-wire system
Reverse polarity protection . . built-in standard feature
Signal range . . . . 4 to 20 mA
Operating range . . . . 3.8 to 21.5 mA
Voltage . . . . DC 8 to 36 V (unloaded circuit)
Max. load . . . . 300 Ohms (6 V at 20 mA)

Common data for all versions

Supply

Supply air pressure . . . . 1.4 to 6 bar (29 to 90 psig)
with spool valve . . . . 1.4 to 7 bar (20 to 105 psig)
Supply air quality . . . . according to ISO 8573-1
Max. particle size and density . . Class 2
Max. oil contents. . . . . Class 3

Response characteristics

Min. Sensitivity. . . . . <0.1% of travel span
Non-linearity
terminal based adjustment. <0.4% of travel span
Hysteresis . . . . <0.3% of travel span
Supply air dependence. . . . . <0.1%/1 bar (15 psi)
Temperature effect . . . . <0.3%/10 K
Mechanical effect
10 to 60 Hz up to 0.14 mm,
60 to 500 Hz up to 2 g . . . <0.25 of travel span

Pneumatic connection

NAMUR mounting . . . . 3x female threads 1⁄4-18 NPT or G1⁄4 for pipe diameter 6 to 12 mm (0.24 to 0.47 in)
Direct mounting . . . . Instead of output y1 an air connection on the backside with O-ring is used (closed at NAMUR mounting).

Electrical connection

Line entry . . . . 1 or 2 cable glands M20 x1.5
or 1⁄2-14 NPT (with Adapter) (for additional Adapter see AD-...)
Cable diameter . . . . 6 to 12 mm (0.24 to 0.47 in)
Screw terminals . . . . 2 terminals for input,
4 terminals for additional inputs/outputs
Wire cross section 0.3 to 2.5 mm2 (AWG 22-14)
Test Sockets . . . . for connection of communicator

Technical Data for Stainless Steel Housing

Material Stainless Steel . . . . 1.4404/316, 1.25 mm
Protection Class . . . . IP 66 acc. to EN 60529
Impact Resistance . . . . 7 Joule acc. to EN 50014
Seals. . . . . VMQ (Silicone)
Weight (Complete Positioner) . . . . 3.5 kg
Pneumatic Connection . . . . . 1/4–18 NPT on manifold, prepared for gauges (option)
Electrical Connection . . . . . . M20 x 1.5 (others with Adapter AD...)

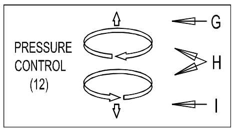
AIR FILTER REGULATOR - P 10

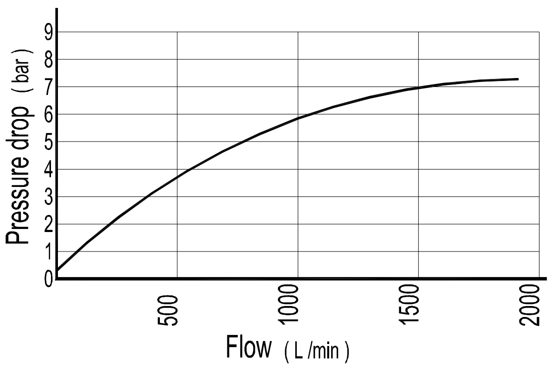
DESCRIPTION
The P10 air filter regulators are used to remove both solid and liquid impurities from the air and to regulate the output pressure to the required value for general purpose pneumatic systems.
The filter bowl which is transparent allows easy monitoring of the condensate level.

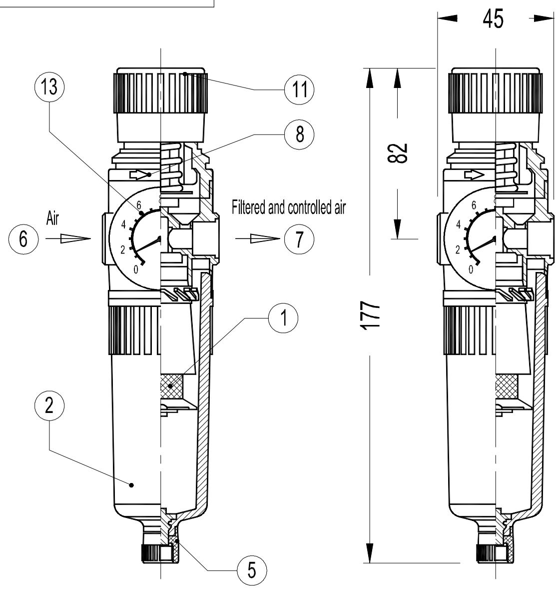
MAIN FEATURES
Self relieving.
Compact combined filter/regulator.
5 micron large surface area element.
Manual and automatic condensate exhaust easier when there is no pressure.
Pressure gauge D.42 x 1/8"
Mounting bracket

USE: Pneumatic systems
AVAILABLE MODELS: P 10
VALVE SIZES: DN ¼"
CONNECTIONS: BSP (BS21-Rp)

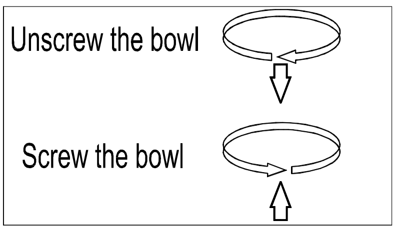
LIMITING CONDITIONS	
Valve model	**P10**
Max.upstream pressure	12 bar
Max.downstream pressure	10 bar
Min.downstream pressure	0,5 bar
Max.design temperature	60 ºC
Min.Operating temperature	-10 ºC







POS.Nr.	DESIGNATION
1	Filtering element
2	Bowl (including bowl guard)
5	Exhaust ring
6	Air inlet connection
7	Low pressure air outlet
8	Flow indicator arrow
11	Pressure regulating knob
13	Pressure gauge



MATERIALS	
Body	Aluminium die cast
Bowl	Polycarbonate

PNEUMATIC ANGLE TYPE INTERCEPTION VALVE - Type PAV 21

DESCRIPTION

The PAV series angle seat interception valves are designed for steam, gas and other fluids used on the process industry and they are the effective response to fluid interception when flexibility and cost is requested. Connections are female screwed.

MAIN FEATURES

Stainless steel body with high coefficient of flow.
Resistance to corrosion
Low air consumption
Nylon rotational servo control
Self-centring plug with soft sealing
Live loading packing gland

OPTIONS: Pilot solenoid valves
Electromechanical switches

USE: Saturated steam, water and other fluids compatible with the construction.

AIR SUPPLY: 5 bar / 8 bar

ACTUATOR CONNECTIONS: PPI-63 G1/8” NPT
PPI-90 G1/4” NPT

AVAILABLE MODELS: PAV 21 - Pneumatic angle valve

SIZES: DN ½” – DN 2”

CONNECTIONS: Threaded ISO

VALVE LIMITING CONDITIONS: Body design conditions:
PN16
Max. Working temperature: 190 ºC
Min. Working temperature: -10 ºC
Ambient temp. : -10 ºC …+ 80 ºC

FLOW RATE COEFFICIENTS						
	SIZES					
	DN15	DN20	DN25	DN32	DN40	DN50
Kvs	4,8	9,5	18	23,2	32,7	52,6

MAX. PERMISSIBLE PRESS.DROP IN bar
Normally closed valve (fluid to open)
Reverse action actuator (air signal to open)

ACT. Type	AIR PRESSURE	SIZES					
		DN15	DN20	DN25	DN32	DN40	DN50
PPI-63	5 - 8 bar	16	16	16	-	-	-
PPI-90	5 - 8 bar	-	-	-	16	16	10

Note: Waterhammer free design.

Kvs in m3/h , see data sheet IS PV10.00 E ;
For conversion Kvs = Cv(US) x 0,855

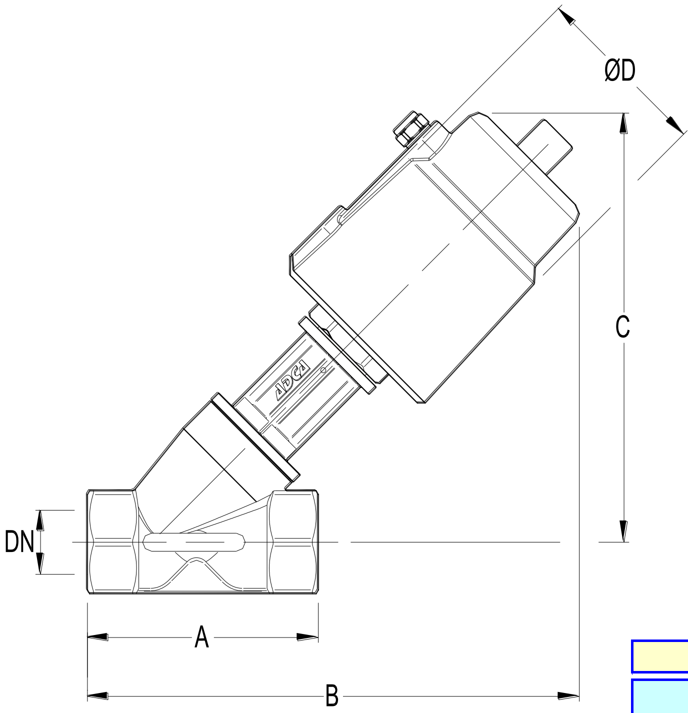
CE MARKING (PED - European Directive 97/23/EC)	
PN 16	Category
DN15 to DN50	SEP - art. 3, paragraph3

MAX. PERMISSIBLE PRESS.DROP IN bar
Normally closed valve (fluid to close)
Reverse action actuator (air signal to open)

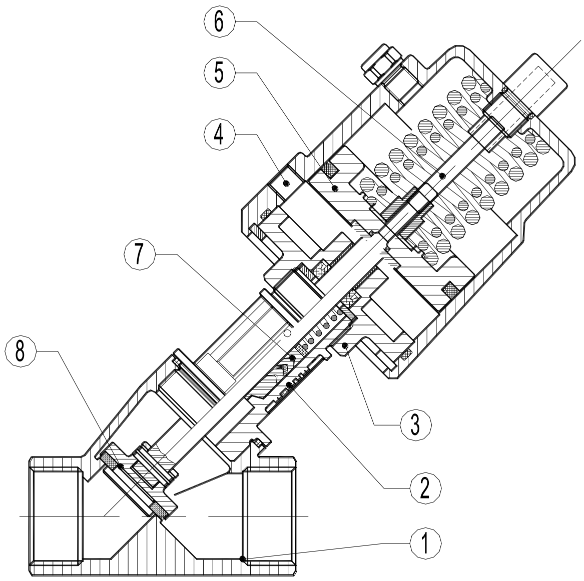
ACT. Type	AIR PRESSURE	SIZES					
		DN15	DN20	DN25	DN32	DN40	DN50
PPI-63	5 - 8 bar	16	16	16	-	-	-
PPI-63	6 - 8 bar	16	16	16	-	-	-
PPI-63	7 - 8 bar	16	16	16	-	-	-
PPI-90	5 - 8 bar	-	-	-	16	-	-
PPI-90	6 - 8 bar	-	-	-	16	16	-
PPI-90	7 - 8 bar	-	-	-	16	16	16

Note: not recommended when controlling liquids at high speed doing to waterhammer occurrence.

PNEUMATIC ANGLE TYPE INTERCEPTION VALVE - Type PAV 21



DIMENSIONS (mm)								
DN	A	B	C Actuator PPI-63	Ø D Actuator PPI-63	C Actuator PPI-90	Ø D Actuator PPI-90	WHT. Kgs w/PPI63	WHT. Kgs w/PPI90
15	68	174	155	75	155	110	1,35	2,4
20	75	182	158	75	158	110	1,45	2,5
25	90	190	166	75	166	110	1,65	2,7
32	116	261	227	75	227	110	2,3	3,3
40	116	265	229	75	229	110	2,55	3,5
50	138	282	238	75	238	110	3,6	4,7



MATERIALS		
POS.	DESIGNATION	MATERIAL
1	Valve Body	CF8M / 1.4408
2	Bonnet	CF8 / 1.4308
3	Actuator Flange	CF8 / 1.4308
4	Actuator Cover	CF8 / 1.4308
5	Piston	Aluminium
6	Indication Stem	Plastic
7	* Packing	PTFE / GR
8	* Valve Plug	1.4401 / PTFE-GR

* Available spare parts

PNEUMATIC ANGLE TYPE INTERCEPTION VALVE - Type PAV 21

ORDERING CODES PAV21

VALVE CODES	PAV					.X.		
Group Designation								
Pneumatic on-off angle valve	PAV							
Valve Model								
Two way straight design,stainless steel construction		.21						
Valve Plug								
Soft (PTFE/GR) PT Type			1					
Pipe Connection								
Threaded BSP ISO 7/1 Rp				A				
Size								
DN 15					15			
DN 20					20			
…								
Fluid Direction								
Normally closed valve,fluid enter above the seat						A		
Normally closed valve,fluid enter below the seat						B		
Actuator							(1)	
Extras (3)								E

ACTUATOR CODES (pneumatic)	Pl.			
Group Designation				
Piston linear actuator	Pl.			
Actuator Size				
Piston pneumatic actuator PPI 63		.63		
Piston pneumatic actuator PPI 90		.90		
Actuator Type				
Direct action (air to close)			.D	
Reverse action (air to open)			.R	
Actuator Constrution				
Stainless steel				(2)

To be introduced on ".X.", if supplied in combination with the valve.

(1)- Indicate actuator type.
(2)- Omitted if the standard actuator is selected.
(3)- To be used only when a non-standard combination valve is supplied

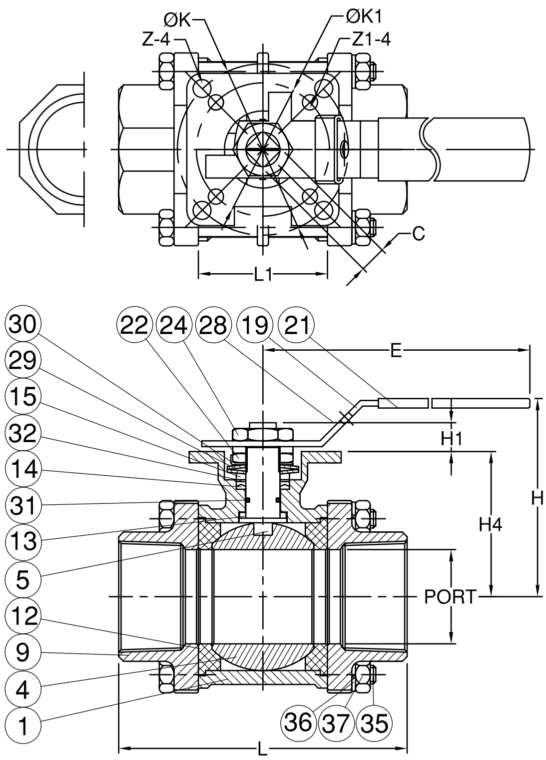
ARMSTRONG
FLOW CONTROL

Valves

BF3S10SPBN

Ball valve, 3-piece full bore design, suitable for air, gas, water and low pressure steam,

- **Body, ball & stem: 316 stainless steel**
- **Seats: RPTFE**
- **End Connections: Screwed BSP or socket weld**
- **Maximum pressure rating: 7,000 kpa (1,000 psi)**
- **Maximum temperature rating: 204 degrees C**
- **Sizes: 8mm to 50mm**



WORKING PRESSURE: 1/4"~2" 1000PSI
2-1/2"~4" 800PSI

MATERIALS LIST

NO.	PART NAME	MATERIAL
1	BODY	ASTM A351 Gr.CF8M
4	BALL	ASTM A351 Gr.CF8M
5	STEM	SS316
9	END CAP	ASTM A351 Gr.CF8M
12	SEAT	RTFE.
13	THRUST WASHER	RTFE.
14	STEM PACKING	RTFE.
15	GLAND BUSH	SS304
19	HANDLE	SS304
21	HANDLE COVER	VINYL GRIP
22	STEM NUT	SS304
24	HANDLE NUT	SS304
28	LOCKING PAD	SS304
29	BELLEVILLE WASHER	SS304-CSP
30	TAB WASHER	SS304
31	O-RING	VITON
32	PACKING FOLLWER	PTFE.+25%G.F.
35	BODY BOLT	SS304
36	BOLT WASHER	SS304
37	BOLT NUT	SS304

DIMENSIONS

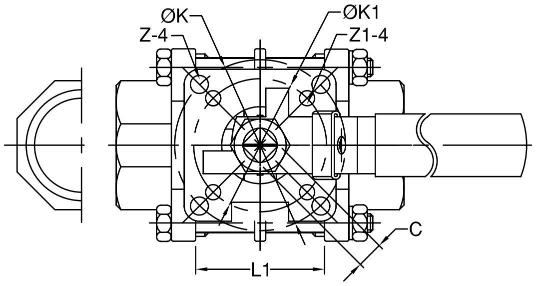
unit:mm

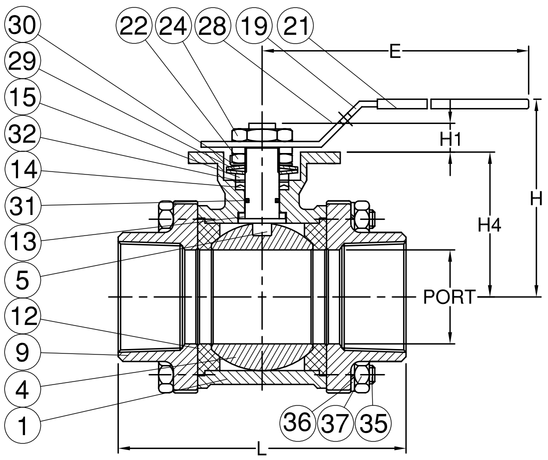
SIZE		PORT	L	E	H	H1	H4	C	ØK	ØK1	Z-4	Z1-4	L1
DN8	1/4"	11.5	63.5	112.0	73.0	8.5	37.0	9.0	50.0	36.0	7.0	6.0	22.5
DN10	3/8"	12.5	63.5	112.0	73.0	8.5	37.0	9.0	50.0	36.0	7.0	6.0	22.5
DN15	1/2"	15.0	63.5	112.0	73.0	8.5	37.0	9.0	50.0	36.0	7.0	6.0	22.5
DN20	3/4"	20.0	72.5	112.0	80.8	8.5	45.0	9.0	50.0	36.0	7.0	6.0	27.5
DN25	1"	25.0	81.0	136.0	90.5	11.4	53.5	9.0	50.0	36.0	7.0	6.0	34.0
DN32	1-1/4"	32.0	94.5	185.0	98.7	11.4	59.0	9.0	50.0	36.0	7.0	6.0	42.5
DN40	1-1/2"	38.0	108.0	197.9	115.3	14.0	74.8	14.0	70.0	50.0	9.0	7.0	52.0
DN50	2"	50.0	121.5	197.9	124.0	13.7	83.5	14.0	70.0	50.0	9.0	7.0	63.5
DN65	2-1/2"	65.0	157.5	267.0	155.0	18.0	108.8	17.0	102.0	70.0	11.0	9.0	85.5
DN80	3"	80.0	190.0	267.0	208.5	18.0	118.3	17.0	102.0	70.0	11.0	9.0	102.0
DN100	4"	100.0	225.0	322.0	216.7	18.0	153.8	17.0	102.0	70.0	11.0	9.0	128.5

BF3S10S50BN

Ball valve, 3-piece full bore design, suitable for steam, water, air, gas and many chemicals.

- **Body, ball & stem: 316 stainless steel**
- **Seats: graphite impregnated PTFE**
- **End Connections: Screwed BSP or socket weld**
- **Direct mount ISO mounting pad suitable for mounting**
- **of pneumatic or electric actuators.**
- **Spring return ("dead man") man handle also available**
- **Maximum pressure rating 7,000 kpa (1,000 psi)**
- **Maximum temperature rating 230 degrees C**
- **Sizes: 8mm to 50mm**





WORKING PRESSURE: 1/4"~2" 1000PSI
2-1/2"~4" 800PSI

MATERIALS LIST

NO.	PART NAME	MATERIAL
1	BODY	ASTM A351 Gr.CF8M
4	BALL	ASTM A351 Gr.CF8M
5	STEM	SS316
9	END CAP	ASTM A351 Gr.CF8M
12	SEAT	50% S.S. Filled PTFE
13	THRUST WASHER	RTFE.
14	STEM PACKING	RTFE.
15	GLAND BUSH	SS304
19	HANDLE	SS304
21	HANDLE COVER	VINYL GRIP
22	STEM NUT	SS304
24	HANDLE NUT	SS304
28	LOCKING PAD	SS304
29	BELLEVILLE WASHER	SS304-CSP
30	TAB WASHER	SS304
31	O-RING	VITON
32	PACKING FOLLWER	PTFE.+25%G.F.
35	BODY BOLT	SS304
36	BOLT WASHER	SS304
37	BOLT NUT	SS304

DIMENSIONS

unit:mm

SIZE		PORT	L	E	H	H1	H4	C	ØK	ØK1	Z-4	Z1-4	L1
DN8	1/4"	11.5	63.5	112.0	73.0	8.5	37.0	9.0	50.0	36.0	7.0	6.0	22.5
DN10	3/8"	12.5	63.5	112.0	73.0	8.5	37.0	9.0	50.0	36.0	7.0	6.0	22.5
DN15	1/2"	15.0	63.5	112.0	73.0	8.5	37.0	9.0	50.0	36.0	7.0	6.0	22.5
DN20	3/4"	20.0	72.5	112.0	80.8	8.5	45.0	9.0	50.0	36.0	7.0	6.0	27.5
DN25	1"	25.0	81.0	136.0	90.5	11.4	53.5	11.0	50.0	36.0	7.0	6.0	34.0
DN32	1-1/4"	32.0	94.5	185.0	98.7	11.4	59.0	11.0	50.0	36.0	7.0	6.0	42.5
DN40	1-1/2"	38.0	108.0	197.9	115.3	14.0	74.8	14.0	70.0	50.0	9.0	7.0	52.0
DN50	2"	50.0	121.5	197.9	124.0	13.7	83.5	14.0	70.0	50.0	9.0	7.0	63.5
DN65	2-1/2"	65.0	157.5	267.0	155.0	18.0	108.8	17.0	102.0	70.0	11.0	9.0	85.5
DN80	3"	80.0	190.0	267.0	208.5	18.0	118.3	17.0	102.0	70.0	11.0	9.0	102.0
DN100	4"	100.0	225.0	322.0	216.7	18.0	153.8	17.0	102.0	70.0	11.0	9.0	128.5

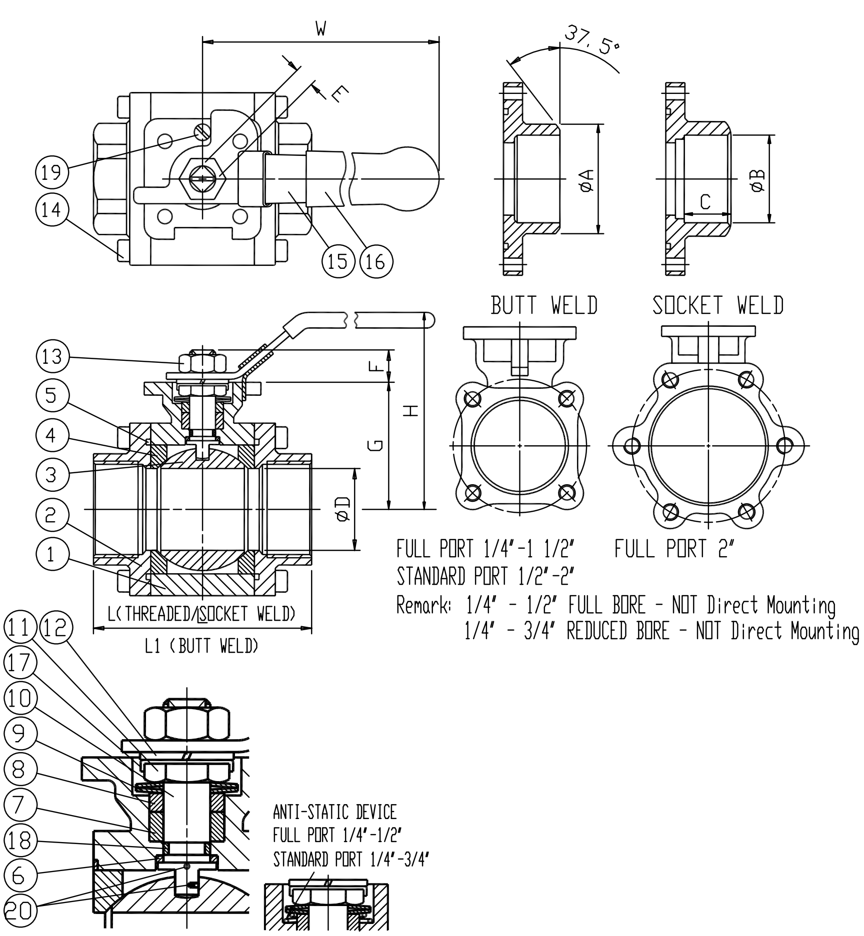
BF3S20SRN(B)F

Ball valve, 3-piece full bore design, firesafe and antistatic

To API 607, BS5146, suitable for flammable fluid and gases,

Water, air, gas and many chemicals.

- **Body, ball & stem: 316 stainless steel**
- **Seats: RPTFE**
- **Body seals and gland packing: Graphite**
- **End Connections: Screwed BSP, NPT or socket weld**
- **Spring return ("dead man") man handle also available**
- **Maximum pressure rating 14,000 kpa (2,000 psi)**
- **Maximum temperature rating 204 degrees C**
- **Sizes: 8mm to 50mm**



AF-35 SIZE: 1/4"-2" FIRE-SAFE API 607

3-PIECE FULL PORT and STANDARD PORT BALL VALVE
SCREWED ENDS, BUTT WELDED END, SOCKET WELDED END
ISO 5211 MOUNTING PAD
DIN 3202-M3 (SCREWED ENDS/SOCKET WELDED ENDS)
-S13 (BUTT WELDED ENDS)
PRESSURE: 2000 PSI(CLASS 800)W.O.G.
STAINLESS STEEL: 316 BODY, with 316 SS TRIM
CARBON STEEL: WCB BODY, with 316 SS TRIM
Remark: 1/4" - 1/2" FULL BORE - NOT Direct Mounting
1/4" - 3/4" REDUCED BORE - NOT Direct Mounting

STANDARDS APPLICABLE
ASME B16.34-STEEL VALVES FLANGED,THREADED,AND WELDING END
ASME B1.20.1-PIPE THREADS,GENERAL PURPOSE
ASME B16.10-FACE TO FACE&END TO END DIMENSIONS OF VALVES
API 598-VALVE INSPECTION AND TESTING
MSS SP72-BALL VALVES WITH FLANGED OR BUTT WELDING ENDS FOR GENERAL SERVICES
MSS SP25-STANDARD MARKING SYSTEM FOR VALVES FITTINGS, FLANGES AND UNIONS

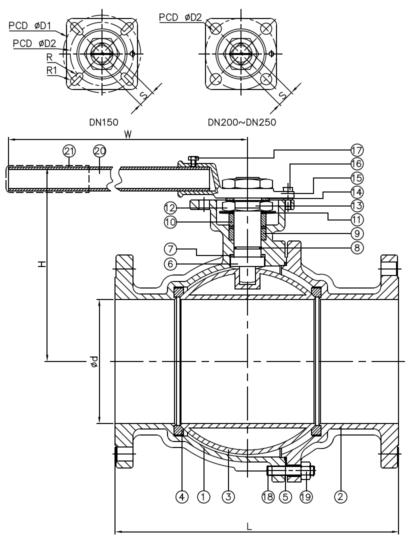
ITEM	DESCRIPTION	STAINLESS STEEL	CARBON STEEL	Q'TY
1	BODY	ASTM A351 CF8M	ASTM A216 WCB	1
2	END CAP	ASTM A351 CF8M	ASTM A216 WCB	2
3	BALL	ASTM A351 CF8M/316	ASTM A351 CF8M/316/304	1
4	SEAT	RPTFE		2
5-1	GASKET	GRAPHITE		2
5-2		PTFE		2
6-1	THRUST WASHER	GRAPHITE		1
6-2		PTFE		1
7	STEM PACKING	GRAPHITE		1
8	GLAND	AISI 304		1
9	BELLEVILLE WASHER	AISI 301		2
10	STEM	ASTM A276 316		1
11	PACKING NUT	AISI 304		1
12	SPRING WASHER	AISI 304		1
13	HANDLE NUT	AISI 304		1
14	BOLT	ASTM A193 B8	ASTM A193 B7	8-12
15	HANDLE	AISI 304	ZINC PLATED STEEL	1
16	HANDLE GRIP	VINIL PLASTISOL		1
17	LOCK SADDLE	AISI 304		1
18	O-RING	VITON		1
19	STOPPOER NUT	AISI 304	CARBON STEEL	1
20	ANTI-STATIC DEVICE	AISI 304		1-2

SIZE		ØD		L		L1		E		F		G		H		W		ØA		ØB		C		ISO 5211 (F)	Weights KG
IN	DN	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM	IN	MM		
1/4"	8	0.43	11.0	2.55	65.0	2.75	70.0	0.35	9.0	0.31	8.0	1.47	37.5	2.75	70.0	5.51	140.0	0.54	13.8	0.56	14.2	0.39	10.0	F04	1.1
3/8"	10																	0.68	17.3	0.69	17.6				1.1
1/2"	15	0.55	14.0	2.95	75.0	2.95	75.0											0.85	21.7	0.86	21.8	0.51	13.0		1.1
3/4"	20	0.80	20.5	3.14	80.0	3.54	90.0	0.43	11.0	0.43	11.0	1.96	52.0	3.54	90.0	7.08	180.0	1.07	27.2	1.07	27.2	0.59	15.0	F04-F05	1.6
1"	25	0.98	25.0	3.54	90.0	3.93	100.0					2.36	60.0	3.93	100.0			1.34	34.0	1.33	33.9				2.2
1 1/4"	32	1.24	31.5	4.33	110.0	4.33	110.0	0.55	14.0	0.67	17.0	2.83	72.0	4.40	112.0	8.46	215.0	1.68	42.7	1.68	42.7			F07	3.3
1 1/2"	40	1.45	37.0	4.72	120.0	4.92	125.0					2.99	76.0	4.52	115.0			1.91	48.6	1.92	48.8	0.63	16.0		4.6
2"	50	1.96	50.0	5.51	140.0	5.90	150.0					3.66	93.0	5.23	133.0			2.38	60.5	2.41	61.2	0.67	17.0		7.3

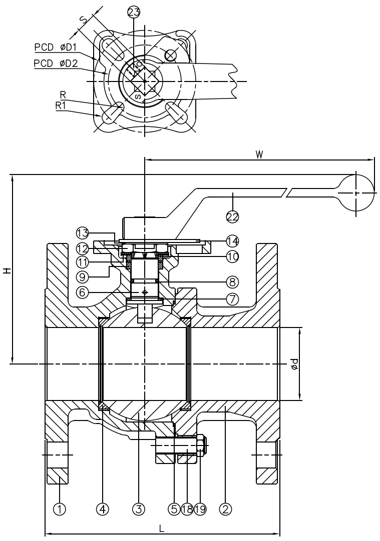
BF2C15SRRF / BF2C15SXRF

Ball valve, 2-piece, split body, full bore design, firesafe and Antistatic to API 607, BS5146, suitable for flammable fluid and gases, Water, air, gas and non corrosive chemicals.

- **Body: Carbon Steel ASTM A 216 Gr WCB**
- **Ball & stem: 316 stainless steel**
- **Seats: RPTFE, TFM 1600 High Temp**
- **Body seals and gland packing: Graphite**
- **End Connections: Flanged ANSI 150 RF**
- **Maximum pressure rating 1,950 kpa**
- **Maximum temperature rating 204 degrees C**
- **Sizes: 15mm to 150mm**



DN200~DN250



DN15~DN100

ITEM	PARTS	MATERIAL	
1	BODY	ASTM A351-CF8M	ASTM A216-WCB
2	CAP		
3	BALL	SOLID: ASTM A351-CF8M / HOLLOW: ASTM A240-316	
4	SEAT	TFM1600 / RTFE	
5	SEAL	GRAPHITE	
6	STEM	ASTM A276-316	
7	THRUST WASHER	CTFE	
8	O-RING	VITON	
9	PACKING	GRAPHITE	
10	GLAND RING	AISI 304	
11	BELLEVILLE WASHER	AISI 301	
12	STEM NUT	AISI 304	
13	LOCKING WASHER		
14	FLAT WASHER		
15	HANDLE HEAD		
16	STOP PIN		
17	BOLT		
18	STUD		
19	NUT		
20	STEEL TUBE		
21	HANDLE SLEEVE	PVC	
22	HANDLE	AISI 301	
23	SOCKET SET SCREW		

- ABOVE MENTIONED MATERIALS APPLY TO FIRE SAFE DESIGN
- ISO 15848 DESIGN SHOULD REPLACE WITH PTFE SEAL & PACKING

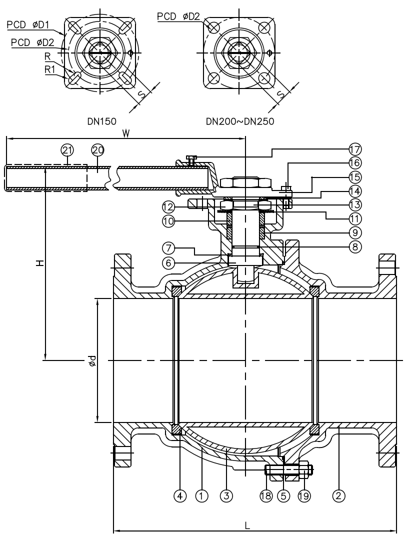
DN	d	CLASS 150			CLASS 300			D1	D2	R	R1	S	Torque(N-M)
		L	H	W	L	H	W						
15	15	108	85	190	140	84.5	197.5	42	36	2.75	2.75	9	5.2
20	20	117	89.5	190	152	94.5	197.5	42	36	2.75	2.75	9	8
25	24	127.5	94.2	190	165	99.5	197.5	50	42	2.75	3.5	11	12.5
32	30	140.5	97.9	190	178	105	197.5	50	42	2.75	3.5	11	12
40	38	165	120.9	235	190	124.5	247.5	70	50	3.5	4.5	14	24.5
50	50	178	129.9	235	216	129	247.5	70	50	3.5	4.5	14	32
65	64	190.5	156.3	325	241	154.5	340	102	70	4.5	5.5	17	38
80	76	203	163.3	325	282	165.5	340	102	70	4.5	5.5	17	45
100	98	229	190.9	325	305	188	340	125	102	5.5	6.5	22	55
125	125	356	232	743	-	-	-	125	102	5.5	6.5	27	160
150	150	394	230	743	403	253	743	125	102	5.5	6.5	27	250
200	200	457	312	840	-	-	-	-	140	8.5	-	36	470
250	250	533	350	1040	-	-	-	-	140	8.5	-	36	750

unit:mm

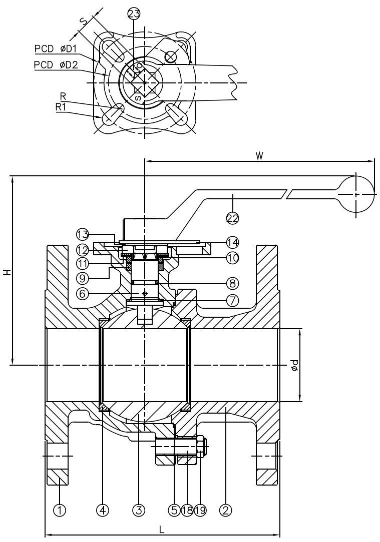
BF2S15SRRF / BF2S15SXRF

Ball valve, 2-piece, split body, full bore design, firesafe and Antistatic to API 607, BS5146, suitable for flammable fluid and gases, Water, air, gas and many chemicals.

- **Body: 316 Stainless Steel ASTM A351 CF8M**
- **Ball & stem: 316 stainless steel**
- **Seats: RPTFE, TFM 1600 High Temp**
- **Body seals and gland packing: Graphite**
- **End Connections: Flanged ANSI 150 RF**
- **Maximum pressure rating 1,950 kpa**
- **Maximum temperature rating 260 degrees C**



DN200~DN250



DN15~DN100

ITEM	PARTS	MATERIAL	
1	BODY	ASTM A351-CF8M	ASTM A216-WCB
2	CAP		
3	BALL	SOLID: ASTM A351-CF8M / HOLLOW: ASTM A240-316	
4	SEAT	TFM1600 / RTFE	
5	SEAL	GRAPHITE	
6	STEM	ASTM A276-316	
7	THRUST WASHER	CTFE	
8	O-RING	VITON	
9	PACKING	GRAPHITE	
10	GLAND RING	AISI 304	
11	BELLEVILLE WASHER	AISI 301	
12	STEM NUT	AISI 304	
13	LOCKING WASHER		
14	FLAT WASHER		
15	HANDLE HEAD		
16	STOP PIN		
17	BOLT		
18	STUD		
19	NUT		
20	STEEL TUBE		
21	HANDLE SLEEVE	PVC	
22	HANDLE	AISI 301	
23	SOCKET SET SCREW		

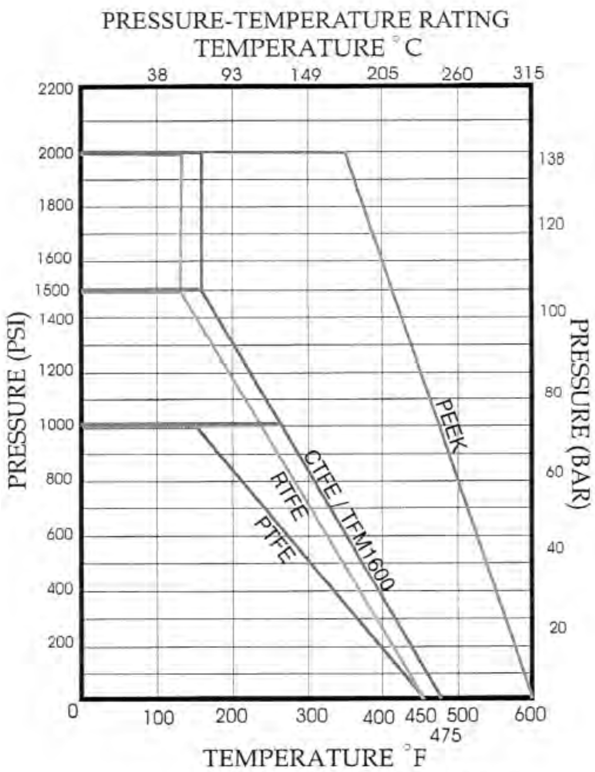
- ABOVE MENTIONED MATERIALS APPLY TO FIRE SAFE DESIGN
- ISO 15848 DESIGN SHOULD REPLACE WITH PTFE SEAL & PACKING

DN	d	CLASS 150			CLASS 300			D1	D2	R	R1	S	Torque(N-M)
		L	H	W	L	H	W						
15	15	108	85	190	140	84.5	197.5	42	36	2.75	2.75	9	5.2
20	20	117	89.5	190	152	94.5	197.5	42	36	2.75	2.75	9	8
25	24	127.5	94.2	190	165	99.5	197.5	50	42	2.75	3.5	11	12.5
32	30	140.5	97.9	190	178	105	197.5	50	42	2.75	3.5	11	12
40	38	165	120.9	235	190	124.5	247.5	70	50	3.5	4.5	14	24.5
50	50	178	129.9	235	216	129	247.5	70	50	3.5	4.5	14	32
65	64	190.5	156.3	325	241	154.5	340	102	70	4.5	5.5	17	38
80	76	203	163.3	325	282	165.5	340	102	70	4.5	5.5	17	45
100	98	229	190.9	325	305	188	340	125	102	5.5	6.5	22	55
125	125	356	232	743	-	-	-	125	102	5.5	6.5	27	160
150	150	394	230	743	403	253	743	125	102	5.5	6.5	27	250
200	200	457	312	840	-	-	-	-	140	8.5	-	36	470
250	250	533	350	1040	-	-	-	-	140	8.5	-	36	750

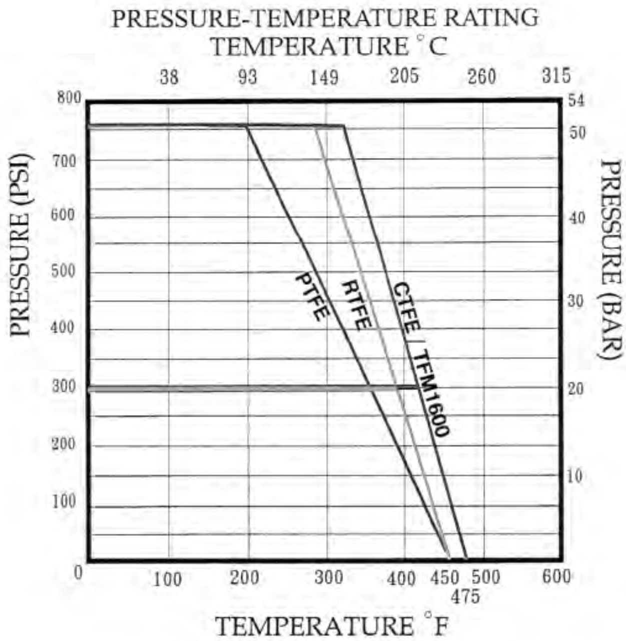
unit:mm

VALVE SEAT MATERIAL SELECTION GUIDE

Material	Description	Color
PTFE	The material is the basic seat material used in most ball valves. Its chemical compatibility is excellent for almost all media service applications.	White
RTFE	15% Glass Reinforced TFE. This material is offered as the standard seal in most HAITIMA valves. Chemical resistance is compatible to virgin TFE with improved cycle life and greater pressure-temperature rating than PTFE.	Off white
CTFE	25% Carbon with 75% TFE. This material offers a wide temperature range with better cycle life than RTFE.	Black
TFM	TFM is chemically modified PTFE that fills the gap between conventional PTFE and melt-processable PFA. According to ASTM D 4894 and ISO Draft WDT 539-1.5, TFM is classified as a PTFE. Compared to conventional PTFE, TFM has lower permeability and much lower deformation under pressure (cold flow) at room and elevated temperature. Also they can be used at higher pressures.	White
PEEK	Polyether-ether-ketone-high temperature semirigid elastomer. Best suited for high pressure and temperature service. Also offers very good corrosion resistance.	Grey
DELRIN	Delrin is capable of handling extremely high pressure. Must not used for oxygen service.	Creamy white
Cavity Filler	Designed to reduce the possibility of contamination by entrapment of process fluids in the void normally found behind the ball and the valve body in conventionally designed ball valves. Ideal for application where cross contamination is a concern, such as paints and dyes.	White



800/1000/1500/2000 WOG



CLASS 150/300

Description

Exclusively designed Armstrong bellows sealed globe valve has a sealing combination featured by using double walls stainless steel bellows as the stem seal elements and graphite packing as seal accessory to prevent leakage. The finely polished planar sealing between the valve and the seat ensures a long-term reliable operation whenever the stem is moving or not. Therefore, it can display remarkable sealing characteristics at any applications.

Armstrong bellows sealed globe valves can be widely applied in the water, steam, oil and other non-corrosion systems in petrochemical, electricity, metallurgy, electronics, textile and other industries.

Connections

Screwed (NPT/BSPT), socket weld, flanged (HG20592 RF, other flanges available, please consult factory).

Bellows Sealed Globe Valves

Model	Body Material	Norm. Pressure (MPa)	Size	Connection Type
BD16	Ductile Iron	1.6	DN15～DN300	Flanged
BD25	Ductile Iron	2.5		
BCS16	Carbon Steel	1.6	DN15～DN50	Flanged
BCS25	Carbon Steel	2.5		
BCS40	Carbon Steel	4.0	DN15～DN50	Screwed, SW
			DN15～DN300	Flanged

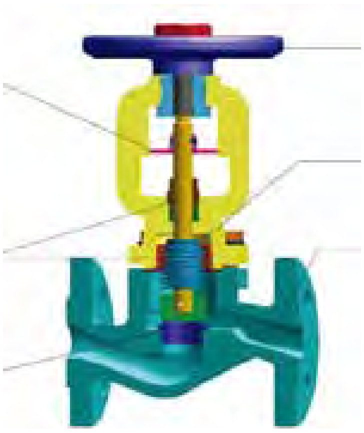
Design Features

Model	BD16	BD25	BCS16	BCS25	BCS40
Max. Allowable Pressure	2.5MPa@ 20℃	4.0MPa@ 20℃	2.5MPa@ 20℃	4.0MPa@ 20℃	6.4MPa @20℃
Max. Operating Pressure	1.6MPa	2.5MPa	1.6MPa	2.5MPa	4.0MPa
Max. Allowable Temperature	350℃	350℃	350℃	350℃	350℃
Min. Operating Temperature	-10℃	-10℃	-30℃	-30℃	-30℃

Pressure-Temperature Ratings

Model	≤120℃	150℃	200℃	250℃	300℃	350℃
BD16	1.6MPa	1.52MPa	1.44MPa	1.28MPa	1.12MPa	0.88MPa
BD25	2.5MPa	2.43MPa	2.25MPa	2.18MPa	2.00MPa	1.75MPa
BCS16	1.6MPa	1.57MPa	1.52MPa	1.44MPa	1.28MPa	1.12MPa
BCS25	2.5MPa	2.45MPa	2.38MPa	2.25MPa	2.00MPa	1.75MPa
BCS40	4.0MPa	3.92MPa	3.80MPa	3.60MPa	3.20MPa	2.80MPa

- **Long-term Operation**
  Its compact yet rugged construction and anti-twist device on the bellows offers long, corrosion resistant service.
- **Double bellows sealing**
  It combines double walls stainless steel bellows seal with graphite packing seal.
- **Planar sealing**
  The planar sealing between the valve and the seat ensures reliable sealing and operation.



- **Easy to Operate**
  Non-rising handwheel travels less and makes responses quicker; free opening/closing in narrow space; on/off position indicator makes operation easier.
- **Maintenance-free**
  Being the key component, double wall bellows seal keeps you free from valve leakage and maintenance.
- **Wide Applications**
  It can be widely used under different pressures, temperatures or vibrating conditions, which makes it ideal for many applications.

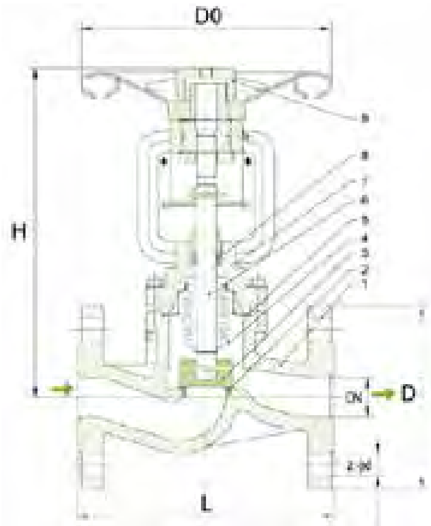


Fig. 1 Bellows Sealed Globe Valve (Flanged)

Globe Valve Physical Data (mm)

Model	DN	D0 (φ)	D (φ)	H	L	z-φd
Ductile Iron BD16/BD25	15	125	95	200	130	4-φ14
	20	125	105	200	150	4-φ14
	25	125	115	210	160	4-φ14
	32	150	140	220	180	4-φ18
	40	150	150	235	200	4-φ18
	50	150	165	235	230	4-φ18
	65	250	185	350	290	4-φ18/8-φ18
	80	250	200	360	310	8-φ18
	100	300	220/235	390	350	8-φ18/8-φ22
	125	300	250/270	500	400	8-φ18/8-φ26
	150	420	285/300	530	480	8-φ22/8-φ26
	200	420	340/360	590	600	12-φ22/12-φ26
	250	520	405/425	765	650	12-φ26/12-φ30
	300	520	460/485	810	750	12-φ26/16-φ30
Carbon Steel BCS16/BCS25/BCS40	15	125	95	200	130	4-φ14
	20	125	105	205	150	4-φ14
	25	125	115	215	160	4-φ14
	32	150	140	235	180	4-φ18
	40	150	150	235	200	4-φ18
	50	150	165	235	230	4-φ18
Carbon Steel BCS40	65	250	185	355	290	8-φ18
	80	250	200	360	310	8-φ18
	100	300	235	390	350	8-φ22
	125	300	270	465	400	8-φ26
	150	425	300	505	480	8-φ26
	200	425	375	600	600	12-φ30
	250	520	450	780	740	12-φ33
	300	520	515	805	850	16-φ33

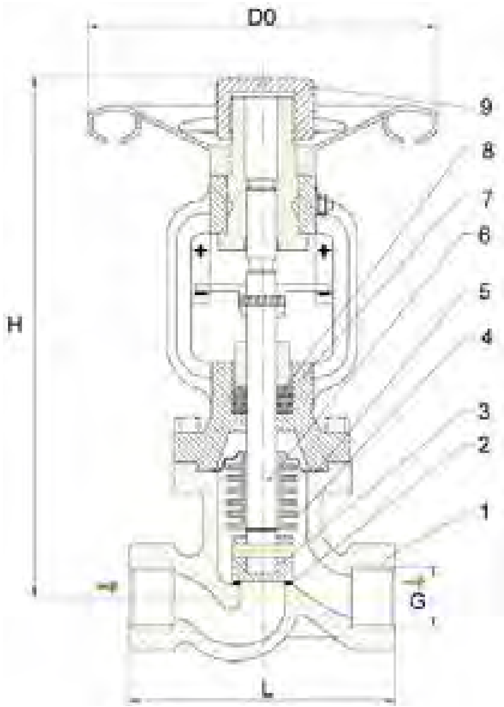


Fig. 2 Bellows Sealed Globe Valve (Screwed)

Globe Valve Physical Data for Screwed Connections (mm)					
Model	**DN**	**D0 (φ)**	**H**	**L**	**G**
Carbon Steel BCS40	15	Φ100	180	90	1/2”
	20	Φ100	180	100	3/4”
	25	φ100	192	120	1”
	32	φ120	212	140	1-1/4”
	40	φ120	220	170	1-1/2”
	50	φ120	235	200	2”

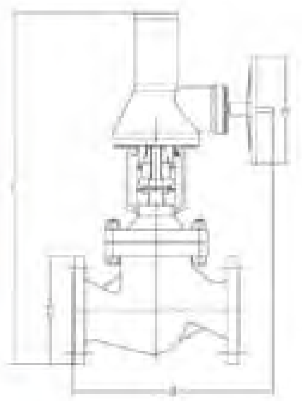
List of Materials			
Part No.	**Part Name**	**BD16/BD25**	**BCS16/BCS25/BCS40**
1	Body	ASTM A395 Ductile Iron	ASTM A216 WCB Cast Steel
2	Seat	Stainless Steel	Stainless Steel
3	Valve	Stainless Steel	Stainless Steel
4	Bellows	304 Stainless Steel	304 Stainless Steel
5	Gasket	Stainless Steel+Expanded Graphite	Stainless Steel+Expanded Graphite
6	Stem	420 Stainless Steel	420 Stainless Steel
7	Cap	ASTM A395 Ductile Iron	ASTM A216 WCB Cast Steel
8	Gland Packing	Expanded Graphite	Expanded Graphite
9	Handwheel	Carbon Steel	Carbon Steel

Performance Parameters															
Name of Parameter	Size / Model	DN 15	DN 20	DN 25	DN 32	DN 40	DN 50	DN 65	DN 80	DN 100	DN 125	DN 150	DN 200	DN 250	DN 300
Flow Coefficient (Kv)	BD16/BD25	5	11	14	20	33	52	74	118	200	285	400	720	1130	1590
	BCS16/BCS25/BCS40	5	11	14	20	33	52	74	118	200	285	400	720	-	-
Valve Stem Stroke (mm)	BD16/BD25	8	10	12	14	15	18	25	28	35	45	58	65	80	94
	BCS16/BCS25/BCS40	8	10	12	14	15	18	25	28	35	45	58	65	-	-
Weight (kg)	BD16	4.5	5	6	9	10	14	23	29	33	71	113	170	275	383
	BD25	4.5	5	6	9	10	14	26	32	38	75	118	176	290	400
	BCS16/ BCS25	4.5	5	6	9	10	14	-	-	-	-	-	-	-	-
	BCS40	6	7	9	12	17	24	33	44	60	89	98	190	318	433
	BCS40(Screwed)	1.5	2	3	5	7	8	-	-	-	-	-	-	-	-

Lift Type Worm Drive Device

The worm drive device featuring high reduction ratio is able to transmit power and perform steadily. It can be widely installed on large sized globe valves serving as valve opening assisting device.

BA series worm drives are optional. See the following table for details.



Worm Drive Device Dimensions and Weights (mm)							
Model	**Worm Drive Model**	**Globe Valve Size**	**A (φ)**	**B**	**C**	**D (φ)**	**Weight (kg) ***
BD16	BA-1	DN150	460	680	960	285	167
		DN200	460	740	1000	340	224
		DN250	460	765	1260	405	329
	BA-2	DN300	460	857	1330	460	437
BD25	BA-1	DN150	460	680	960	300	167
		DN200	460	740	1000	360	224
		DN250	460	765	1260	425	329
	BA-2	DN300	460	857	1330	485	437
BCS40	BA-1	DN150	460	680	1095	425	152
		DN200	460	740	1170	425	234

Note: The weight consists of the weight of globe valve and the worm drive device.

Please indicate when ordering

• Model • Max. Operating Pressure • Max. Temperature • Nom. Pressure • Connection Type • Options

All dimensions and weights are approximate. Use certified print for exact dimensions. Design and materials are subject to change without notice.

BL301NV

Butterfly valve, wafer design.

Suitable for hot water, air, gas and many chemicals

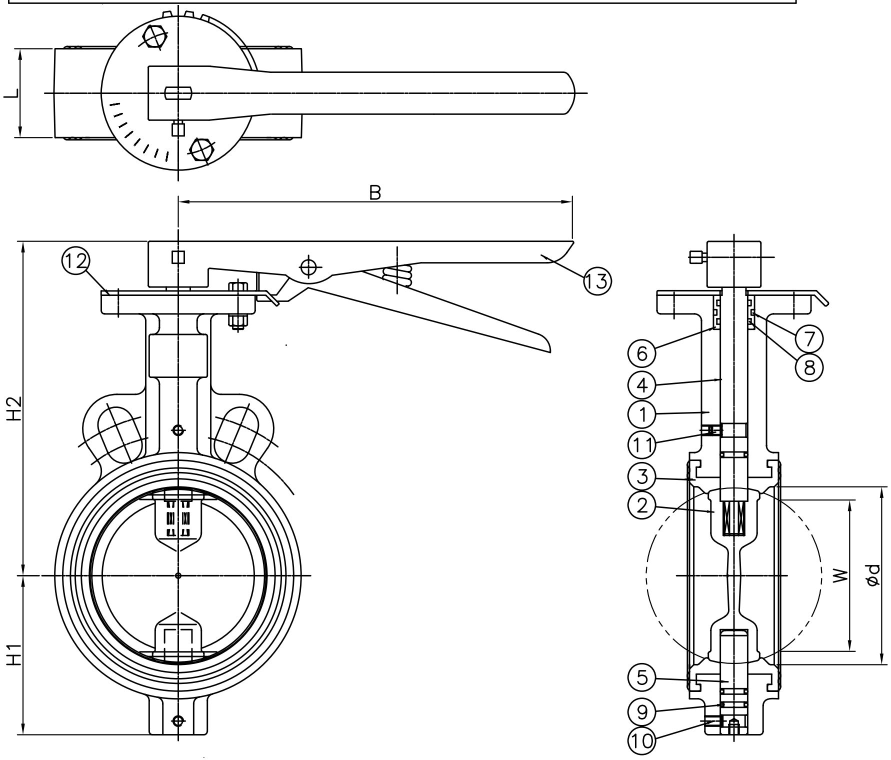
- **Body: Cast Iron**
- **Disc: 316 Stainless steel**
- **Seat: Viton**
- **End Connections: wafer design to suit ANSI 150, AS2129 Table E / D**
- **Maximum pressure rating 1,000 kpa**
- **Maximum temperature rating 220 degrees C**
- **Sizes: 50mm to 200mm**

DIMENSIONS — UNIT: mm

NOMINAL DIAMETER	ød	L	FLANGE øC	FLANGE n−øh	H1	H2	B	W	WEIGHT (KG)
40(1.5”)	40	33			60	155	205	27	2.2
50(2”)	50	43			61	158	205	28	2.7
65(2.5’)	67	46			73	169	205	51	3.4
80(3”)	79	46			80	180	205	67	3.8
100(4”)	101	52			93	194	265	89	4.9
125(5”)	124	56			113	207	265	113	6.8
150(6”)	147	56			126	220	265	139	8.6
200(8”)	197	56			157	275	350	191	13.1

FLANGE RATING : MULTI−DRILLING(5K,10K,PN10,PN16,150LB)

P.NO.	PART NAME	MATERIAL	Q'TY	REMARK
1	BODY	FC200	1	
2	DISC	SCS13	1	
3	SEAT RING	EPDM	1	
4	MAIN STEM	SUS410	1	
5	STUB STEM	SUS410	1	
6	O−RING HOLDER	ACETAL	1	
7	O−RING	EPDM	2	
8	O−RING	EPDM	1	
9	O−RING	EPDM	3	
10	STOP BOLT	SS400	1	
11	BOLT/O−RING/BOLT	SS400/NBR/SUS304		1SET
12	INDICATOR	SS400	1	GALVANIZED
13	LEVER	ASS'Y	1	



NOTES

1. "W" DIMENSION IS THE MINIMUM ALLOWABLE FLANGE INSIDE DIAMETER OR PIPE INSIDE DIAMETER AT THE CENTERED BODY FACE WHEN IN THE OPEN POSITION
2. HYDROSTATIC TEST
   −BODY : 15 BAR
   −SEAT : 11 BAR
3. FACE TO FACE : ISO 5752

BL302NV

Butterfly valve, lugged design.

Suitable for hot water, air, gas and many chemicals

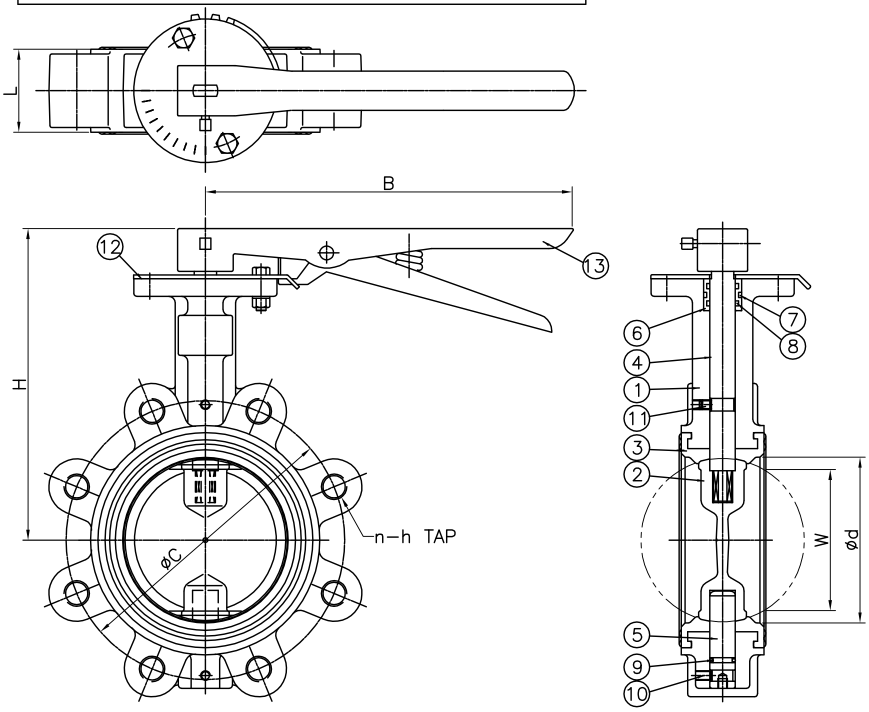
- **Body: Cast Iron**
- **Disc: 316 Stainless steel**
- **Seat: Viton**
- **End Connections: lugged design to suit ANSI 150**
- **Maximum pressure rating 1,000 kpa**
- **Maximum temperature rating 220 degrees C**
- **Sizes: 50mm to 200mm**

DIMENSIONS UNIT: mm

NOMINAL DIAMETER	ød	L	FLANGE øC	FLANGE n−h	H	B	W
40(1.5")	40	33	98.4	4−1/2"	155	205	27
50(2")	50	43	120.7	4−5/8"	158	205	28
65(2.5')	67	46	139.7	4−5/8"	169	205	51
80(3")	79	46	152.4	4−5/8"	180	205	67
100(4")	101	52	190.5	8−5/8"	194	265	89
125(5")	124	56	215.9	8−3/4"	207	265	113
150(6")	147	56	241.3	8−3/4"	220	265	139
200(8")	197	60	298.5	8−3/4"	275	350	191

FLANGE RATING : ANSI #150

P.NO	PART NAME	MATERIAL	Q'TY	REMARK
1	BODY	FC200	1	
2	DISC	SCS14	1	CF8M
3	SEAT RING	VITON	1	
4	MAIN STEM	SUS410	1	
5	STUB STEM	SUS410	1	
6	O−RING HOLDER	ACETAL	1	
7	O−RING	EPDM	2	
8	O−RING	EPDM	1	
9	O−RING	EPDM	1	
10	STOP BOLT	SS400	1	
11	BOLT/O−RING/BOLT	SS400/NBR/SUS304	1SET	
12	INDICATOR	SS400	1	GALVANIZED
13	LEVER	ASS'Y	1	



NOTES

1. "W" DIMENSION IS THE MINIMUM ALLOWABLE FLANGE INSIDE DIAMETER OR PIPE INSIDE DIAMETER AT THE CENTERED BODY FACE WHEN IN THE OPEN POSITION

2. HYDROSTATIC TEST
   −BODY : 15 BAR
   −SEAT : 11 BAR

3. FACE TO FACE : ISO 5752

BLWCI15SP

Butterfly valve, wafer design.

Suitable for hot water, air, gas and many chemicals

- **Body: Cast Iron**
- **Disc: 316 Stainless steel**
- **Seat: PTFE**
- **End Connections: wafer design to suit ANSI 150, AS2129 Table E / D**
- **Maximum pressure rating 1,000 kpa**
- **Maximum temperature rating 204 degrees C**
- **Sizes: 50mm to 200mm**

D I M E N S I O N S UNIT: mm

NOMINAL DIAMETER	ød	L	FLANGE øC	FLANGE n−øh	H1	H2	B	W
50(2")	50	43			61	158	205	28
80(3")	79	46			80	180	205	67

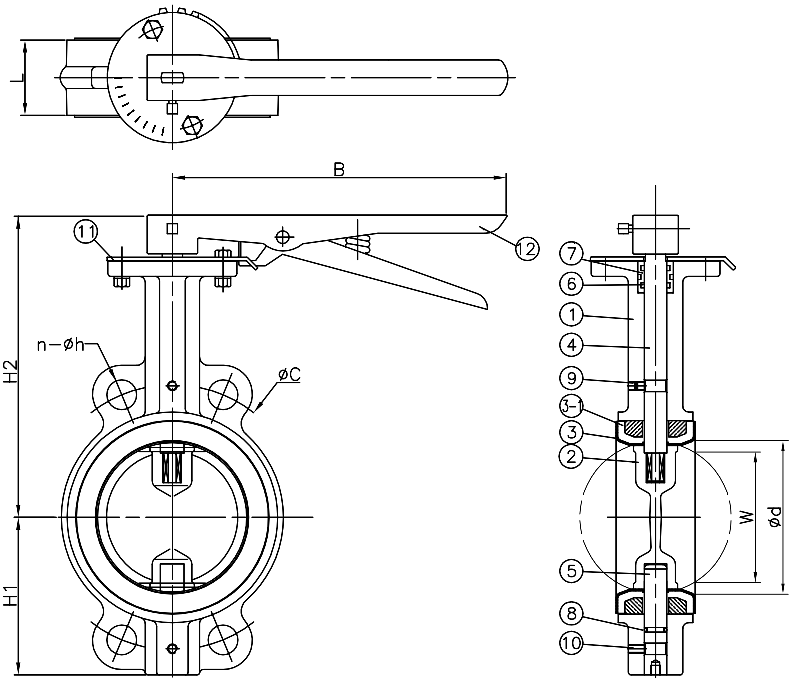
FLANGE RATING : MULTI−DRILLING(5K,10K,PN10,PN16,150LB)

D I M E N S I O N S UNIT: mm

NOMINAL DIAMETER	ød	L	FLANGE øC	FLANGE n−øh	H1	H2	B	W
100(4")	102	52	190.5	8−19	110	212	205	91
150(6")	154	56	241.3	8−22	155	263	265	143

FLANGE RATING : ANSI #150

P.NO.	PART NAME	MATERIAL	Q'TY	REMARK
1	BODY	FC200	1	
2	DISC	SCS14	1	CF8M
3	SEAT	PTFE	1	
3−1	BACKUP SEAT	EPDM	1	
4	MAIN STEM	SUS410	1	
5	STUB STEM	SUS410	1	
6	O−RING HOLDER	ACETAL	1	
7	O−RING	EPDM	3	
8	O−RING	EPDM	1	
9	STOP BOLT	SS400	1	
10	BOLT/O−RING/BOLT	SS400/NBR/SUS304	1SET	
11	INDICATOR	SS400	1	GALVANIZED
12	LEVER	ASS'Y	1	



N O T E S

1. "W" DIMENSION IS THE MINIMUM ALLOWABLE FLANGE INSIDE DIAMETER OR PIPE INSIDE DIAMETER AT THE CENTERED BODY FACE WHEN IN THE OPEN POSITION

2. HYDROSTATIC TEST
 −BODY : 15 BAR
 −SEAT : 6 BAR

3. FACE TO FACE : ISO 5752

BLWS15SP

Butterfly valve, wafer design.

Suitable for hot water, air, gas and many chemicals

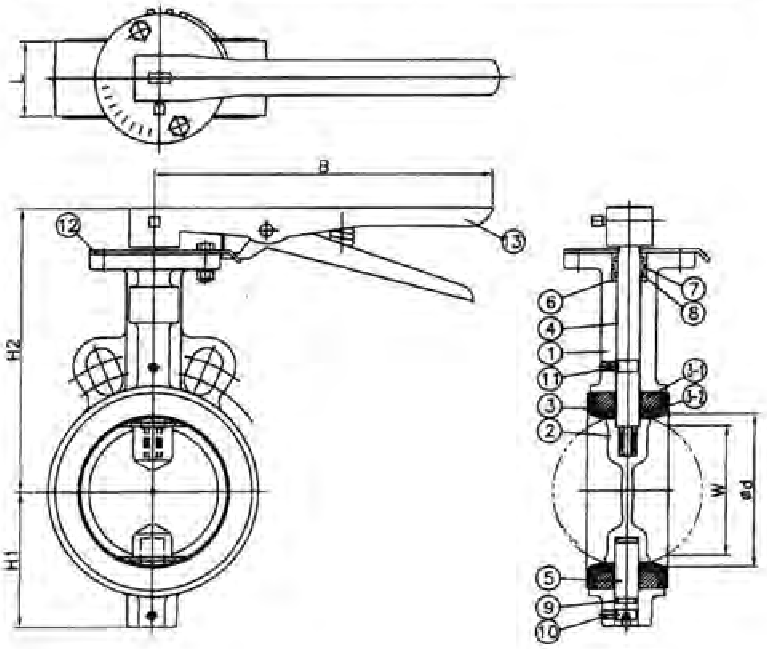
- Body: 316 Stainless steel
- Disc: 316 Stainless steel
- Seat: PTFE
- End Connections: wafer design to suit ANSI 150, AS2129 Table E / D
- Maximum pressure rating 600 kpa
- Maximum temperature rating 204 degrees C
- Sizes: 20mm to 200mm

D I M E N S I O N S   UNIT: mm

NOMINAL DIAMETER	ød	L	FLANGE		H1	H2	B	W	WEIGHT (KG)
			øC	n−øh					
50(2")	50	43			61	158	205	28	2.7
65(2.5")	67	46			73	169	205	51	3.4
80(3")	79	46			80	180	205	67	3.8
100(4")	101	52			93	194	265	89	4.9
125(5")	124	56			113	207	265	113	6.8
150(6")	147	56			126	220	265	139	8.6
200(8")	197	56			157	275	350	191	13.1

FLANGE RATING : MULTI−DRILLING(5K,10K,PN10,PN16,150LB)

P.NO	PART NAME	MATERIAL	Q'TY	REMARK
1	BODY	SCS14	1	CF8M
2	DISC	SCS14	1	CF8M
3	SEAT	PTFE	1	
3	BACKUP SEAT	EPDM	1	
3	BACKUP RING	PHENOLIC	1	
4	MAIN STEM	SUS316	1	
5	STUB STEM	SUS316	1	
6	O−RING HOLDER	ACETAL	1	
7	O−RING	EPDM	2	
8	O−RING	EPDM	1	
9	O−RING	EPDM	1	
10	STOP BOLT	SS400	2	
11	BOLT/O−RING/BOLT	SS400/NBR/SUS304		1SET
12	INDICATOR	SS400	1	GALVANIZED
13	LEVER	ASS'Y	1	



N O T E S

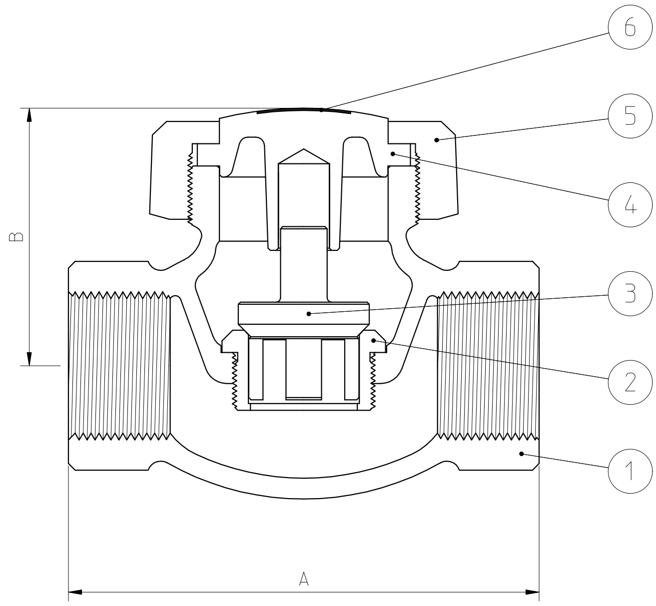
1. "W" DIMENSION IS THE MINIMUM ALLOWABLE FLANGE INSIDE DIAMETER OR PIPE INSIDE DIAMETER AT THE CENTERED BODY FACE WHEN IN THE OPEN POSITION
2. HYDROSTATIC TEST
   −BODY : 15 BAR
   −SEAT : 6 BAR
3. FACE TO FACE : ISO 5752

CP460

Check valve, piston type, union cap.

Suitable for steam, water, air, gas and non corrosive chemicals

- **Body & cover: Bronze B61**
- **Disc & Seat: 410 Stainless steel**
- **End Connections: Screwed BSP**
- **Maximum pressure rating 4,000 kpa cold, 2,000 kpa steam**
- **Maximum temperature rating 215 degrees C**
- **Sizes: 15mm to 50mm**



HIDROSTATIC TEST	
BODY	900 PSI (62 BAR)
SEAT	600 PSI (41 BAR)

WORKING CONDITIONS		
SATURATED STEAM	300 PSI (21 BAR)	NON SHOCK
WATER, OIL	600 PSI (41 BAR)	

	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"
A	75	90	106	122	135	165
B	46	52	60	69	77	94

MAXIMUM TEMPERATURE = 232 °C

POS.	QUANT.	DENOMINATION	MATERIAL	ABNT SPECIFICATION	ASTM SPECIFICATION
6	01	IDENT. PLATE	ALUMINUM		
5	01	UNION BONNET RING	BRONZE	NBR6314/C92200	B62/C92200
4	01	BONNET	BRONZE	NBR6314/C83600	B62/C83600
3	01	DISC	ST. STEEL	NBR5601/410	A276/410
2	01	SEAT	ST. STEEL	NBR5601/410	A276/410
1	01	BODY	BRONZE	NBR6314/C83600	B62/C83600

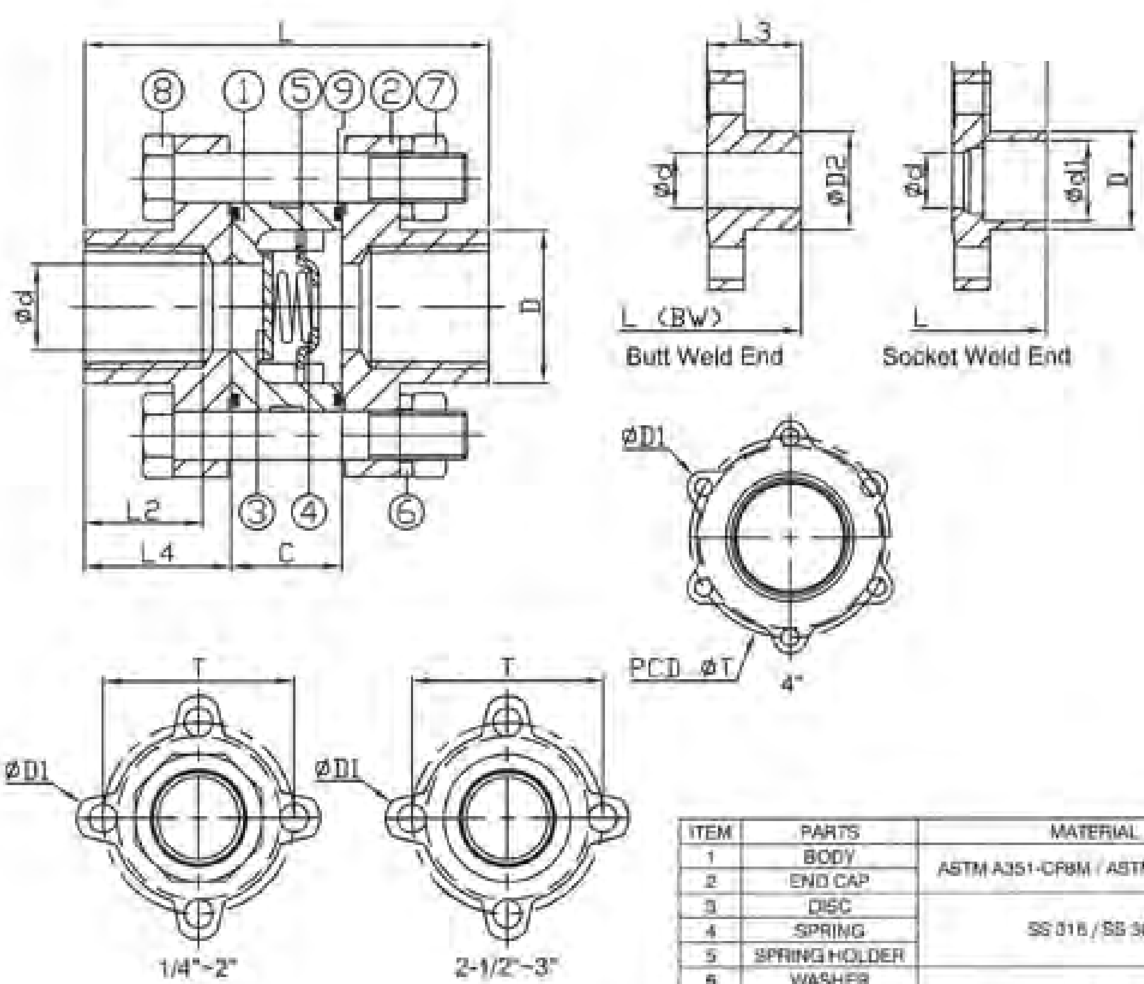
NOTE: THE DIMENSIONS ARE EXPRESSED IN MILLIMETERS.

CS3SS10B

Check valve, 3-piece, in-line spring loaded type.

Suitable for steam, water, air, gas and most chemicals

- **Body, disc & seat: 316 stainless steel**
- **End Connections: Screwed BSP**
- **Maximum pressure rating 7,000 kpa cold**
- **Maximum temperature rating 185 degrees C**
- **Sizes: 15mm to 50mm**



ITEM	PARTS	MATERIAL
1	BODY	ASTM A351-CF8M / ASTM A216-WCB
2	END CAP	
3	DISC	SS 316 / SS 304
4	SPRING	
5	SPRING HOLDER	
6	WASHER	SS 304
7	NUT	
8	BOLT	
9	SEAL	PTFE

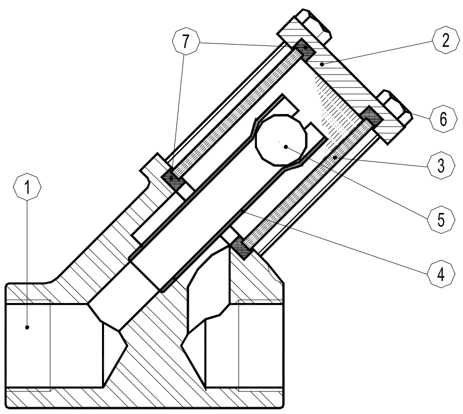
DN	d	D1	L	L (BW)	L1	L2	L3	L4	C	D2	D1	D	T	Weight Kg
8	11	14.8	65	68	15.5	18	24	21	18	18	12	30	36.5	0.8
15	15	17.6	65	66	15.5	18	24	21	19	20.5	13	28	36.6	0.8
15	14	21.6	69	67	12.5	18	24	22	19	22	14	33	42.7	0.8
20	18	27.4	71	81	14.1	20	25.5	25.5	24	28	13	35	51.7	0.8
25	25	34.1	81.5	83.5	15.7	22	31	26	29.5	31.5	13	39	58.7	1.1
32	31	42.7	91	92	17.7	25	33.5	30	30	40	13	46	78.7	1.3
40	38	49	87.5	103.5	19.5	25	33	33	37.5	48	13	58	89.7	1.7
50	49	61	117	117	22	27	38	37	47	61	13	69	98.7	3.1
65	64	77	131.5	131.5	26.3	35	42	42	47.5	76	13	89	129	4.3
80	76	90.2	143.5	143.5	29.1	38	50	34	58.5	91.5	13	102	155.5	6.2
100	97	115.3	174.5	174.5	31.5	40	40	40	70.6	121.8	13	127.9	186.5	11

Unit: mm

SIGHT CHECKER - SCK

DESCRIPTION
Being installed after the steam trap, the sight checker is a device to be used for visually checking the conditions and leakage of steam traps.
SCK sight checker functions as both sight glass and check valve.
Connections are female screwed.

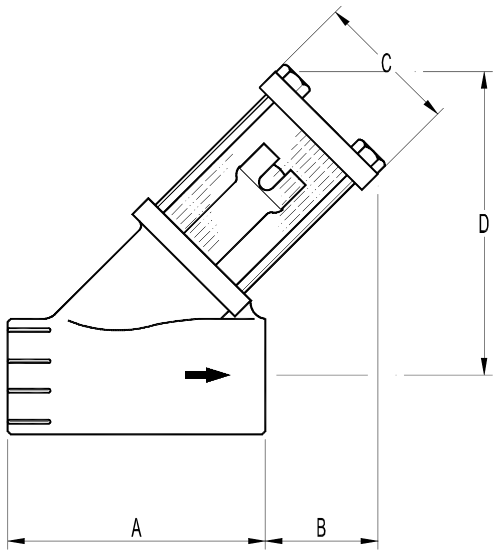
USE:	Condensate pipes downstream steam traps.
AVAILABLE MODELS:	SCK
SIZES:	½”, 3/4” and DN 1”
CONNECTIONS:	Female screwed ISO 7/1Rp(BS21).
INSTALLATION:	Horizontal or vertical (bottom to top) installation. See IMI, installation and maintenance instructions.
CAUTION:	SCK should be fitted at least 1m from the trap in order to protect the glass from thermal pressure or shock.



PMO – Max. operating pressure	10	bar
TMO – Max. operating temperature	150	ºC

How to order: i.e. SCK DN ½” BSP.

DIMENSIONS (mm)					
SIZE DN	A	B	C	D	WGT. Kgs
1/2"	80	36	45	95	0,9
3/4"	80	36	45	95	0,9
1"	90	40	56	110	1,3



MATERIALS		
POS.Nr.	DESIGNATION	MATERIAL
1	Body	Bronze B62 / ASTM B148-97
2	Cover	Brass EN12165 / CuZn39Pb2
3	* Sight tube	Borosilicate glass
4	Discharge tube	Copper
5	Ball check	Stainless steel
6	Bolts	Seel 8.8
7	* Gasket	Graphite

*Available spare parts.

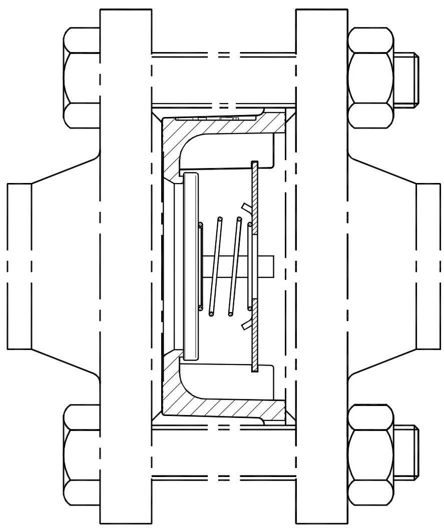
WAFER-TYPE NON-RETURN VALVE

RD40 DN15 – DN100

DESCRIPTION
The RD40 all stainless steel disc check valve has a compact design and was specially designed for use with steam and hot condensate.
Connections are flanged (wafer type)

MAIN FEATURES
Low pressure drop.
Simple and compact design.
Overall lengths according to DIN 3202 part 3-K4

OPTIONS:	Soft sealing : EPDM (E), NBR (N), VITON (V), PTFE (T). Inconel springs
USE :	Saturated steam, water and other gases (Group 2) compatible with the construction
AVAILABLE MODELS :	RD 40
SIZES :	DN 15 to DN 100
CONNECTIONS :	Sandwiched between flanges as per EN 1092 or ANSI.
INSTALLATION :	Horizontal or vertical installation See IMI, installation and maintenance instructions.
RATING :	PN 25 / PN 40
LIMIT OF OPERATION:	As per EN 1092



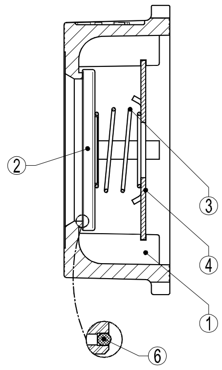
Recommended limit of operation with soft seats (ºC)			
EPDM (E)	NBR (N)	VITON (V)	PTFE (T)
130º	95º	180º	180º

CE MARKING (PED - European Directive 97/23/EC)		
PN 25	PN 40	Category
DN15 to DN40	DN15 to DN32	SEP - art. 3, paragraph3
DN50 to DN100	DN40 to DN80	Category 1 (CE Marked)
-	DN100	Category 2 (CE Marked)

WAFER-TYPE NON-RETURN VALVE

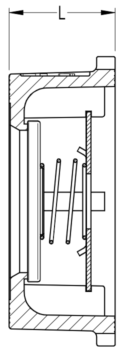
RD40 DN15 – DN100

DIMENSIONS (mm)									
DN	***15***	***20***	***25***	***32***	***40***	***50***	***65***	***80***	***100***
D1	43	53	64	75	86	96	115	132	152
D2	50	60	70	81	91	105	126	141	167
L	17	20	23	28	32	40	46	50	60
Kgs	0,18	0,2	0,25	0,5	0,7	1,3	1,7	2,8	4,5

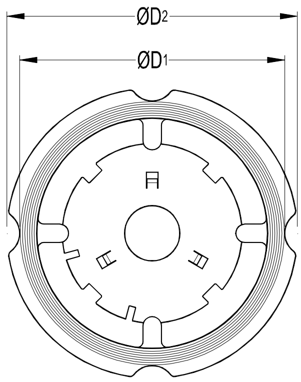


MATERIALS		
POS.	***DESIGNATION***	***MATERIAL***
1	Valve body	CF8M / 1.4408
2	*Disc	AISI316 / 1.4401
3	*Spring	AISI302 / 1.4300
4	Star	AISI316 / 1.4401
6	* Soft seal	See options

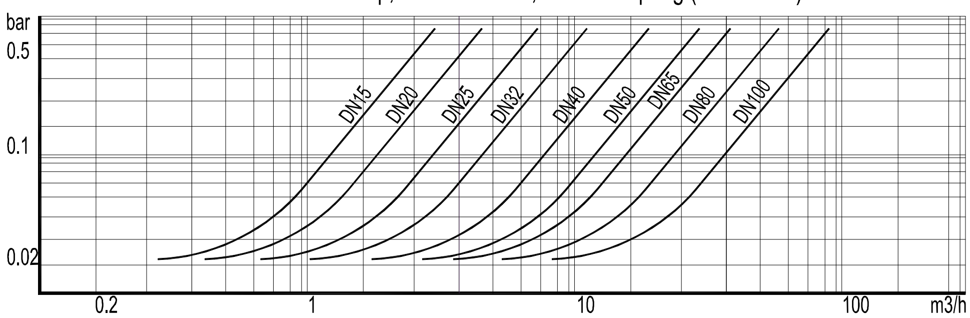
*Available spare parts



Minimum opening pressures with standard spring in mbar										
DN		***15***	***20***	***25***	***32***	***40***	***50***	***65***	***80***	***100***
D.P.	↑	25	25	25	27	28	29	30	31	33
D.P.	→	23	23	23	24	25	25	26	26	27
D.P.	↓	21	21	21	21	21	21	21	21	21
*D.P.	↑	2	2	2	3	4	4	5	5	6
* Vertical installation without springs (bottom to top). → Flow direction.										



Pressure drop, horizontal flow, standard spring (water - 20º)

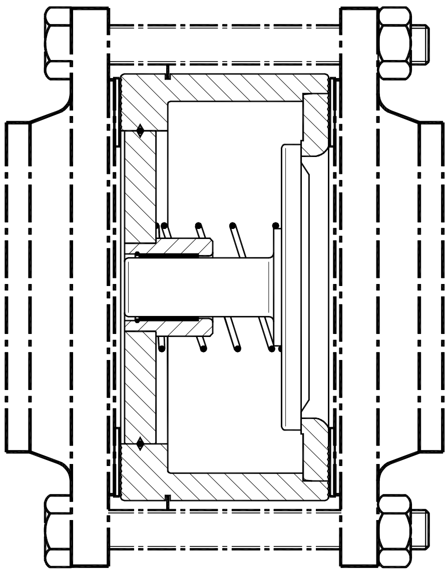


To determine the pressure drop of other mediums the equivalent water flow volume has to be calculated: $V_W = \sqrt{\frac{Q}{1000}} \times V$

Vw = Equivalent water flow volume in m3/h ; Q = Density in Kg/m3 ; V = Flow volume in m3/h

WAFER-TYPE NON-RETURN VALVE

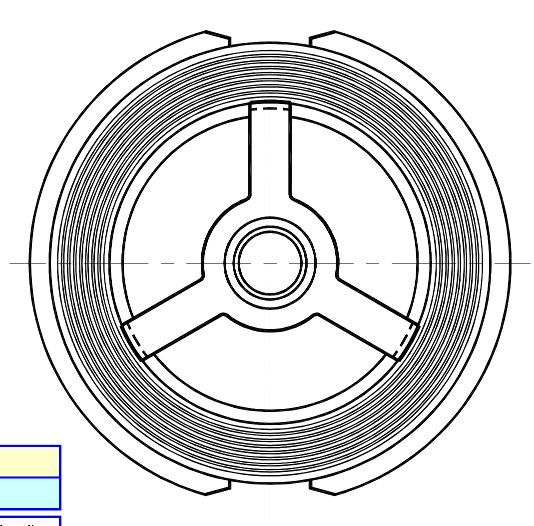
RD40 DN 125 – DN 200



DESCRIPTION
The RD40 disc check valve has a compact design and was specially designed for use with steam and hot condensate.
Connections are flanged (wafer type)

MAIN FEATURES
Low pressure drop.
Simple and compact design.
Overall lengths according to DIN 3202 part 3-K4

OPTIONS:	Soft sealing : EPDM (E), NBR (N), VITON (V), PTFE (T). Inconel springs
USE :	Saturated steam, water and other gases (Group 2) compatible with the construction
AVAILABLE MODELS :	RD 40
SIZES :	DN 125 to DN 200
CONNECTIONS :	Sandwiched between flanges as per EN 1092 or ANSI.
INSTALLATION :	Horizontal or vertical installation .See IMI, installation and maintenance instructions.
RATING :	PN 10 / PN 40
LIMIT OF OPERATION:	As per EN 1092



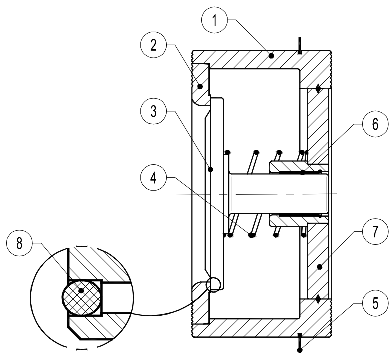
Recommended limit of operation with soft seats (ºC)			
EPDM (E)	NBR (N)	VITON (V)	PTFE (T)
130º	95º	180º	180º

CE MARKING (PED - European Directive 97/23/EC)			
PN 10/16	PN 25	PN 40	Category
DN125 to DN200	DN125	/	Category 1 (CE marked)
/	DN150-DN200	DN125	Category 2 (CE marked)
/	/	DN150-DN200	Category 3 (CE marked)

WAFER-TYPE NON-RETURN VALVE

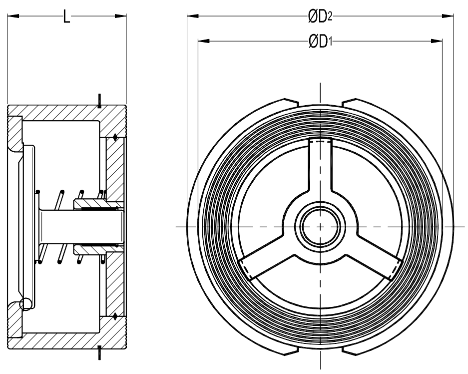
RD40 DN 125 – DN 200

DIMENSIONS (mm)							
DN	***D1 PN10/16***	***D2 PN25***	***D2 PN40***	***D2 ANSI150***	***D2 ANSI300***	***L***	***Weight Kgs***
125	192	192	192	192	216	90	11
150	218	226	226	218	251	106	13,5
200	273	286	293	273	308	140	24

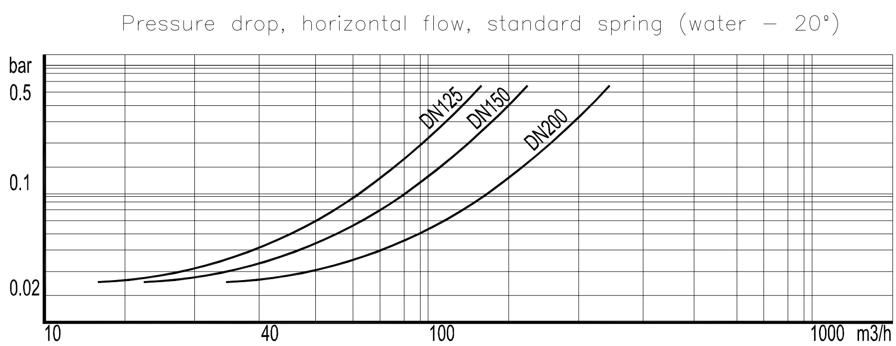


MATERIALS		
POS.	***DESIGNATION***	***MATERIAL***
1	Valve body	S355J2G3 / 1.0570
2	Seat	AISI316 / 1.4401
3	*Disc	AISI316 / 1.4401
4	*Spring	AISI302 / 1.4300
5	Centering ring	AISI304 / 1.4301
6	Bearing	Steel Fe Zn
7	Star	S355J2G3 / 1.0570
8	*Soft seal	See options

*Available spare parts



Minimum opening pressures with standard spring in mbar				
DN		***125***	***150***	***200***
D.P.	↑	37	40	46
D.P.	→	22	25	28
D.P.	↓	7	10	10
Flow direction.	→			



To determine the pressure drop of other mediums the equivalent water flow volume has to be calculated: $V_W = \sqrt{\frac{Q}{1000}} \times V$

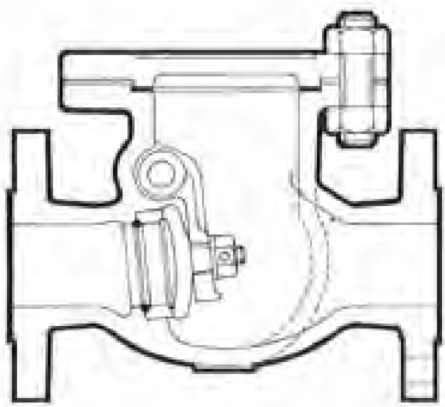
Vw = Equivalent water flow volume in m3/h ; Q = Density in Kg/m3 ; V = Flow volume in m3/h

CKBC1508R

Swing type, bolted cover, Class 150#.

Suitable for steam, water, air, gas and non corrosive chemicals

- **Body & Cover: Cast Steel ASTM A216 Gr WCB**
- **Piston: 13% Chrome stainless steel**
- **Seat: Stellite #6**
- **End Connections: Flanged ANSI 150**
- **Maximum pressure rating: 1,171 at 260 deg C, 1,964 kpa at -29 to +35 deg C**
- **Sizes: 50mm to 200mm**

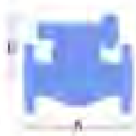


PART	MATERIAL	A.S.T.M.
Cover nut	Steel	A194 Gr 2H
Cover	Cast steel	*A216 Gr WCB
Cover stud	Alloy steel	A193 Gr B7
Gasket	Soft steel	
Hinge pin	13% chrome steel	A479-410
Hinge plug bolt	Steel	A307B
Hinge plug gasket	Soft steel	
Hinge	Cast steel	*A216 Gr WCB
Hinge nut	Steel	A307B
Body seat ring	Stellite faced	A108 Gr 1020 + St
Washer	Steel	
Split pin	Steel	A580-304
Disc	13% chrome steel	A217 CA15
Body	Cast steel	*A216 Gr WCB

*Carbon content 0.25% max

DIMENSIONS:

Nominal Size mm	50	65	80	100	150	200	250	300	350	400	450	500	600
A mm	203	216	241	292	356	495	622	699	787	864	978	978	1295
B mm	151	163	175	210	251	296	333	352	401	430	520	564	683
Approx Weight kg	17	22	31	50	92	136	195	285	420	500	640	780	1490

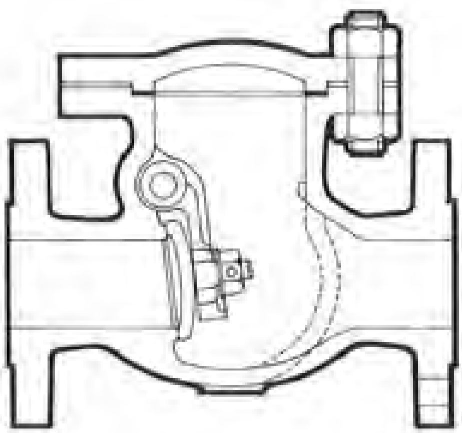


CKBS1512R

Swing type, bolted cover, Class 150#.

Suitable for steam, water, air, gas and non corrosive chemicals

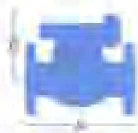
- **Body & Cover: Stainless steel CF8M**
- **Disc: 316 stainless steel**
- **Seat: Stainless steel + Stellite #6**
- **End Connections: Flanged ANSI 150**
- **Maximum pressure rating: 1,171 at 260 deg C, 1,896 kpa at -29 to +35 deg C**
- **Sizes: 50mm to 200mm**



PART	MATERIAL	A.S.T.M
Cover	Stainless Steel	A351-CF8M
Cover Nut	Stainless Steel	A194-8
Cover Bolt	Stainless Steel	A193-B8
Gasket	Teflon	
Rod Pin	Stainless Steel	A479-316
Plug Bolt	Stainless Steel	A479-316
Plug Gasket	Teflon	
Arm	Stainless Steel	A351-CF8M
Arm Nut	Stainless Steel	A194-8
Split Pin	Stainless Steel	A580-316
Washer	Stainless Steel	A240-316
Disc	Stainless Steel	A351-CF8M
Body	Stainless Steel	A351-CF8M

DIMENSIONS

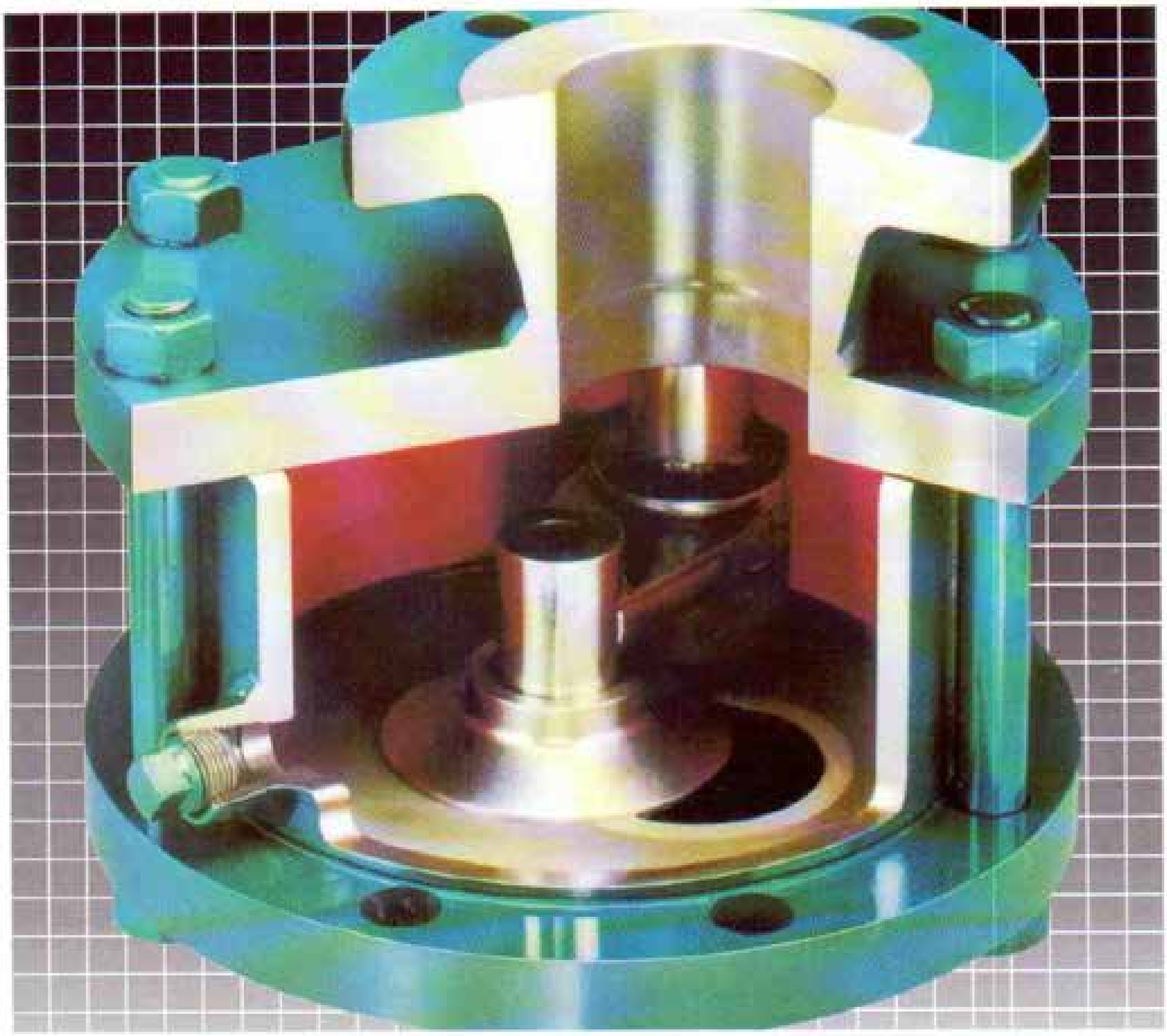
Nominal Size mm	15	20	25	40	50	65	80	100	150	200	250	300
A mm	108	117	127	165	203	216	241	292	356	495	622	699
B mm	76	80	96	114	144	162	171	190	238	266	323	354
Approx. Weight kg	2	3	4	7	13	18	21	34	59	102	139	209



Everlasting®

ROTATING DISC VALVES

- Temperatures to 1500 +F • Pressures to 10,000 psig • Abrasives • Corrosives • Coking • Slurries
- High Cycling • Bi-Directional • Intrinsically Fire Safe

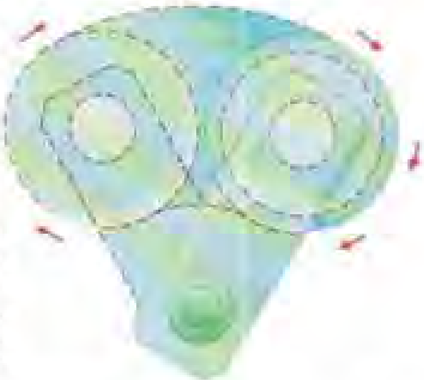


OVER 80 YEARS OF FIELD PROVEN SERVICE – WITH APPLICATIONS WORLDWIDE.

PROVEN CONCEPT Starting in 1904 the unique rotating shearing disc concept was the standard for steam locomotive boiler blowdown. Following this the packaged boiler industry has also accepted the Everlasting quick opening valve where our reputation remains unchallenged. The valve handles boiler blowdown, scale, chemicals, high pressures, temperatures, and flashing condensate, they have an average life of 16 years.

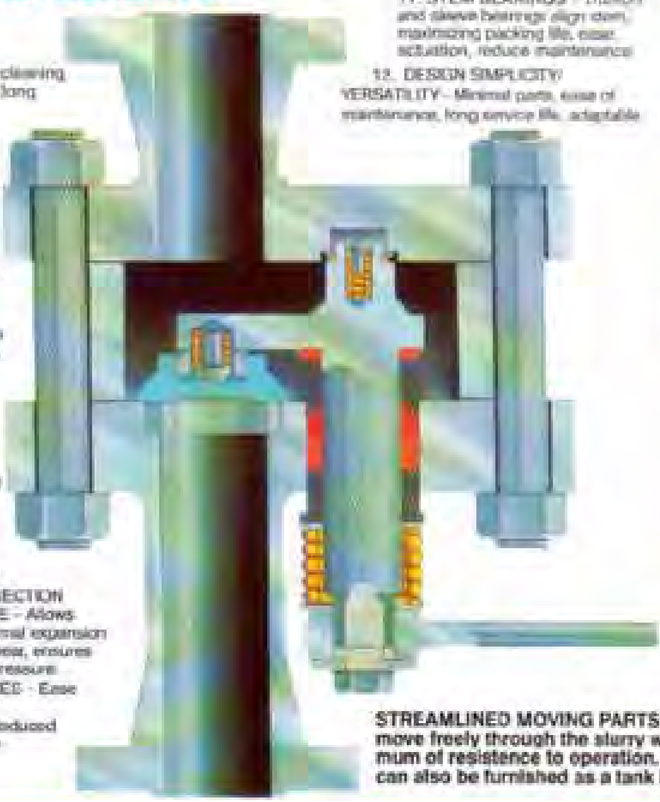
Our slurry valves are installed throughout the world in processes that are abrasive, corrosive or fouling and that have high pressure, temperature or cycling. The unique self lapping metal to metal seat design provides repeated tight shutoff in severe service, while sealing improves with use.

PRINCIPAL OF OPERATION The actuator moves the stem and lever arm a quarter turn which drives the disc. The entire sealing surface of the disc is constantly in contact with the seat or pad through force exerted by coiled springs. These springs allow the disc to move vertically. This compensates for thermal expansion and contraction of the valves components also overcoming the effect of any back pressure for which it was designed and prevents particles from lodging between the sealing surfaces. Differences in tangential disc to seat friction forces cause the disc to rotate on its seat as the valve cycles, thereby shearing and wiping away any process material that may accumulate. No other valve is similar.



FEATURES AND BENEFITS

1. UNIQUE ROTATING/SHEARING DISC – Self lapping disc, enhance seat cleaning action, cuts through solids, long lasting tight shut-off
2. METAL TO METAL SEATING – abrasion resistance, wide temperature range.
3. WIDE BAND SEATING – High pressure capability, better sealing than industry standards, force distributed over larger area, less trim wear.
4. FULL PORT – abrasion resistance, no obstruction to flow, minimal pressure drop.
5. ROTATING STEM – Increased packing life, wide selection of actuators.
6. SELF DRAINING BODY – Reduced chance of jamming due to material entrainment, stagnation and degradation.
7. BODY PURGE CONNECTIONS – Ability to flush valve cavity and internals while in operation.
8. SPRING LOADED CONNECTION BETWEEN DISC AND DRIVE – Allows disc to compensate for thermal expansion or contraction, adjusts for wear, ensures tight shut-off, resists back pressure.
9. FLAT SEATING SURFACES – Ease of maintenance.
10. REPAIRABLE SEAT – Reduced inventory, less maintenance expense.
11. STEM BEARINGS – Trunion and sleeve bearings align stem, maximizing packing life, ease actuation, reduce maintenance
12. DESIGN SIMPLICITY/VERSATILITY – Minimal parts, ease of maintenance, long service life, adaptable



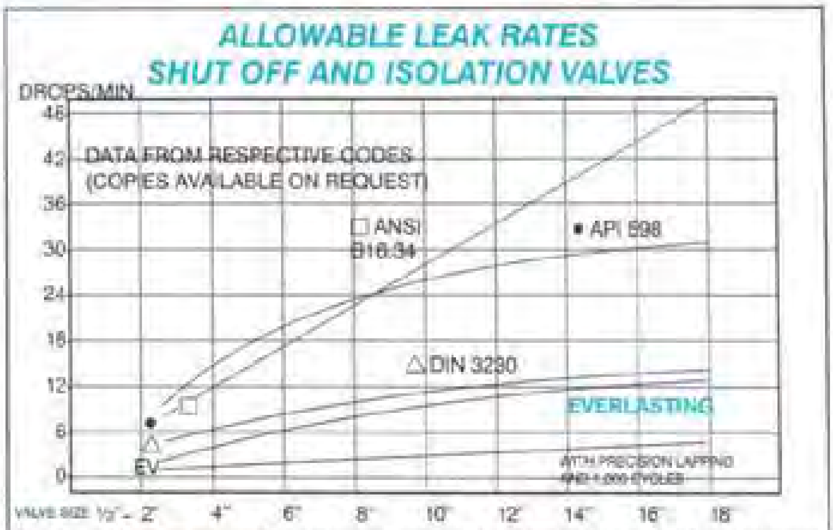
STREAMLINED MOVING PARTS are made to move freely through the slurry with a minimum of resistence to operation. This design can also be furnished as a tank bottom valve.

THREE WAY, DIVERTING, OR CONVERGING. This valve is shown in cast configuration suitable to 300 psig. Fabricated version is available for higher pressures and temperatures.

DURABILITY AND PERFORMANCE FOR SHUT OFF AND ISOLATION APPLICATIONS

SELF LAPPING, WEARS IN-NOT OUT Rotation of the disc produces an action that in the process medium renews and polishes the metal seating surfaces with each operation. This concept is unique causing the Everlasting valve to wear in with use while all other valves are busy wearing out.

TIGHT SEAL ASSURED The wide seat and disc surfaces are routinely machine lapped during manufacture within several light bands of flatness. This produces a seal that is better than industry standards for SHUT OFF and ISOLATION valves. (Refer to graph). Precision lapping and factory cycling of the valve can reduce leak rates further.



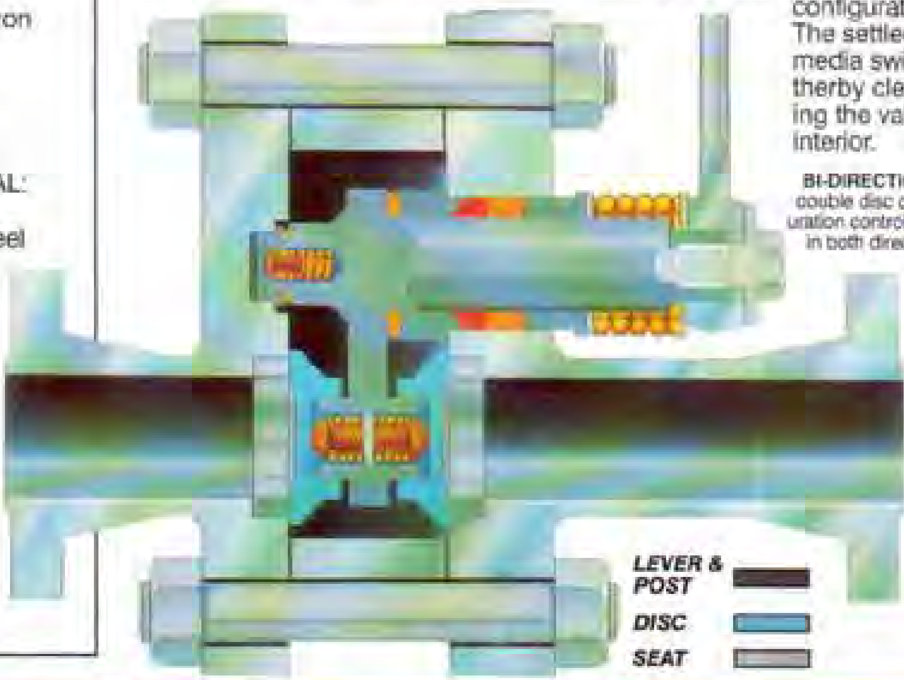
Everlasting Valve standard manufacturing practices produce a seal that exceeds ANSI, API and DIN criteria

CONSTRUCTION

- SIZES ½" to 18"
- END CONNECTIONS:
  Screwed, flanged, socket and butt weld
- BODY MATERIAL:
  Cast Iron/Ductile Iron
  Carbon Steel
  Stainless Steel
  Weldable Alloys
  Packing Seals
  Grafoil or PTFE
- DISC/SEAT MATERIAL:
  Stellite #6
  440C Stainless Steel
- BASIS OF DESIGN:
  Vaccum to
  10,000 PSIG
  ANSI Classes
  150, 300, 600,
  900, 1500, 2500
- TEMPERATURES:
  -350 F to 1500+F
- ACTUATORS:
  Manual Lever
  Manual Wheel
  Pneumatic
  Hydraulic
  Electric

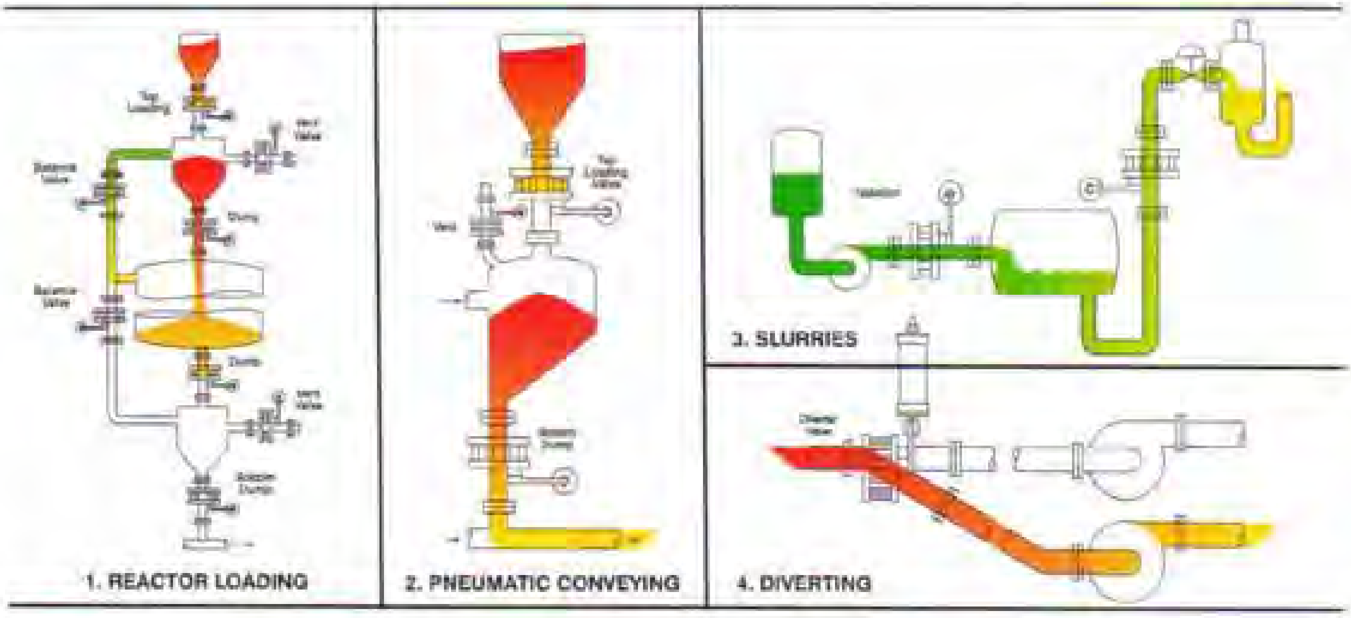
SELF CLEANING The valve body openness provides space for the product to be freely displaced by the lever arm and disc with each cycle. Fines can not compact in small open areas and possibly jam components as is the case with other valve concepts. Each time the valve opens to discharge product, a vortex is caused by the eccentric body to port configuration. The settled media swirls; therby cleaning the valve's interior.

BI-DIRECTIONAL double disc configuration controls flow in both directions.



Everlasting Abrasive Service Valves

Everlasting PROCESS and BULK MATERIAL VALVES are used where existing valves or rotary feeders are repaired or replaced more than once a year. Sizes range from 1/2" to 18", vacuum to class 2500, temperatures +1500° F.



Their open body concept is self cleaning and incorporates precision flat lapped hard metal seats and discs that move in non-wedging, non-binding fashion through abrasive materials whether they are dry powders or in a slurry. Differences in tangential disc to seat friction cause the disc to rotate a few degrees with each cycle. This rotation polishes the mating surfaces improving the valves seal with each operation. HERE ARE SOME APPLICATIONS

1. REACTOR LOADING
Everlasting valves are use to replace other valves or rotary feeders for reactors that can begin its process with positive pressure then drop to a negative pressure. Pressure Equalizing valves balance the loading or let-down hoppers so the reactor valves may cycle with zero differential. They also may cycle with a full differential Pressure Equalizing valves are opened to either allow media to enter the loading hopper or the let-down hopper.

2. PNEUMATIC CONVEYING
Usually there are trains of two or more vessels that alternate continually to transport media. The vessel valves duty cycle are often less than once a minute. The vent valve being smaller is exposed to higher than system velocities, it must resist erosion from the particulate laden atmosphere being discharged between vessel cycles. Everlastings unique totaling disc valves are being bought for more of these systems with each day.

3. SLURRIES
Everlastings eccentric body configuration tends to swirl the flowing media. This design was developed over 86 years ago to handle solids specifically. Other types of valves allow the media to accumulate in small clearances around the seats or between its sealing member and body causing them to jam.

In this real situation the vessel volume is 18,000 cubic feet maintained above 500 psig including mine tailings dissolved in acid that exceeds 400°F. The isolation valves are normally open and cycle closed after several months operation for change out of a modulating flash letdown valve without losing system pressure. When the isolation valves fail to seal it takes nearly a day to bleed the system and half a week to start-up. Production loss is worth a small fortune, literally and so are yours. Space age metals and ceramics used alone could not overcome the attacks of corrosion, erosion, and agglomerating media. The Everlasting Process valves combined the latest materials and its unique design to solve this problem.

4. DIVERTING
The rotating disc concept is ideal for diverting flow to storage bins or silos and to isolate pumps for maintenance. Everlasting diverters remain operating for years in 65% coal and sludge slurries. Turn them around and they converge the process from separate sources into a single stream. There are no small spaces where fines can compact to jam its components. After the customer tested a dozen other manufacturers products in a simulated system the Everlasting Diverter design was selected for use in processing abrasive, corrosive, chemical waste.

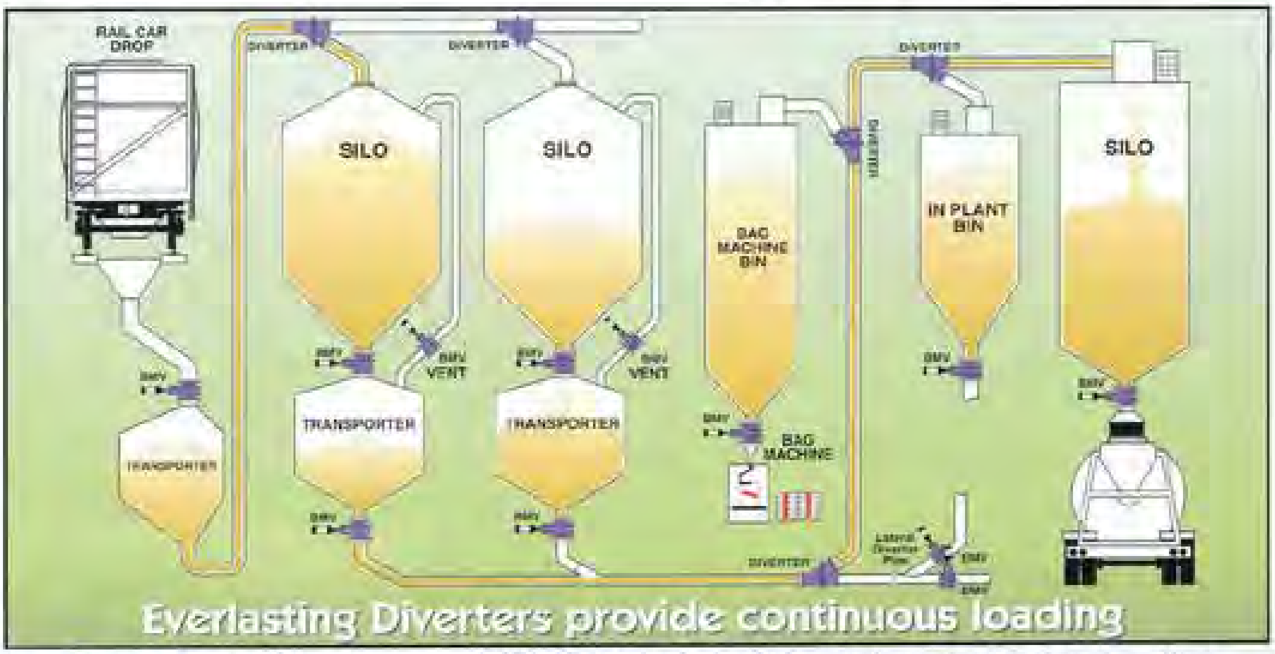
Whether your applications require carbon, stainless steel or space age materials, you can give your abrasives handling problem to the Everlasting 86 year old workaholic.


Everlasting
VALVE COMPANY, INC.
ISO 9001
CERTIFIED
COMPANY
EVERLASTING
PROCESS DIVERTER
DIVERTER VALVES
Switch on the fly, Dependably
For applications of erosive slurries or whenever abrasive solids are conveyed
Everlasting Valve Company, Inc.

The Everlasting Diverter that's built

Switch lines on-the-fly

A major cement company produced 55 ton/hour, but to switch lines they had to stop the compressor then take 15 minutes to come back to pressure. Each time the lines were switched 13.75 tons of product was not conveyed. With Everlasing Diverters there is no time lost. Are your down stream lines plugging, is the fringe bin full, do you have an off quality silo? How much are you losing with your present non-switch on the fly diverters? How much are your installed diverters costing you in parts, labor and lost production?

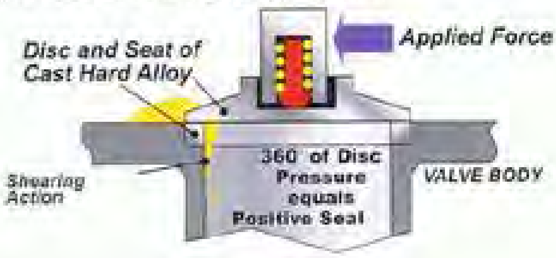


Everlasting Diverters are Self-Cleaning, Self-Lapping and Long-Lasting

SELF-CLEANING Everlasting valves are designed with an open valve body that provides ample room for free flowing media to be displaced by the small volume disc and lever arm. The eccentric body to pipe connections cause the media to swirl in the open body. With the lateral piped to a vertical line media drops by gravity then is discharged through the straight leg with the next cycle. The closed port seat and disc surfaces are always shielded from harsh media.

SELF-LAPPING SEALING SURFACES With each cycle the flat disc freely rotates around a spring loaded rivet internal to the disc drive. Disc rotation occurs as the center of friction under the disc seeks alignment with applied force. Scratches that may develop in the wide sealing surfaces are polished away as the disc moves from one port to the other. This feature is unique to Everlasting Valve. No other valve is similar.

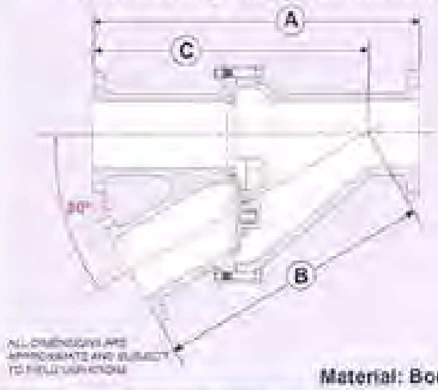
POSITIVE SHUT-OFF Machine lapping of the sealing surfaces at the factory assures tight shut off. Leak rates are less than industry standard ANSI B.16.34; MSS-SP61 for metal seated valves. Each valve is tested to assure seat and body integrity. The spring loaded disc is held firmly against the path that it travels. Having sharp edges the seat and disc shear away any deposits from their sealing surfaces. Valve may be used for Converging applications.



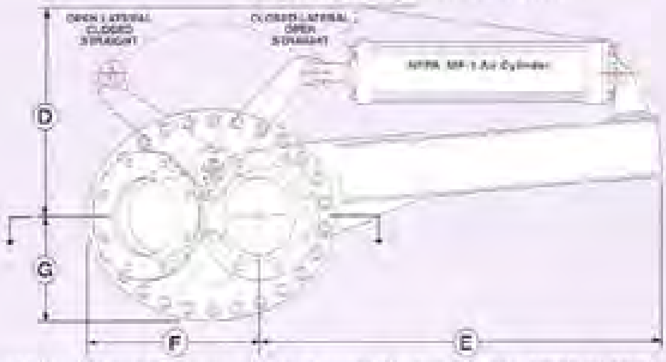
to handle your most abrasive media

Diverter dimensions specifications and options

Cast diverting valve cross section



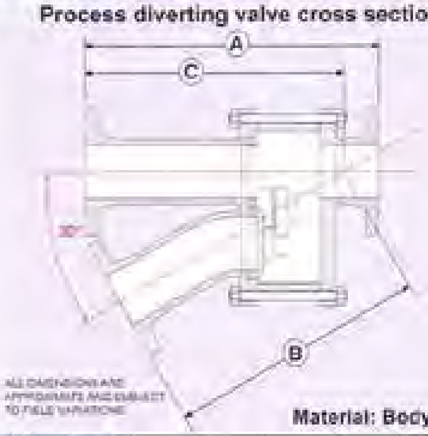
Cast diverting valve end view



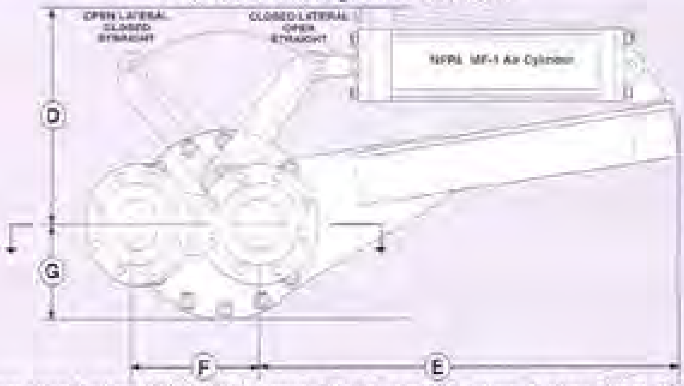
Material: Body cast iron, class 125 flanges, disc & seats hardened alloy 38RC to 59RC

Valve (mm)	A	B	C	D	E	F	G	Press/Temp Rating
4" (100)	22"	23 1/8"	23 1/8"	16 7/8"	31 1/8"	9 5/8"	6 1/8"	100 psi / 7 bar 450° F / 232° C
5" (125)	21 3/4"	19 3/8"	19 3/8"	17 1/2"	32 1/4"	12 7/8"	7 1/2"	
6" (150)	29"	23 1/8"	23 1/8"	21 1/4"	44"	12 7/8"	7 1/2"	
8" (200)	29 1/2"	25 1/4"	25 1/4"	20 1/2"	43 7/8"	19 1/8"	10 7/8"	
10" (250)	35 1/2"	30 3/8"	30 3/8"	23 1/8"	42 7/8"	21"	11 3/8"	
12" (300)	40"	35 3/8"	35 3/8"	23 7/8"	45 1/8"	22 1/4"	11 3/8"	

Process diverting valve cross section

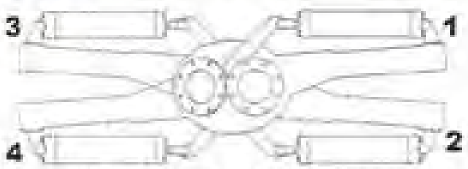


Process diverting valve end view



Material: Body Carbon steel / alloy ANSI, DIN flanges, disc & seats hardened alloy 38RC to 59RC

Valve (mm)	A	B	C	D	E	F	G	Press/Temp Rating
2" (50)	16 1/2"	12"	12"	10 7/8"	24 1/8"	6 3/8"	4 3/8"	ANSI B 16.34 CLASS 150
3" (80)	19 1/2"	15 1/4"	15 1/4"	16 1/8"	33"	9 5/8"	6 1/2"	
4" (100)	21"	18 1/2"	18 3/8"	16 1/8"	31 1/2"	9 5/8"	7"	
6" (150)	22 1/2"	23"	23 1/8"	21"	44 1/4"	13 3/8"	9 5/8"	
8" (200)	26 1/2"	26 3/4"	26 1/2"	21 3/4"	41 5/8"	17"	12"	
10" (250)	30"	31 5/8"	31 1/2"	24 1/4"	47 7/8"	20 1/8"	14 1/4"	



Actuator mounting positions code

ACTUATION

Lever, manual	standard
Wheel, manual	standard
Pneumatic cylinder	standard
Electric	optional

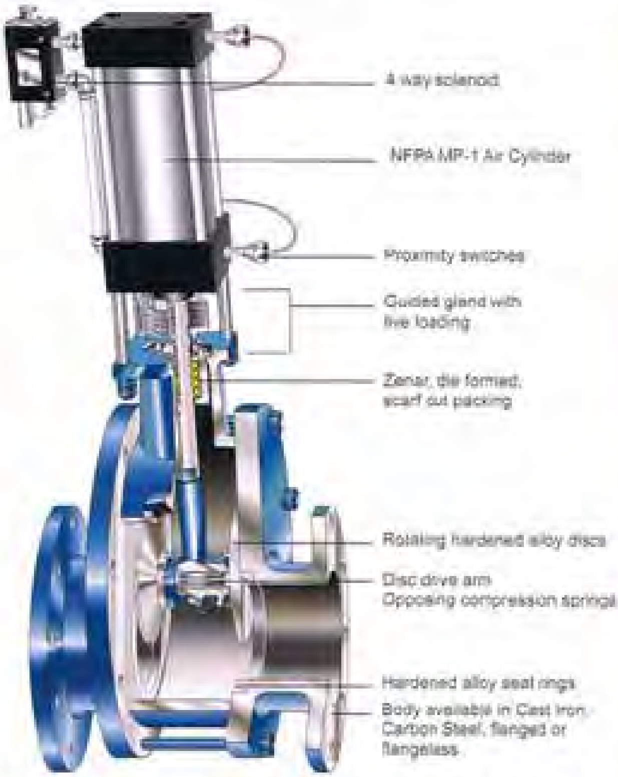
OPTIONS

Solenoid valve	4-way
Limit switches	Proximity or mechanical
Fail Safe	Air reservoir type or SR

Process Diverter standard materials of construction are carbon steel or stainless steel, other alloys are selected to suit your application. Disc and seats are solid hardened alloys in the 38RC to 59RC range for long life in abrasive media. Diverters are designed to ANSI codes and Everlasting will fabricate the valve to meet your process conditions. Various end connection configurations are available including DIN flanges. Please refer to www.everlastingvalveusa.com to download a Request For Quote form (RFQ). Start saving time and money today.

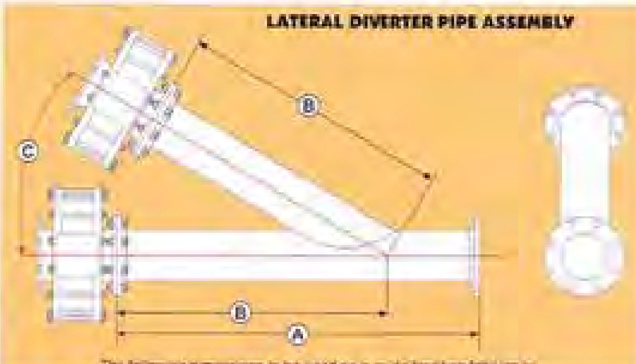
Everlasting BMV series valves used in diverting lines

Everlasting Valve produces a complete line of Bulk Material Valves that when used in tandem with a fabricated lateral "Y" connection becomes a Diverter that can be used to divert, mix, or completely stop any media flow. The Everlasting BMV series uses the same proven and patented rotating disc and seat design that Everlasting is known for. Dynamic spring loaded stuffing box can be re-packed with valve in place.



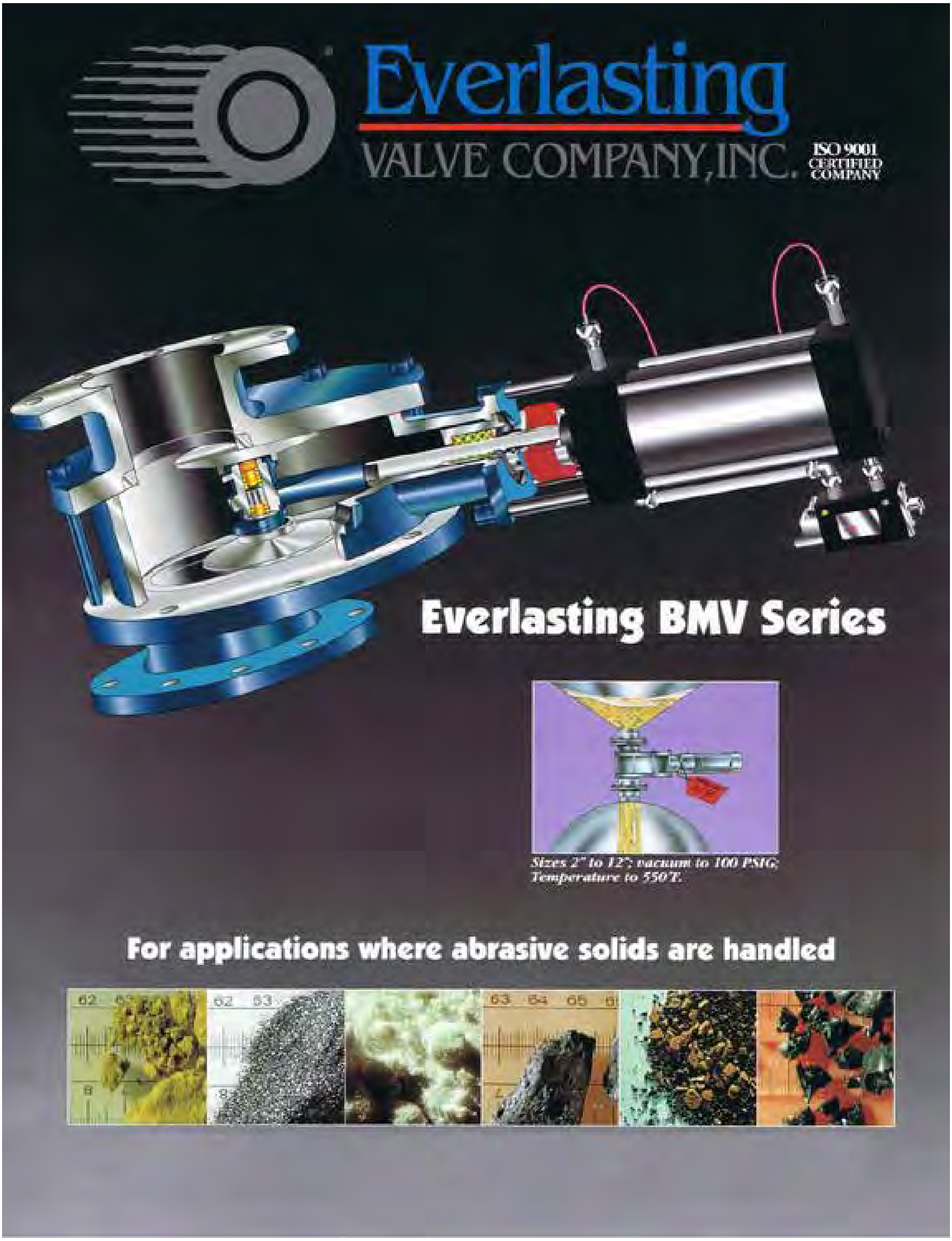
Everlasting Bulk Material Valve

The Everlasting Diverter and BMV are excellent in fly ash, Portland cement, kiln dust, alumina hydrate, alumina silica, calcined kaolin, sugar, titanium dioxide, ilmenite and rutile ores, pet coke, coal, catalyst and many other abrasives. Please request our booklet on the Everlasting Bulk Material Valves. Dimensions in this booklet are approximate and are used for estimating.



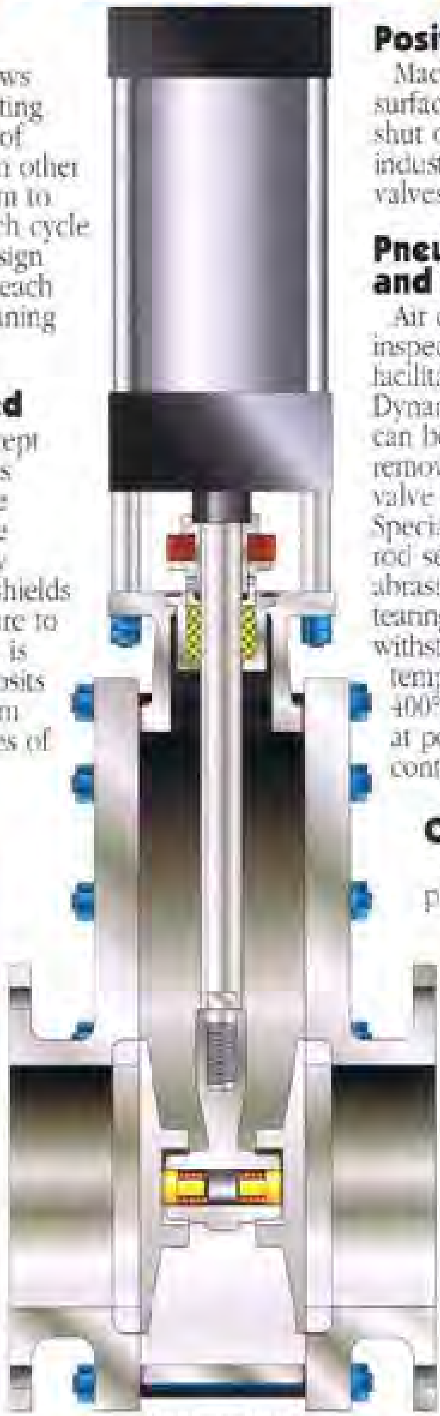
The following dimensions is to be used as a guide for shop fabrication

[illegible]	(C) Angle	(A) Straight	(B) Lateral / Intersect
3"- (80)	30°	30"	24"
	45°	21"	15"
4"- (100)	30°	34"	28"
	45°	24"	19"
5"- (125)	30°	44"	32"
	45°	30"	20"
6"- (150)	30°	46"	36"
	45°	40"	24"
8"- (200)	30°	60"	46"
	45°	48"	30"
10"- (250)	30°	72"	54"
	45°	54"	36"
12"- (300)	30°	84"	56"
	45°	62"	42"


Everlasting
VALVE COMPANY, INC.
ISO 9001 CERTIFIED COMPANY
Everlasting BMV Series
Sizes 2" to 12"; vacuum to 100 PSIG; Temperature to 550°F.
For applications where abrasive solids are handled

The bulk material valve that's built to tak

Everlasting

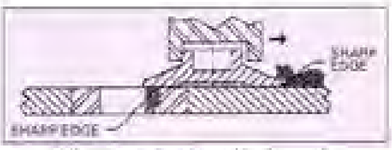


Self Cleaning Internals

Its open body configuration allows fines to move about freely preventing accumulation that causes binding of moving parts or damage to seats in other traditional designs. Media has room to be displaced by the discs with each cycle and the eccentric body to port design promotes settled product to swirl each time the valve opens, thereby cleaning it's interior.

Sealing Surfaces Protected

The Rotating Shearing Disc concept since being introduced in 1904 has proven itself in applications where media is abrasive and erosive. The spring loaded discs are held firmly against the path they travel, then shields their sealing surfaces from exposure to any harsh process while the valve is open. Valve is bi-directional. Deposits that may form will be sheared from the sealing surfaces by sharp edges of the seat rings and rotating discs.



Shearing action clears disc face and its path of particulate.

Self Lapping Discs

They rotate as the center of the applied force and the centroid of friction force move toward alignment. High cycling is beneficial. Scratches that develop on the wide sealing surfaces are polished away as the valve is opened and closed, there is no similar valve.

Positive Shut Off

Machine lapping of the sealing surfaces at the factory assures tight shut off. Leak rates are less than industry standards for metal seated valves: ANSI B16.34, MSS-SP61.

Pneumatic Actuator and Valve Are Separated

Air cylinder standoff allows easy inspection of sealing means and facilitates field packing. Dynamically loaded stuffing box can be field packed without removing the valve from line. Special cylinder rod seal resists abrasion and tearing, and withstands temperatures to 400°F (+204°c) at point of contact.

Self lapping discs

Options

Air cylinder mounted proximity limit switches on single rod cylinder, or mechanical style with double ended cylinder. Electric solenoid or manually operated cylinder air valve. All NEMA classifications can be furnished to meet your specifications.

Plant air or electric loss fail safe protection using an electro-pneumatic air reservoir system is available. Special bracketing of the air cylinder increases valve temperature rating to 750°F.

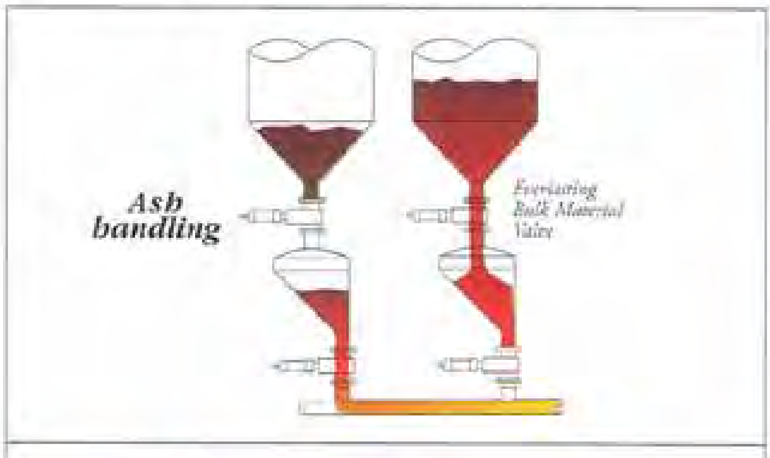
U.S. PATENT [illegible]

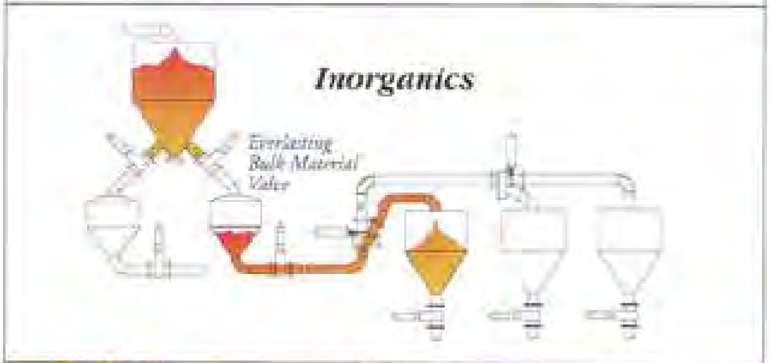
The Everlasting bulk material valve.

A compact valve that performs where others require repairing or replacement more than once a year.

most abrasive situations year after year

Ideally suited for dense phase pneumatic conveying and line isolation in dry powder systems.





Everlasting diverters

Everlasting solves plant problems.

Ash Handling

Problem: Sealing members would erode and have to be replaced on a weekly basis.
Solution: Flapper style valves cycling once a minute wouldn't always close against large chunks of 600°f vitrified coal ash trapped between its sealing members. Their disc would erode needing replacement on a weekly basis. The **Everlasting BMV** (bulk material valve) was installed providing trouble free service in this high temperature (see options), high cycling application.

Inorganics

Problem: Production is moving granular abrasives with a bulk density of over 100 lbs/ft3.
Solution: Everlasting Valves replaced transporter feed knife gate valves that developed internal and external leakage. Transporter outlets, now fitted with **Everlasting Valves**, replaced ball valves that suffered packing leaks. Our diverter valves have eliminated endless hours of maintenance in the finished product area that were previously spent repairing pinch valves. In each location the users enjoyed a fast pay back on their investment.

Diverter Valves

The **Everlasting Diverter Valves** can be switched on the fly, and no lubrication is required. The designs of each style are based on the open body Rotating Disc technology proven since 1904 in our two-way valves. The disc and seats are solid hardened alloys in the 38RC to 59RC range this provides exceptionally long life in abrasive media. These valves have performed in titanium dioxide, fly ash, Portland cement, Alumina silica and calcified Kaolin, sugar, coal and other erosive particulate. Actuators include lever, handwheel, pneumatic cylinder, the valves are flanged, and pressure and temperature ranges vary with design type.

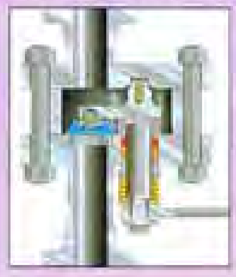
Everlasting BMV series specifications

Standard Design:

Press Range: Vacuum to 100 psig (7 bar)
Temp Range: Cast Iron 450°F (+232°C)
Carbon Steel 550°F (+287°C)
Ends: Flat Faced – 125# Drill
Operator: Air Cylinder, Linear

Options:

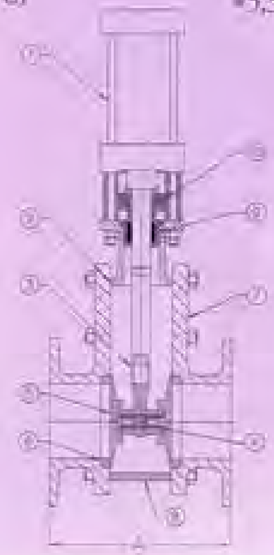
- Limit or Proximity Switches
  * Field mounted Limit Switches or Visual Indication require Double Ended Air Cylinder
- Solenoid Valve
- Manual Air Valve
- Fail-Safe Air Reservoir

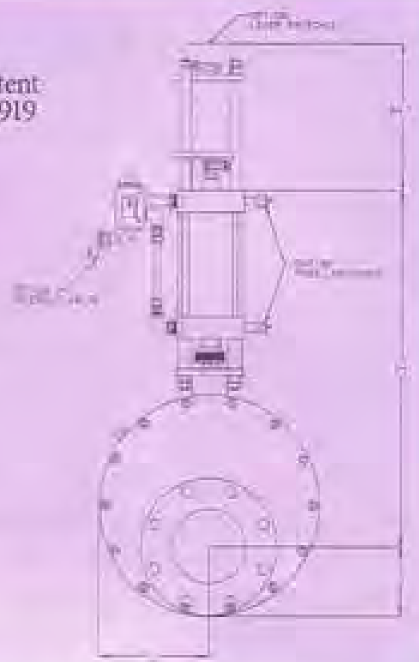


- 750°F (+400°C) Design

Process Valve pressures from vacuum to 10,000 psig, temperatures to +1,500°F, sizes 1/2" to 18"

U.S. Patent #5,396,919





Item No.	Nomenclature	Construction
1	Air Cylinder	Aluminum Body
2	Gaskets	Synthetic Fiber - Nitrile Binder
3	Disc Drive	Hardened Steel Alloy
4	Disc Springs	17-7 Stainless Steel
5	Discs	440 Stainless Steel
6	Seats	440 Stainless Steel
7	Body	Cast Iron or Carbon Steel
8	Distance Ring	Cast Iron or Carbon Steel
9	Stuffing Box	Brass - Zenic Graphite Packing
10	Gland Springs	Electroless Nickel Plated

Inquire for other sizes. Dimensions are approximate: use for estimating. Consult factory for construction drawings.

*Cast Iron only **Carbon Steel only

Size in. (mm)	A	H	H¹	J	L	Wt. approx. lb (kg)
2* (50)	7 (179)	17.375 (440)	7 (178)	3 (76)	3.75 (95)	60 (27)
2.5 (65)	8.25 (210)	19.25 (489)	7.5 (196)	3.5 (89)	5 (127)	65 (30)
3 (80)	8.25 (210)	19.5 (495)	8 (203)	3.75 (95)	5 (127)	70 (32)
4 (100)	9.75 (248)	23 (584)	9 (229)	4.5 (114)	6.25 (159)	110 (50)
5 (125)	10.5 (267)	25.5 (648)	11 (280)	5 (127)	7.75 (196)	180 (82)
6 (150)	10.5 (267)	28.75 (730)	12 (305)	5.5 (140)	9 (229)	220 (100)
8 (200)	13.5 (343)	36 (915)	13.5 (343)	7 (178)	11.5 (292)	350 (160)
10** (250)	15 (381)	41.25 (1049)	13 (330)	8.13 (207)	13 (330)	480 (220)
12** (300)	15 (381)	47.875 (1216)	18 (457)	9 (229)	15.5 (394)	700 (320)

How to order Bulk Material Valve: Figure number example: 6" BAO-SVGO

Six inch, Bulk Material Valve, cast iron construction, outside stuffing box, solenoid valve, GO proximity limit switches. Materials of construction stated above are standard. Mechanical and field mounted limit switches require double-ended air cylinders.

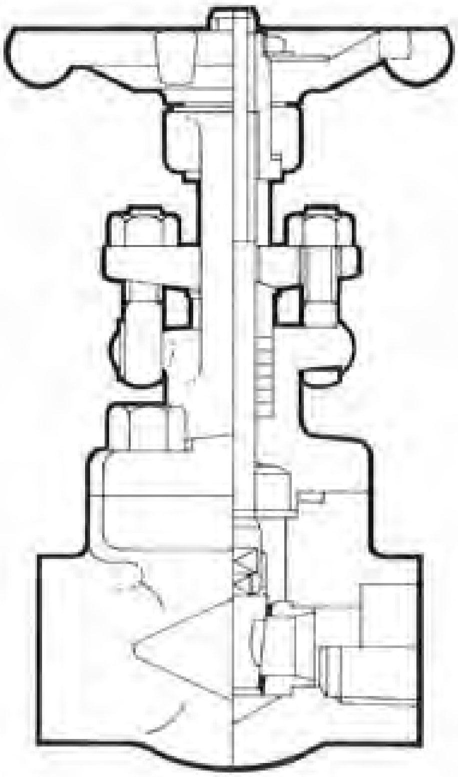
Series	Body	Options			
B - BMV	**A** - Cast Iron	**SV**	- Solenoid Void	**FS**	- Fail-Safe Air Reservoir System
	C - Carbon Steel	**GO**	- "GO" Proximity Switches	**HT**	- High Temperature (750°F)
		EX	- Mechanical Limit Switches (H¹)	**SP**	- Special Accessories or Design
		MV	- Manual Air Valve		

GABF8008N(S)

Gate valve, OS&Y, bolted bonnet, Class 800#.

Suitable for steam, water, air, gas and non corrosive chemicals

- **Body & bonnet: Forged Steel ASTM A105**
- **Wedge: 13% Chrome stainless steel**
- **Seat: ASTM A276-410 + Stellite #6**
- **End Connections: Screwed NPT or socket weld**
- **Maximum pressure rating: 5,512 at 454 deg C, 13,780 kpa at -29 to +35 deg C**
- **Sizes: 15mm to 50mm**



PART	MATERIAL	A.S.T.M.
Handwheel nut	Carbon steel	A563A
Tooth washer	Carbon steel	
Name plate	Aluminium	
Hand wheel	Malleable iron	A197
Yoke sleeve	13Cr Stainless steel	A582-416
Thrust washer	13Cr Stainless steel	A276-410
Eye bolt	13Cr Stainless steel	A276-410
Gland nut	Carbon steel	A194-2H
Gland flange	Forged steel	*A105
Gland	13Cr Stainless steel	A276-410
Retaining washer	Carbon steel	A283 D
Gland packing	Non-asbestos	
Bonnet Bolt	Alloy steel	A193-B7
Bonnet	Forged steel	*A105
Gasket	304 Hoop-teflon	
Stem	13Cr Stainless steel	A276-410
Seat ring	13Cr S/S + Stellite #6	A276-410
Wedge	13Cr Stainless steel	A217-CA15
Body	Forged steel	*A105

*Carbon content [illegible]

DIMENSIONS:

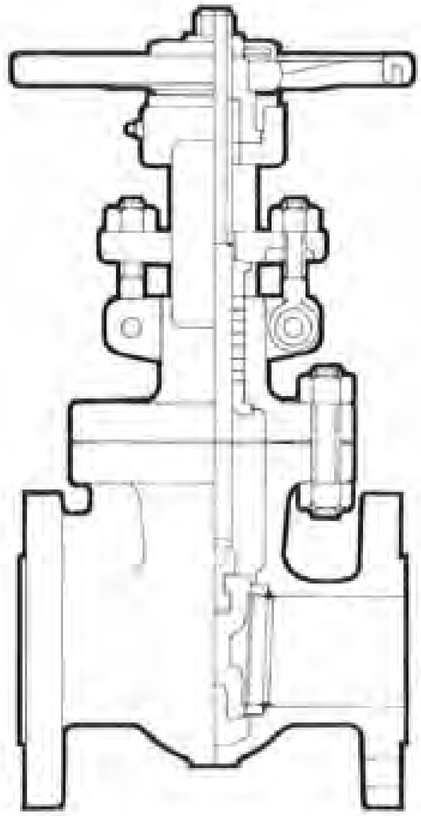
Nominal Size mm	8	10	15	20	25	40	50
A mm	76	76	76	86	102	117	133
B mm (open)	145	145	145	153	192	245	267
C mm	102	102	102	102	114	140	165
Approx Weight kg	1.5	1.5	1.5	2.0	2.8	5.2	8.2

GABC1508R

Gate valve, OS&Y, bolted bonnet, Class 150#.

Suitable for steam, water, air, gas and non corrosive chemicals

- **Body & bonnet: Cast Steel ASTM A216 Gr WCB**
- **Wedge: 13% Chrome stainless steel**
- **Seat: ASTM A105 + Stellite #6**
- **End Connections: Flanged ANSI 150**
- **Maximum pressure rating: 1,171 at 260 deg C, 1,964 kpa at -29 to +35 deg C**
- **Sizes: 50mm to 200mm**



PART	MATERIAL	A.S.T.M.
Handwheel nut	Malleable iron	A47 Gr 32510
Handwheel set screw	Steel	
Handwheel	Malleable iron	A197
Yoke sleeve ret. nut	Steel	A47 Gr 32510
Yoke sleeve	Austen duct. iron	A439 Type D2C
Lubricator	Steel	
Spindle	13% chrome steel	A479-410
Gland nut	Steel	A307B
Gland flange	Steel	A105
Gland follower	Steel chrome plated	A108 Gr 1020 + Cr
Gland eye bolt	Alloy steel	A307B
Gland hinge pin	Steel	A108 Gr 1020
Gland packing	JIC 3085	Non-Asbestos
Bonnet nut	Steel	A194 Gr 2H
Bonnet stud	Alloy steel	A193 Gr B7
Bonnet	Cast steel	*A216 Gr WCB
Gasket	Soft steel	
Back seat bush	13% chrome steel	A479-410
Body seat ring	Stellite faced	A108 Gr 1020 + St
Wedge	13% chrome steel	A217-CA15
Body	Cast steel	*A216 Gr WCB

*Carbon content 0.25% max

DIMENSIONS

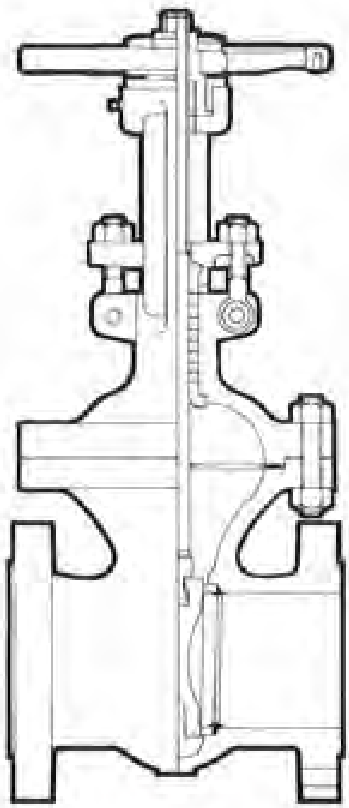
Nominal Size mm	50	65	80	100	150	200	250	300	350	400	450	500	600
A mm	178	191	203	229	267	292	330	356	381	407	432	457	508
B mm (open)	367	397	458	560	763	960	1166	1369	1515	1824	1900	2124	2502
C mm	200	200	224	250	315	335	400	450	500	560	630	710	800
Approx Weight kg	19	26	33	48	87	129	180	280	410	580	675	842	1380

GABC3008R

Gate valve, OS&Y, bolted bonnet, Class 300#.

Suitable for steam, water, air, gas and non corrosive chemicals

- **Body & bonnet: Cast Steel ASTM A216 Gr WCB**
- **Wedge: 13% Chrome stainless steel**
- **Seat: ASTM A105 + Stellite #6**
- **End Connections: Flanged ANSI 300**
- **Maximum pressure rating: 1,860 at 454 deg C, 5,100 kpa at -29 to +35 deg C**
- **Sizes: 50mm to 200mm**



PART	MATERIAL	A.S.T.M
Handwheel nut	Malleable iron	A47 Gr 32510
Handwheel set screw	Steel	
Handwheel	Malleable iron	A197
Yoke sleeve ret. nut	Steel	A47 Gr 32510
Yoke sleeve	Austen, duct iron	A439 Type D2C
Lubricator	Steel	
Spindle	13% chrome steel	A479-410
Gland nut	Steel	A307B
Gland flange	Steel	A105
Gland follower	Steel chrome plated	A108 Gr 1020 +Cr
Gland eye bolt	Alloy steel	A307B
Gland hinge pin	Steel	A108 Gr 1020
Gland packing	JIC 3085	Non-Asbestos
Lantern Ring	13% chrome steel	A479 410
Bonnet nut	Steel	A194 Gr 2H
Bonnet stud	Alloy steel	A193 Gr B7
Bonnet	Cast steel	*A216 Gr WCB
Gasket	Soft steel	
Back seat bush	13% chrome steel	A479-410
Body seat ring	Stellite faced	A105 Gr 1020 + Stl
Wedge	13% chrome steel	A217 CA15
Body	Cast steel	*A216 Gr WCB

*Carbon content 0.25% max

DIMENSIONS

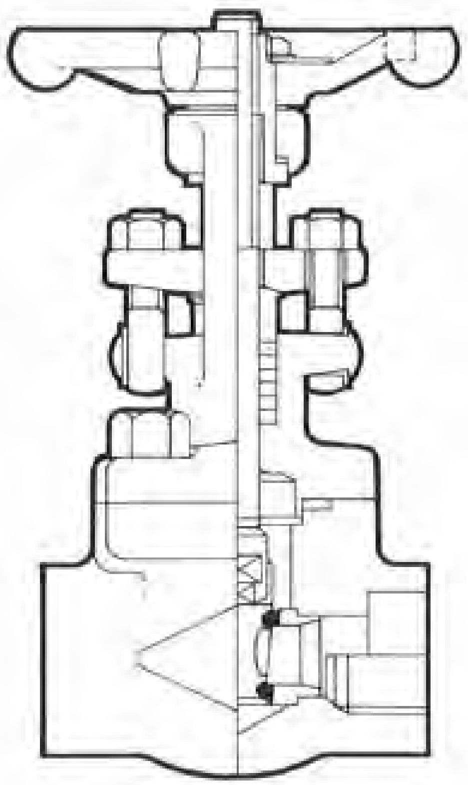
Nominal Size mm	50	65	80	100	150	200	250	300	350	400	450	500	600
A mm	216	241	283	305	403	419	457	502	762	838	914	991	1143
B mm (open)	405	440	500	592	816	1042	1227	1442	1588	1890	2040	2197	3078
C mm	200	200	224	250	355	400	450	500	560	620	710	800	900
Approx Weight kg	28	35	50	75	145	260	323	481	682	972	1260	1611	2470

GABS8008N(S)

Gate valve, OS&Y, bolted bonnet, Class 800#.

Suitable for steam, water, air, gas and most chemicals

- **Body & bonnet: 316L Stainless steel**
- **Wedge: 316L Stainless steel**
- **Seat: Stainless steel + Stellite #6**
- **End Connections: Screwed NPT or socket weld**
- **Maximum pressure rating: 5,930 at 454 deg C, 11,032 kpa at -29 to +35 deg C**
- **Sizes: 15mm to 50mm**



PART	MATERIAL	A.S.T.M.
Handwheel Nut	Carbon Steel	A563A
Tooth Washer	Carbon Steel	
Name Plate	Stainless Plate	
Hand Wheel	Malleable Iron	A197
Yoke Sleeve	13Cr Stainless Steel	A582-416
Thrust Washer	13Cr Stainless Steel	A276-410
Eye Bolt	Stainless Steel	A276-304
Gland Nut	Stainless Steel	A194-8
Gland Flange	Stainless Steel	A182-F304
Gland	Stainless Steel	A276-304
Retaining Washer	Stainless Steel	A276-304
Gland Packing	Grafoil	
Bonnet Bolt	Stainless Steel	A193-B8
Bonnet	Stainless Steel	A182-F316L
Gasket	304 Hoop-Teflon	
Stem	Stainless Steel	A276-316
Seat Ring	S/S + Stellite #6	A276-316
Wedge	S/S + Stellite #6	A351-CF8M
Body	Stainless Steel	A182-F316L

DIMENSIONS

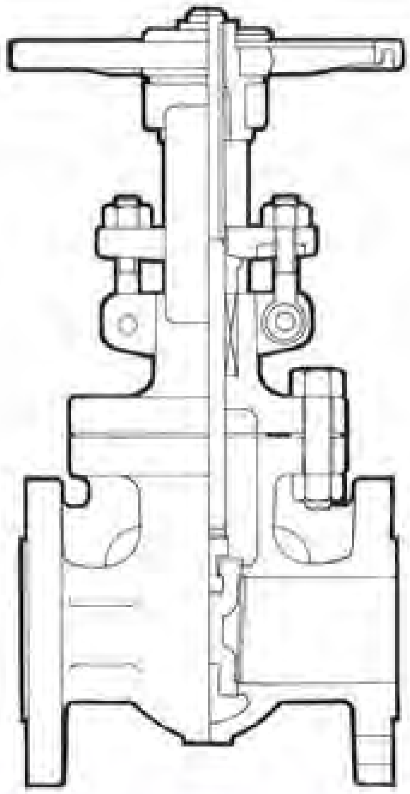
Nominal Size mm	8	10	15	20	25	40	50
A mm	76	76	76	86	102	117	133
B mm (open)	145	145	145	153	192	245	267
C mm	102	102	102	102	114	140	165
Approx. Weight kg	1.5	1.5	1.6	2.0	2.8	5.1	8.2

GABS1512R

Gate valve, OS&Y, bolted bonnet, Class 150#.

Suitable for steam, water, air, gas and most chemicals

- **Body & bonnet: Stainless steel CF8M**
- **Wedge: 316 stainless steel**
- **Seat: Stainless steel + Stellite #6**
- **End Connections: Flanged ANSI 150**
- **Maximum pressure rating: 1,171 at 260 deg C, 1,896 kpa at -29 to +38 deg C**
- **Sizes: 50mm to 200mm**



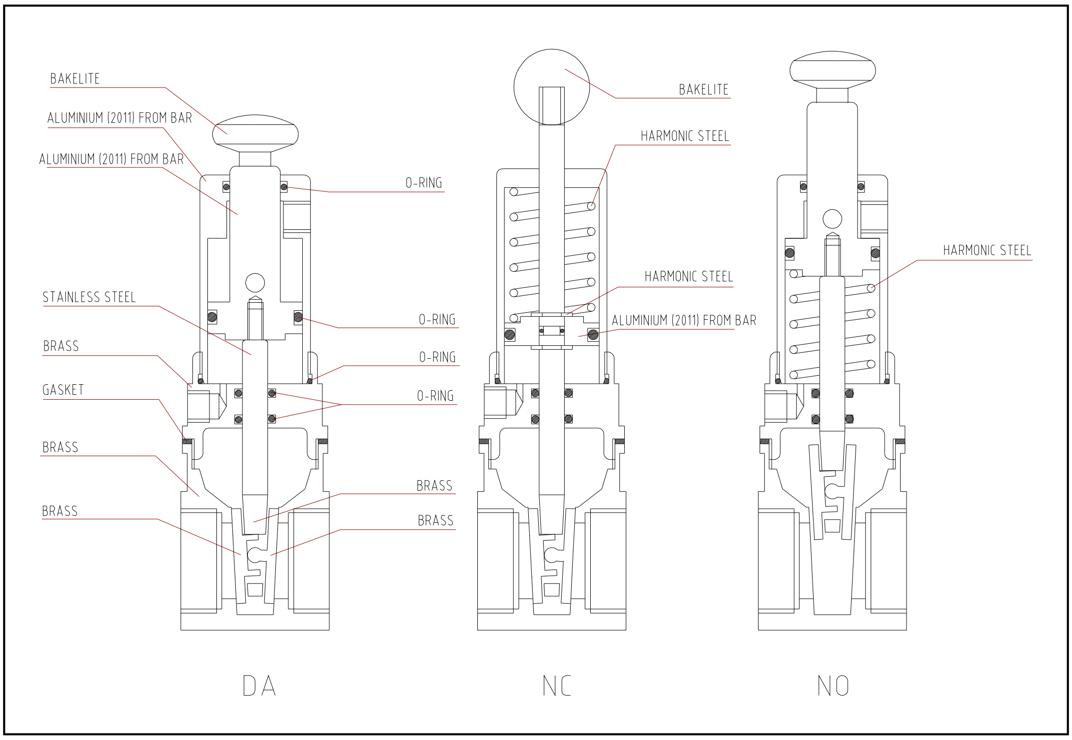
PART	MATERIAL	A.S.T.M
Handle Nut	Steel chrome plated	A47-32510+Cr
Set Screw	Steel	
Hand Wheel	Malleable Iron	A197
Yoke Sleeve	Austen. duct. iron	A439-D2C
Thrust Washer	Stainless Steel	A479-410
Stem	Stainless Steel	A479-316
Hinge Bolt	Stainless Steel	A479-F304
Hinge Nut	Stainless Steel	A194-8
Gland Flange	Stainless Steel	A351-CF8
Packing Gland	Stainless Steel	A479-316
Hinge Pin	Stainless Steel	A479-304
Packing	Teflon	
Bonnet Bolt	Stainless Steel	A193-B8
Bonnet Nut	Stainless Steel	A194-8
Gasket	Teflon	
Bonnet	Stainless Steel	A351-CF8M
Wedge	Stainless Steel	A351-CF8M
Body	Stainless Steel	A351-CF8M

DIMENSIONS

Nominal Size mm	15	20	25	40	50	65	80	100	150	200	250	300
A mm	108	117	127	165	178	191	203	229	267	292	330	356
B mm (open)	190	198	232	283	332	381	424	529	730	934	1114	1314
C mm	100	100	120	140	160	180	200	250	315	355	355	450
Approx Weight kg	2	3	5	9	13	18	22	34	57	97	132	197

ART “A” - GATE VALVE

Metal sealing with free disks (male/female disk) in the wedge of the gate.
Practically no maintenance is required for the special closing system (metal to metal), but a perfect airtight is not assured.
Pneumatic actuator, with reciprocating movement, is equipped with manual emergency knob.
The pneumatic gate valve can intercept liquid fluids and gases without solid suspensions (keep into account the closing system).
Standard: Connections with inner GAS ISO 228 female-female.
On request: NPT connections.
Control air 1/8" GAS connections.
OPERATING TEMPERATURE: from -20°C to +80°C.
ACTUATOR PILOT PRESSURE: Max 8 bar.
VERSIONS AND SIZES
GAS threaded connection
DA: 3/4” - 1” - 1”1/4 - 1”1/2 - 2” - 2”1/2 - 3” - 4”
SANC: 3/4” - 1” - 1”1/4 - 1”1/2 - 2” - 2”1/2 - 3”
SANO: 3/4” - 1” - 1”1/4 - 1”1/2 - 2”
NPT connection
DA: 3/4” - 1” - 1”1/4 - 1”1/2 - 2” - 3”
SANC: 3/4” - 1” - 1”1/4 - 1”1/2 - 2” - 3”
SANO: 3/4” - 1” - 1”1/4 - 1”1/2 - 2”
ANODIZING TREATMENT ON OUTSIDE DETAILS MADE IN ALUMINIUM

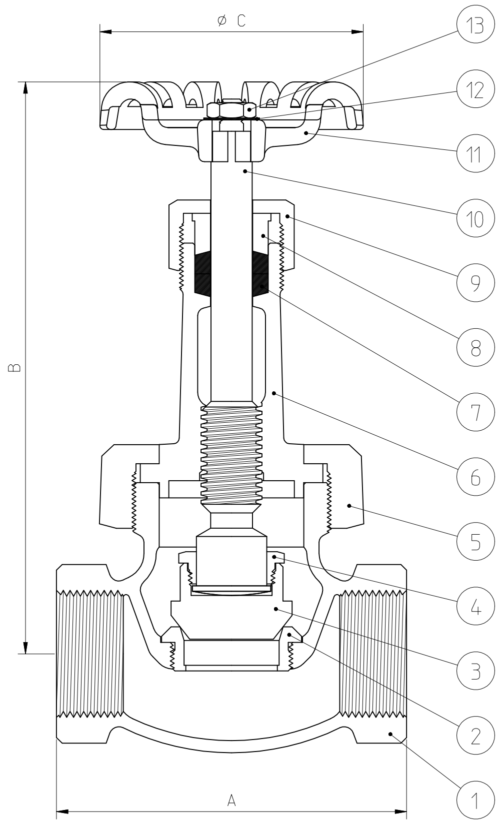


GL012

Globe valve, union bonnet, Steam.

Suitable for steam, water, air, gas and most chemicals

- **Body & bonnet: Bronze B62**
- **Disc & Seat: Stainless steel ASTM A276-410**
- **End Connections: Screwed BSP**
- **Maximum pressure rating: 2,100 kpa at 217 deg C, 4,100 kpa at -29 to +38 deg C**
- **Sizes: 15mm to 50mm**



	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"
A	75	90	106	122	135	165
B	145	162	175	206	232	261
ØC	67	72	82	92	102	122

HIDROSTATIC TEST	
BODY	900 PSI (62 BAR)
SEAT	600 PSI (41 BAR)

WORKING CONDITIONS		
SATURATED STEAM	300 PSI (21 BAR)	NON SHOCK
WATER, OIL	600 PSI (41 BAR)	

MAXIMUM TEMPERATURE = 232 °C

POS.	QUANT.	DENOMINATION	MATERIAL	ABNT SPECIFICATION	ASTM SPECIFICATION
13	01	NUT	ST. STEEL	NBR5601/304	A276/304
12	01	IDENT. PLATE	ALUMINUM		
11	01	HANDWHEEL	ALUMINUM		B85/S12A
10	01	STEM	BRASS	NBR6188/C37700	B124/C37700
9	01	PACKING NUT	BRONZE	NBR6314/C83600	B62/C83600
8	01	GLAND	BRASS	NBR6188/C37700	B124/C37700
7	02	PACKING	PTFE		
6	01	BONNET	BRONZE	NBR6314/C83600	B62/C83600
5	01	UNION BONNET RING	BRONZE	NBR6314/C92200	B61/C92200
4	01	SUPPORT. WASHER	BRASS	NBR5023	B16/C36000
3	01	PLUG DISC	ST. STEEL	NBR5601/410	A276/410
2	01	SEAT	ST. STEEL	NBR5601/410	A276/410
1	01	BODY	BRONZE	NBR6314/C83600	B62/C83600

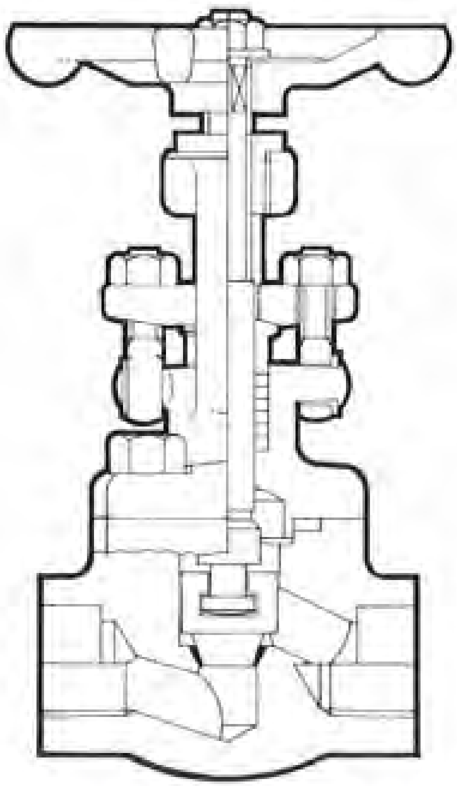
NOTE: THE DIMENSIONS ARE EXPRESSED IN MILLIMETERS.

GLBF8008N(S)

Globe valve, OS&Y, bolted bonnet, Class 800#.

Suitable for steam, water, air, gas and non corrosive chemicals

- **Body & bonnet: Forged Steel ASTM A105**
- **Disc: 13% Chrome stainless steel**
- **Seat: ASTM A276-410 + Stellite #6**
- **End Connections: Screwed NPT or socket weld**
- **Maximum pressure rating: 5,512 at 454 deg C, 13,780 kpa at -29 to +35 deg C**
- **Sizes: 15mm to 50mm**



PART	MATERIAL	A.S.T.M.
Handwheel nut	Carbon steel	A563A
Handwheel washer	Carbon steel	A283 D
Name plate	Aluminium	
Hand wheel	Malleable iron	A197
Yoke bush	13Cr Stainless steel	A582-416
Eye bolt	13Cr Stainless steel	A276-410
Gland nut	Carbon steel	A194-2H
Gland flange	Forged steel	*A105
Gland	13Cr Stainless steel	A276-410
Retaining washer	Carbon steel	A283 D
Gland packing	Non-asbestos	
Bonnet bolt	Alloy steel	A193-B7
Bonnet	Forged steel	*A105
Gasket	304 Hoop-teflon	
Stem	13Cr Stainless steel	A276-410
Disc	13Cr Stainless steel	A217-CA15
Seat	Stellite #6/Equiv.	
Body	Forged steel	*A105

*Carbon content 0.25% max

DIMENSIONS:

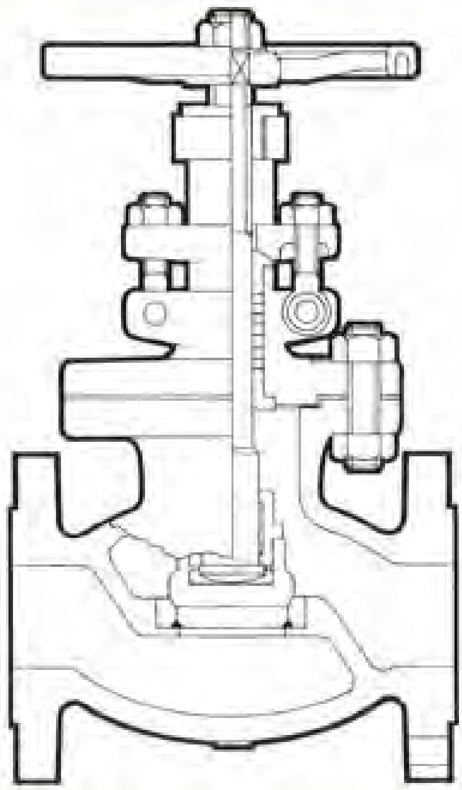
Nominal Size mm	8	10	15	20	25	40	50
A mm	76	76	76	86	102	152	172
B mm (open)	149	149	149	157	190	225	267
C mm	102	102	102	102	114	140	165
Approx. Weight kg	1.6	1.8	1.8	2.1	2.9	6.2	9.7

GLBC1508R

Globe valve, OS&Y, bolted bonnet, Class 150#.

Suitable for steam, water, air, gas and non corrosive chemicals

- **Body & bonnet: Cast Steel ASTM A216 Gr WCB**
- **Disc: 13% Chrome stainless steel**
- **Seat: ASTM A105 + Stellite #6**
- **End Connections: Flanged ANSI 150**
- **Maximum pressure rating: 1,171 at 260 deg C, 1,964 kpa at -29 to +35 deg C**
- **Sizes: 50mm to 300mm**



PART	MATERIAL	A.S.T.M.
Handwheel nut	Steel	A307B
Washer	Steel	
Handwheel	Malleable iron	A197
Yoke Bush	Austen. duct iron	A439 Type D2C
Spindle	13% chrome steel	A479-410
Gland Nut	Steel	A307B
Gland flange	Steel	A105
Gland eye bolt	Alloy steel	A307B
Gland follower	Steel chrome plated	A108 Gr 1020 + Cr
Gland hinge pin	Steel	A108 Gr 1020
Gland packing	JIC 3085	Non-Asbestos
Bonnet nut	Steel	A194 Gr 2H
Bonnet	Cast steel	*A216 Gr WCB
Bonnet stud	Alloy steel	A193 Gr B7
Gasket	Soft steel	
Back seat bush	13% chrome steel	A479-410
Disc ret. nut	13% chrome steel	A479-410
Disc	13% chrome steel	A217 CA15
Body seat ring	Stellite faced	A108 Gr 1020 + Stl
Body	Cast steel	*A216 Gr WCB

*Carbon content 0.25% max.

DIMENSIONS:

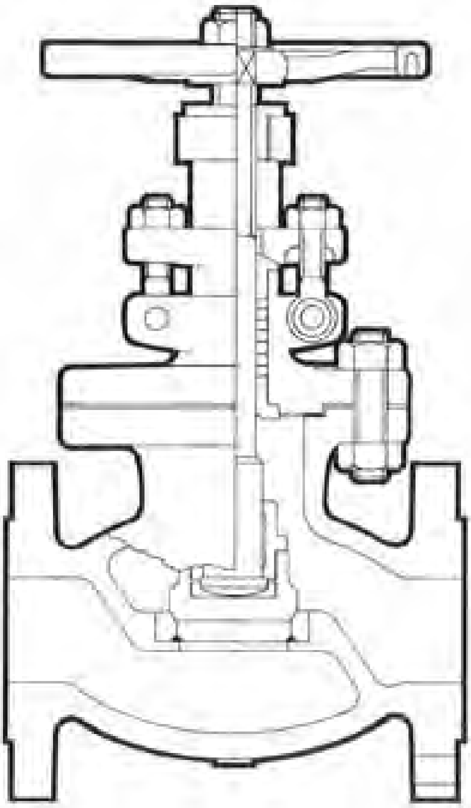
Nominal Size mm	50	65	80	100	150	200	250	300
A mm	203	216	241	292	406	495	622	699
B mm (open)	316	330	365	414	502	590	775	825
C mm	200	200	224	280	355	400	450	500
Approx. Weight kg	20	28	34	52	89	168	242	404

GLBC3008R

Globe valve, OS&Y, bolted bonnet, Class 300#.

Suitable for steam, water, air, gas and non corrosive chemicals

- **Body & bonnet: Cast Steel ASTM A216 Gr WCB**
- **Disc: 13% Chrome stainless steel**
- **Seat: ASTM A105 + Stellite #6**
- **End Connections: Flanged ANSI 300**
- **Maximum pressure rating: 1,860 at 454 deg C, 5,100 kpa at -29 to +35 deg C**
- **Sizes: 50mm to 300mm**

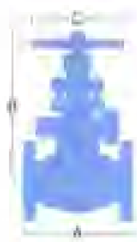


PART	MATERIAL	A.S.T.M.
Handwheel nut	Steel	A307B
Washer	Steel	
Handwheel	Malleable iron	A197
Yoke bush	Austen. duct iron	A439 Type D2C
Spindle	13% chrome steel	A479-410
Gland Nut	Steel	A307B
Gland flange	Steel	A105
Gland eye bolt	Alloy steel	A307B
Gland follower	Steel chrome plated	A108 Gr 1020 ± Cr
Gland hinge pin	Steel	A108 Gr 1020
Gland packing	JIC 3085	Non-Asbestos
Lantern Ring	13% chrome steel	A479-410
Bonnet nut	Steel	A194 Gr 2H
Bonnet	Cast steel	*A216 Gr WCB
Bonnet stud	Alloy steel	A193 Gr B7
Gasket	Soft steel	
Back seat bush	13% chrome steel	A479-410
Disc ret. nut	13% chrome steel	A479-410
Disc	13% chrome steel	A217 CA15
Body seat ring	Stellite faced	A108 Gr 1020 + Stl
Body	Cast steel	*A216 Gr WCB

*Carbon content 0.25% max.

DIMENSIONS:

Nominal Size mm	50	65	80	100	150	200	250	300
A mm	267	292	318	356	445	559	622	711
B mm (open)	350	391	420	492	620	793	1145	1260
C mm	200	224	280	355	450	560	560	710
Approx Weight kg	26	40	53	80	168	248	456	608

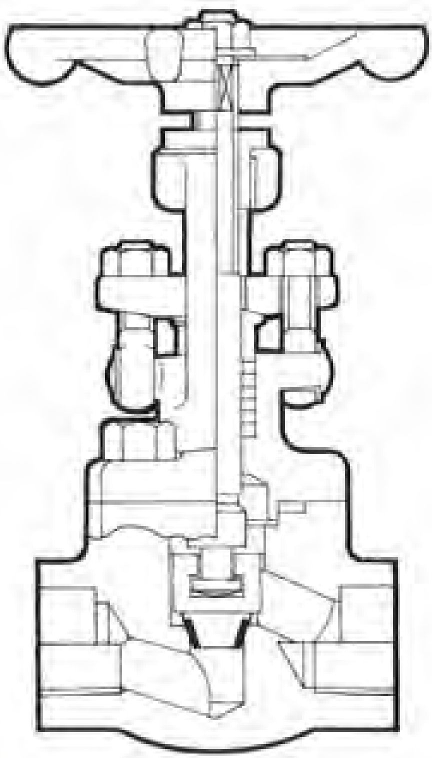


GLBS8008N(S)

Globe valve, OS&Y, bolted bonnet, Class 800#.

Suitable for steam, water, air, gas and most chemicals

- **Body & bonnet: 316L Stainless steel**
- **Disc: 316L Stainless steel**
- **Seat: Stainless steel + Stellite #6**
- **End Connections: Screwed NPT or socket weld**
- **Maximum pressure rating: 5,930 at 454 deg C, 11,032 kpa at -29 to +35 deg C**
- **Sizes: 15mm to 50mm**



PART	MATERIAL	A.S.T.M.
Handwheel Nut	Carbon Steel	A563 A
Handwheel Washer	Carbon Steel	A283 D
Name Plate	Stainless Plate	
Hand Wheel	Malleable Iron	A197
Yoke Bush	13Cr Stainless Steel	A582-416
Eye Bolt	Stainless Steel	A276-304
Gland Nut	Stainless Steel	A194-8
Gland Flange	Stainless Steel	A182-F304
Gland	Stainless Steel	A276-304
Retaining Washer	Stainless Steel	A276-304
Gland Packing	Grafoil	
Bonnet Bolt	Stainless Steel	A193-B8
Bonnet	Stainless Steel	A182-F316L
Gasket	304 Hoop-Teflon	
Stem	Stainless Steel	A276-316
Disc	S/S + Stellite #6	A351-CF8M
Seat	Stainless Steel	A182-F316L
Body	Stainless Steel	A182-F316L

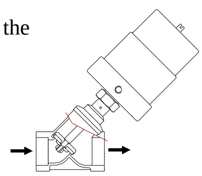
DIMENSIONS

Nominal Size mm	8	10	15	20	25	40	50
A mm	76	76	76	88	102	152	172
B mm (open)	149	149	149	157	190	225	267
C mm	102	102	102	102	114	140	165
Approx Weight kg	1.8	1.8	1.8	2.1	2.9	6.2	9.7

ART "DV" SHUTTER ANGLE VALVE FOR STEAM AND HIGH TEMPERATURE

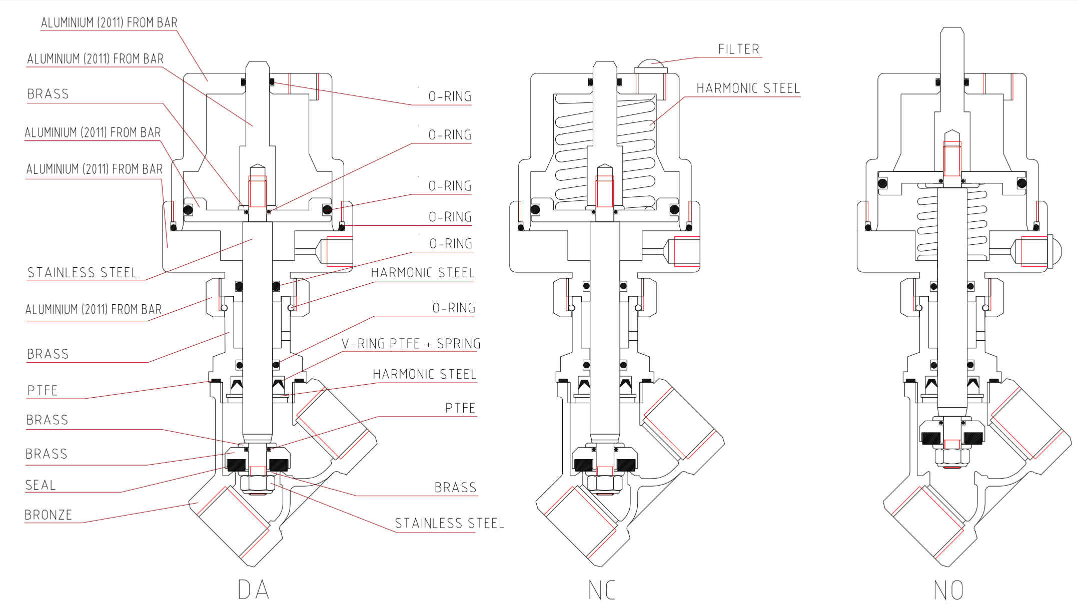
Angle valve at 45° with flat shutter closing .
SEAL: PTFE.
Seal in PTFE **energized** with stainless steel spring on the stem.
Special gaskets for high temperature on the pneumatic side.
Perfect airtight. Long life even with high operating frequencies.
Pneumatic actuator with reciprocating piston movement.
It is equipped with a **NUT** which, turning the cylinder by 360°, allows the desired positioning of air side connection.
Connections with inner GAS ISO 228 thread female-female.
On request with NPT connections.
Control air 1/8" GAS connections.
ALLOWABLE TEMPERATURES
Operating temperature: from -20°C to +200°C
ACTUATOR PILOT PRESSURE. Max 8 bar.
For steam please refer to the Differential pressure and Satured Steam Charts.
VERSIONS AND SIZES
DA: 1/2" - 3/4" - 1"
SANC: 1/2" - 3/4" - 1" - 1"1/4 - 1"1/2 - 2" - 2"1/2 - 3"
SANO: 1/2" - 3/4" - 1"
ANODIZING TREATMENT ON OUTSIDE DETAILS MADE IN ALUMINIUM

It is **not subject** to the "Water Hammer" if the fluid pass through the valve in the direction of the arrow printed on the body (under the actuator).
With these conditions the tightness is guaranteed up to the pressures shown in the Differential Pressure Chart.



MINIMUM PRESSURE REQUIRED TO OPEN NC VERSION

G	1/2"	3/4"	1"	1"1/4	1"1/2	2"	2"1/2	3"
BAR	4	4	5	5	5	5	5	5

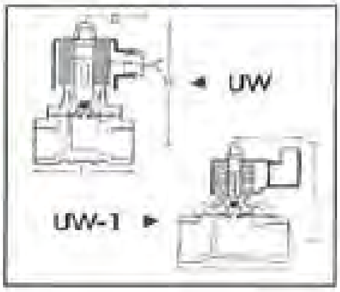


UW

Solenoid valve, light pattern, normally closed.

Suitable for water, air, gas and oil

- **Body & bonnet: Brass**
- **Diaphragm & Disc: NBR**
- **Coil: DIN**
- **Available voltages: 240vAC, 110vAC and 24vDC**
- **End Connections: Screwed BSP**
- **Maximum pressure rating: 1,000 kpa cold up to 25mm, 500 kpa 32mm to 50mm**
- **Sizes: 15mm to 50mm**



MATERAIL	
PARTS	MATERAIL
Body	Forge Brass / Cast Bronze
Coil	Special Copper Wire (H)
Core	Stainless Steel
Tube	Stainless Steel
Spring	Stainless Steel
Plug	NBR,Viton,Silicon
Diaphragm	NBR,Viton,Silicon

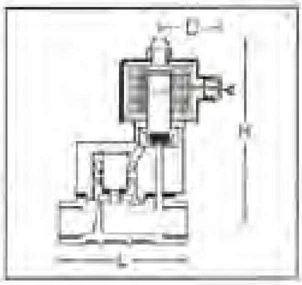
DIN	MODEL	PIPE SIZE	Cv	ORIFICE	FLUID TEMP. C	MAX. OPERATING PRESSURE DIFF. KGf/CM²			DIMENSION(mm)			WEIGHT (kg)
						AIR	WATER	LIGHT OIL	L	H	D	
●	UW-10	3/8"	2.4	15 mm	-5C ~ 80C	0-7	0-5	0-3	70	100	53	0.8
●	UW-15	1/2"	4.5	15 mm	-5C ~ 80C	0-7	0-5	0-5	70	110	60	0.9
●	UW-20	3/4"	6.0	20 mm	-5C ~ 80C	0-7	0-5	0-5	73	132	53	1.0
●	UW-25	1"	12	25 mm	-5C ~ 80C	0-7	0-5	0-5	93	135	59	1.8
●	UW-35-1	1 1/4"	24	35 mm	-5C ~ 80C	0-7	0-5	0-5	125	140	58	3.2
●	UW-40-1	1 1/2"	28	40 mm	-5C ~ 80C	0-7	0-5	0-5	125	140	58	3.5
●	UW-50-1	2"	48	50 mm	-5C ~ 80C	0-7	0-5	0-5	167	170	58	5.4

SUS

Solenoid valve, stainless steel construction, heavy pattern.

Suitable for steam, water, air, gas and most chemicals

- **Body & bonnet: 316 stainless steel**
- **Plug: PTFE**
- **Core needle, tube & Spring: Stainless steel**
- **Available voltages: 240vSC, 110vAC and 24vDC**
- **End Connections: Screwed BSP**
- **Maximum pressure rating: 1,500 kpa cold, 1,035 kpa steam**



MATERAIL	
PARTS	MATERAIL
Body	CF8M
Coil	Special Copper Wire (H)
Core	Stainless Steel
Tube	Stainless Steel
Spring	Stainless Steel
Plug	PTFE
Bonnet/Nut	PTFE
Piston	#316

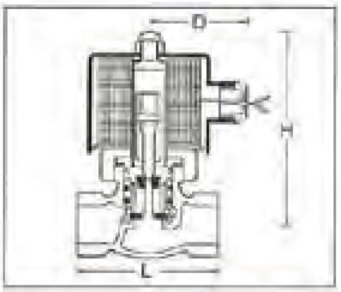
DIN	MODEL	PIPE SIZE	Cv	ORIFICE	FLUID TEMP. C	MAX. OPERATING PRESSURE DIFF. KGf/CM²				DIMENSION(mm)			WEIGHT (kg)
						WATER	AIR	STEAM	LIGHT OIL	L	H	D	
●	SUS-15#316	1/2"	4.0	17 mm	-5C ~ 185C	0.5-10	0.5-10	0.5-10	0.5-10	82	120	46	1.4
●	SUS-20#316	3/4"	6.0	17 mm	-5C ~ 185C	0.5-10	0.5-10	0.5-10	0.5-10	82	120	46	1.6
●	SUS-25#316	1"	12	22 mm	-5C ~ 185C	0.5-10	0.5-10	0.5-10	0.5-10	100	134	46	1.8
●	SUS-35#316	1 1/4"	18	30 mm	-5C ~ 185C	0.5-10	0.5-10	0.5-10	0.5-10	125	138	46	2.8
●	SUS-40#316	1 1/2"	22	30 mm	-5C ~ 185C	0.5-10	0.5-10	0.5-10	0.5-10	125	146	46	2.9
●	SUS-50#316	2"	48	50 mm	-5C ~ 185C	0.5-10	0.5-10	0.5-10	0.5-10	168	175	46	5.6

US

Solenoid valve, heavy pattern, normally closed.

Suitable for steam, water, air, gas and most non corrosive chemicals

- **Body & bonnet: Bronze**
- **Plug: PTFE + 15% GF**
- **Core needle, tube & Spring: Stainless steel**
- **Available voltages: 240vAC, 110vAC and 24vDC**
- **End Connections: Screwed BSP**
- **Maximum pressure rating: 1,500 kpa cold, 1,035 kpa steam**
- **Sizes: 15mm to 50mm**



MATERAIL	
PARTS	MATERAIL
Body	Cast Bronze
Coil	Special Copper Wire (H)
Core Needle	Stainless Steel
Tube	Stainless Steel
Spring	Stainless Steel
Plug	PTFE + 15%GF
Bonnet/Nut	PTFE
Piston	Brass

DIN	MODEL	PIPE SIZE	Cv	ORIFICE	FLUID TEMP. C	MAX. OPERATING PRESSURE DIFF. KGf/CM²				DIMENSION(mm)			WEIGHT (kg)
						WATER	AIR	STEAM	HEAVY OIL	L	H	D	
	US-15	1/2"	4.0	17 mm	-5C ~ 185C	0.5-15	0.5-15	0.5-10	0.5-10	82	120	56	1.7
	US-20	3/4"	6.0	17 mm	-5C ~ 185C	0.5-15	0.5-15	0.5-10	0.5-10	82	128	56	1.7
	US-25	1"	12	22 mm	-5C ~ 185C	0.5-15	0.5-15	0.5-10	0.5-10	91	130	56	2.0
	US-35	1 1/4"	18	30 mm	-5C ~ 185C	1-10	1-15	1-10	1-10	119	141	56	3.1
	US-40	1 1/2"	22	30 mm	-5C ~ 185C	1-10	1-15	1-10	1-10	119	144	56	3.3
	US-50	2"	48	50 mm	-5C ~ 185C	1-10	1-15	1-10	1-10	183	173	56	7.2

Actuation

Max-Air TECHNOLOGY

PRODUCT OVERVIEW

RACK & PINION ALUMINUM ACTUATORS

Certificati ATEX II 2GD
ATEX II 2GD approved

CARATTERISTICHE E VANTAGGI

1. Progettati secondo le norme NAMUR VDI/VDE 3845 e ISO 5211, la serie MAX-AIR utilizza lo stesso corpo e testate nelle configurazioni semplice e doppio effetto.
2. L'angolo standard di rotazione è 90°. Sono disponibili, a richiesta, anche le versioni 120°, 135°, 150° e 180°. L'MT15 (UT15) e unità superiori sono dotate di serie di un **doppio registro (Brevetto Internazionale)** che consente una registrazione di ± 10° sia in apertura che in chiusura.
3. La chiave femmina del pignone è, nella configurazione standard, un Doppio Quadro; a richiesta può essere offerta come Doppio-D, con foro tondo e chiavetta o progettata secondo le esigenze del cliente.
4. I pistoni ed il pignone sono dotati di bussole e pattini per impedire un contatto diretto con il corpo dell'attuatore.
5. L'altezza del pignone (NAMUR H= 30) consente di effettuare manovre manuali di emergenza senza interferire con l'indicatore e di utilizzare un'unica staffa per il montaggio degli accessori.
6. I pistoni della serie MT sono dotati di chiavella di sicurezza per garantire l'antiesplulsione del pignone e anodizzati per anticorrosione.
7. Indicatore esterno aperto/chiuso nella dotazione standard, disponibile per tutte le rotazioni.
8. Le molle, realizzate in acciaio speciale e con verniciatura anticorrosione, sono premontate solo con materiale tecnopolimero.

SOLO PER SERIE UT

9. La flangia inferiore consente da un lato di bloccare (dispositivo anti-espulsione) il pignone e dall'altro garantisce una maggiore flessibilità nel montaggio in quanto in essa è possibile inserire dadi in AISI 304 (esecuzione standard) o viti in AISI 304 (a richiesta) posizionati secondo le norme ISO oppure, a richiesta, secondo dimensioni desiderate dal cliente.

FEATURES & BENEFITS:

1. *Designed according to Namur VDI/VDE 3845 and ISO 5211 standard, the MAX-AIR series utilizes the same body and end caps for double acting and spring return units.*
2. *The standard angle of rotation is 90°. Additional travel rotations of 120°, 135°, 150° and 180° are available. MT15 (UT15) and upper sizes feature as standard a **double travel stop (International Patent)** which allows ± 10° stroke adjustment both in the closing and opening phase of the actuator stroke.*
3. *The female pinion drive is standard with a double square output drive, and optional with a double-D drive, keyed drive and designs to meet your specific requirements.*
4. *Pistons and pinion are equipped with wear pads and bearings to isolate them from the housing and support them for high cycle applications.*
5. *The pinion teeth are engaged the full length and stroke of the piston. The pinion height NAMUR H30 allows manual override without disturbing the indicated positions and using the same bracket size to mount accessories on all the series*
6. *MT series pistons feature a keyway as anti-blowout system and anodized for corrosion resistance.*
7. *External open/close indicator as standard, available for all the rotations.*
8. *Epoxy coated special steel springs are pre-loaded with non-metallic materials. The stainless steel end cap fasteners are extra long to allow for spring relaxation. All parts are corrosion resistant.*

ONLY FOR UT SERIES

9. *The "patent pending" bottom plate design, unique to MAX-AIR, secures a captive pinion (anti-blowout system) and permits flexibility in mounting by retaining AISI 304 nuts (standard) or AISI 304 bolts (optional) in either dual ISO patterns, or to customer dimensions.*

Testate e pistoni: I pistoni sono in alluminio pressofuso ed anodizzati o verniciati come trattamento anti corrosione. Le testate sono realizzate in alluminio pressofuso con verniciatura epossidico

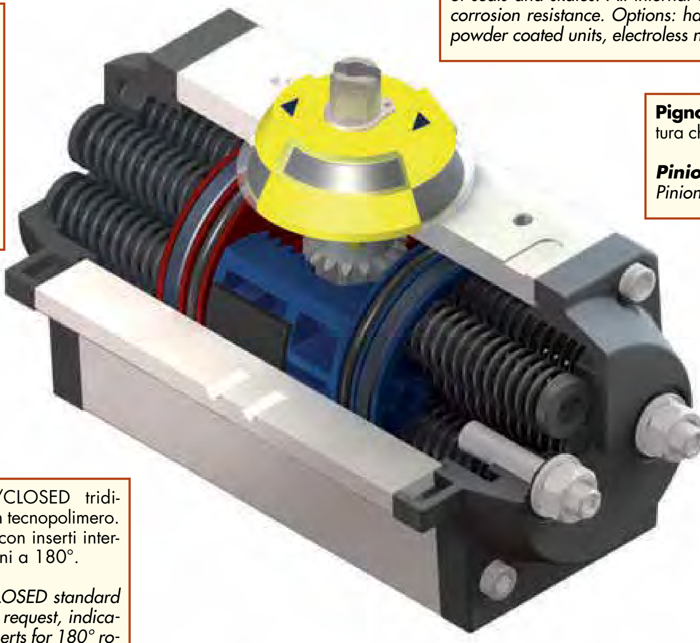
End caps and pistons: *Die-cast aluminium pistons are anodized or epoxy powder coated for corrosion resistance; Die-cast aluminium end caps are epoxy powder coated.*

Corpo: Il corpo è in alluminio estruso (6063 o 6005). Superfici interne lappate per ridurre gli attriti e aumentare la durata delle guarnizioni. Anodizzazione esterna/interna per migliore protezione alla corrosione Opzionale anodizzazione dura, PTFE, verniciatura epossidica o nichelatura chimica.

Body: *Extruded aluminium body (6063 or 6005) is internally machined to exact specifications and lapped to reduce frictions and to increase the life of seals and skates. All internal and external surfaces are anodized for corrosion resistance. Options: hard anodizing with PTFE coating, epoxy powder coated units, electroless nickel plating.*

Pattino guida:
In tecnopolimero
Ampia area di contatto
Elevata durata
Ottima scorrevolezza

Bearing pad:
Techno-polymer
Large contact area
High performance
Long life resistance



Pignone: In acciaio al carbonio con nichelatura chimica (Acciaio inossidabile a richiesta).

Pinion: *Electroless nickel coated carbon steel Pinion (stainless steel available on request).*

Guarnizioni: La configurazione standard prevede l'impiego di guarnizioni Buna-N, che consentono un utilizzo dell'attuatore a temperatura da -20°Ca 80°C. Temperature più elevate possono essere raggiunte utilizzando guarnizioni in Viton e i pattini guida e le bussole in tecnopolimero (120°C continui e 150°C ciclici). Le basse temperature (-50°C) sono ottenibili con le guarnizioni in silicone.

Seals: *Temperature range from -20°C to 80°C (-10°F to 176°F) with standard Buna-N nitrile seals. Higher temperature with optional Viton seals and techno-polymer piston guides and bearings:120°C (250°F) continuous and 150°C (300°F) cyclic. Lower temperature available with silicones seals –50°C (-55°F).*

Indicatore: OPEN/CLOSED tridimensionale standard in tecnopolimero. A richiesta indicatore con inserti intercambiabili per rotazioni a 180°.

Indicator: *OPEN/CLOSED standard in techno-polymer. On request, indicator with changeable inserts for 180° rotation*

Cartucce molla: Le molle sono realizzate in acciaio per molle e verniciate con vernice anti-corrosione

Spring cartridges: *Springs are carbon steel and coated for corrosion resistance.*

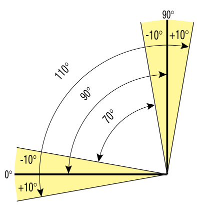
Disponibili GRANI SPECIALI per regolazione completa della corsa
Available extended travel stopos for FULL STROKE adjustment

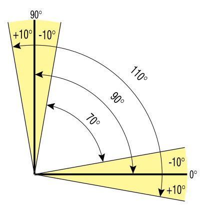
INDICATORE: OPEN/CLOSED tridimensionale standard in tecnopolimero per 90°.
Indicatore con inserti intercambiabili per rotazioni a 180°.

INDICATOR: *OPEN/CLOSED standard in techno-polymer for 90°.*
Indicator with changeable inserts for 180° rotation

DOPPIO REGISTRO BREVETTATO

Gli attuatori Max-Air sono dotati di un doppio registro **(Brevetto Internazionale)** che consente di regolare, attraverso il grano e l'asta inseriti nella testata, la corsa dell'attuatore di ± 10° - **IL PIU' AMPIO SUL MERCATO** - sia nella fase di apertura che di chiusura. **La corsa dell'attuatore può pertanto variare da 70° a 110°.** Il grano e l'asta sono stati progettati per assorbire la massima coppia nominale dell'attuatore e i carichi massimi associati alle diverse velocità di funzionamento. Inoltre per garantire una maggiore resistenza dei pistoni sia l'asta che il grano di registro agiscono nella parte in cui essi hanno il maggior spessore di materiale. La **Regolazione** sia per le unità con apertura antioraria che oraria è ottenuta agendo dall'esterno sul grano (MAX) e sull'asta (0°) di registro per aumentare o ridurre la rotazione.



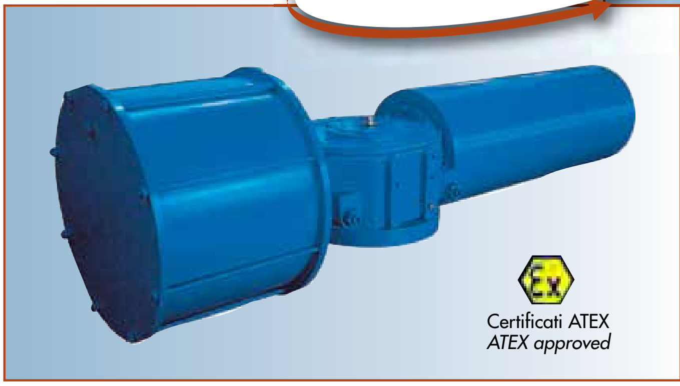


BI-DIRECTIONAL PATENTED DOUBLE TRAVEL STOP

*Max-Air actuators feature a bi-directional travel stop **(InternationalPatent)**. Side located stops allow a ± 10° adjustment -BEST IN THE MARKET - in both closing and opening directions, so guarantee a **range of adjustment between 70°and 110° of actuator stroke**.*
Travel stops are designed to absorb the maximum rated torque of the actuator and the maximum impact load associated with recommended speed stroke.To increase pistons resistance both travel stops arrest the pistons in their part with the largest mass of material.
***Adjustment** of the counter clockwise and clockwise rotation is accomplished by turning the respective left (MAX) and right stop (0°) adjustment screws to increase or reduce output rotation.*

SCOTCH-YOKE ACTUATORS

Torques up to 250,000 Nm



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CARATTERISTICHE E VANTAGGI

1. **Design stagno**
   Grazie alla presenza di OR su corpo e testate, la serie SY è stagna e protetta da ingressi di acqua rendendola idonea per applicazioni interne ed esterne
2. **ISO e NAMUR Standard**
   La serie SY è dotata di attacchi inferiori per collegamento alla valvola secondo ISO 5211.
   L'uscita dello stelo e la foratura di fissaggio superiori secondo NAMUR ed identici su tutti gli attuatori della serie SY, consentono un semplice montaggio di accessori quali box fine corsa e posizionatori
3. **Lubrificazione & Resistenza all'usura**
   Tutti gli attuatori della serie SY hanno di serie il doppio registro che consente regolazione sia in apertura che in chiusura ed una effettiva corsa da 80° a 100°
4. **Efficienza & Durata**
   L'asta di guida e del pistone hanno un trattamento superficiale che garantisce, in combinazione con pattini e boccole in materiale auto lubrificante, un'alta resistenza all'usura e lungo ciclo di vita.
5. **Resistenza alla Corrosione**
   Il trattamento superficiale delle aste e il materiale auto lubrificante di pattini e boccole, garantiscono il massimo trasferimento di energia direttamente allo stelo della valvola; le molle precompresse minimizzano i carichi radiali sull'asta del pistone incrementando ulteriormente l'efficienza dell'attuatore e la sua durata.
6. **Design Modulare**
   Ogni attuatore della serie SY è dotato nella versione standard di 3 strati interni ed esterni di verniciatura per una superiore resistenza alla corrosione. In particolare la superficie interna del cilindro ha una protezione in PTFE che oltre a garantire un'eccellente resistenza alla corrosione è auto lubrificante per un migliore scorrimento e resistenza all'usura
7. **Sicurezza del Modulo delle Molle**
   Tutti gli attuatori Max-Air sono progettati considerando la sicurezza come priorità massima. La serie SY è dotata di serie di uno speciale dispositivo di blocco in modo tale che il modulo delle molla possa essere rimosso dal corpo centrale solo quando le molle sono completamente distese. Questa importante caratteristica previene possibili danni e infortuni per un'improvvisa estensione delle molle.
8. **Valvola di Ritegno Integrata**
   Una valvole di ritegno è integrata nel design degli attuatori SY per evitare un'eccessiva pressurizzazione e ingresso di materiale o acqua nell'unità. Questo previene rotture dell'attuatore e aumenta la vita dello stesso.

FEATURES & BENEFITS:

1. ***Water tight Design***
   O Rings are sized to exact specifications creating a water tight design and making the SY series suitable for indoor and outdoor applications
2. ***ISO and NAMUR standard***
   The SY series actuators bottom interface meets ISO 5211 standard for an easy valve connection.
   The top-works dimensions, both for shaft height and drilling, are according to NAMUR and identical on all SY actuators, allowing easy and standard accessories assembly
3. ***Self-Lubricating & Wear Resistance***
   Each SY actuator has been engineered with bi-directional travel stops which allow for total travel adjustment between 80° and 100°
4. ***Efficiency & High Cycle Bearings***
   The guide rod and piston rod have an advanced surface treatment providing superior wear resistance. All SY series actuators have been designed to be completely self-lubricating, requiring no further lubrication, ensuring maximum wear resistance and long cycle life.
5. ***Corrosion Resistance***
   Each SY unit comes standard with a minimum of three progressive stages of internal and external coating for corrosion resistance. The inner lining of the cylinder wall is coated in infused PTFE, thereby enhancing internal corrosion resistance and self-lubrication.
6. ***Modular Design***
   The Max-Air SY series scotch yoke actuator has a highly efficient and interchangeable modular design (air cylinder, power drive, spring pack and override module) providing for easy field modification and serviceability.
7. ***Safety Lock – Safe Spring Module***
   All Max-Air actuators have been engineered with safety as its highest priority. The SY series actuators features a specially designed safety lock mechanism so that the spring module can only be removed from the power module when the spring is fully decompressed. This important safety feature prevents accidental release of spring tension. The spring lock mechanism safely retains the spring module under load, and prevents the module from being removed when the actuator is under load conditions.
8. ***Integral Check Valve***
   An integral check valve is incorporated in incorporated into the design of the SY series actuator to prevent over pressurizing and foreign material from getting inside the unit. This prevents premature break down and increases the life of the actuator.

TECHNOPOLYMER ACTUATORS

La serie di attuatori in Tecnopolimero MAX-AIR da oltre 13 anni viene utilizzata nel mondo per applicazioni negli ambienti più aggressivi. La serie è ora anche disponibile in **POLIPROPILENE** diventando così la miglior scelta per prestazioni, caratteristiche tecniche e costo per ambienti corrosivi.

*For more than 13 years, the Max-Air line of **thermoplastic actuators** has been installed worldwide in the most arduous environments. The series is now also available in **GLASS-REINFORCED POLYPROPYLENE** becoming the most effective choice for your corrosion resistance applications.*

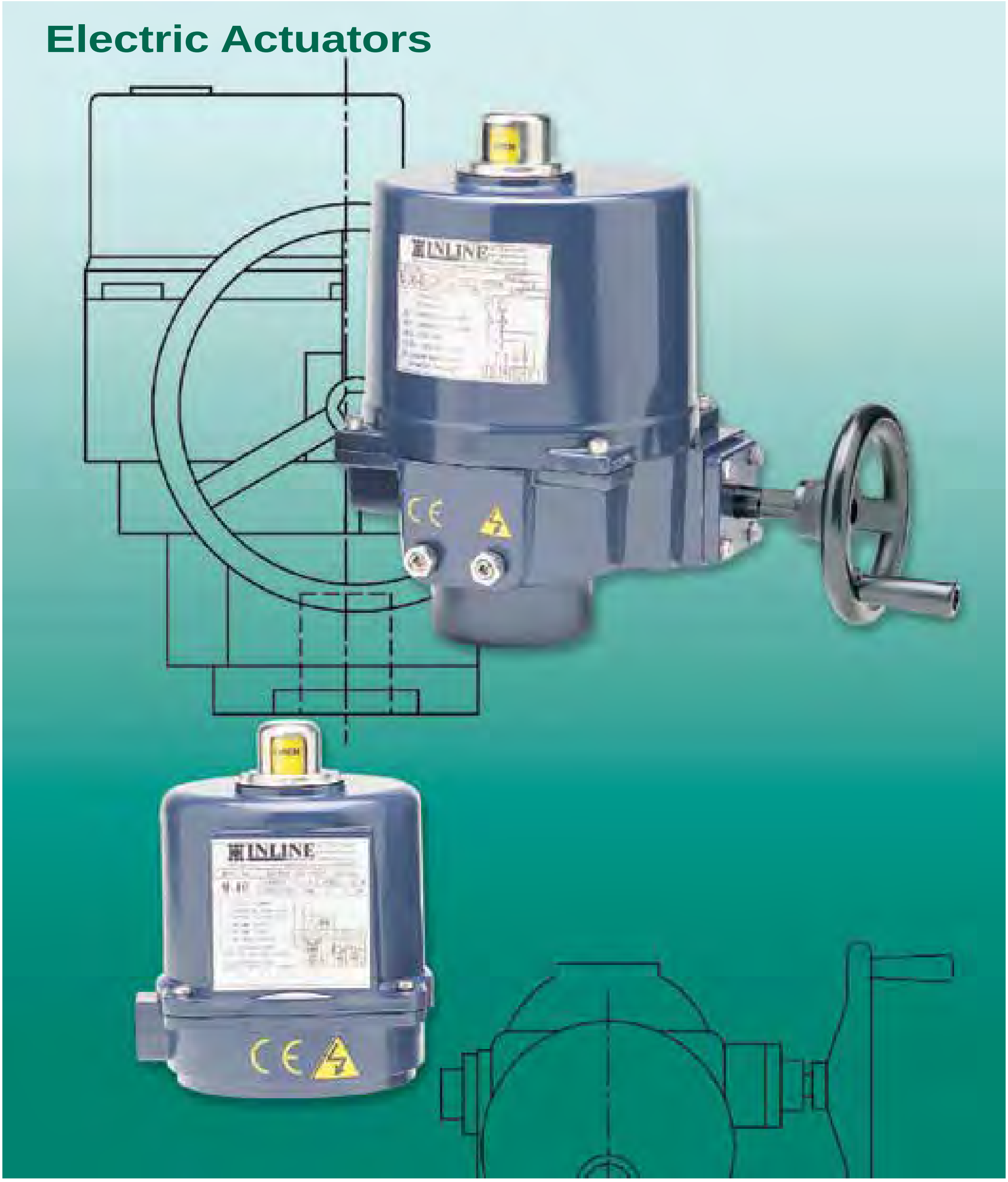
CARATTERISTICHE E VANTAGGI

- Progettati secondo NAMUR VDI/VDE 3845 e ISO 5211, la serie MAX-AIR utilizza lo stesso corpo e testate per Doppio e Semplice Effetto.
- Pignone in acciaio al carbonio nichelato (in acciaio inox a richiesta – di serie per la versione in Polipropilene).
- La flangia inferiore consente da un lato di bloccare (dispositivo anti-espulsione) il pignone e dall'altro garantisce una maggiore flessibilità nel montaggio in quanto in essa è possibile inserire dadi in AISI 304 (esecuzione standard) o viti in AISI 304 (a richiesta) posizionati secondo le norme ISO oppure, a richiesta, secondo dimensioni desiderate dal cliente.
- Alimentazione con aria (possibilmente lubrificata), olio idraulico, acqua emulsionata, min 2 Bar – max 8 Bar.
- Temperature standard di funzionamento: -20°C +80°C.

FEATURES & BENEFITS:

- *Designed according to Namur VDI/VDE 3845 and ISO 5211 standard, the MAX-AIR series utilizes the same body and end caps for double acting and spring return units.*
- *Carbon steel nickel plated pinion (stainless steel as option and standard for Polipropilene series).*
- *The bottom plate design, unique to MAX-AIR, secures a captive pinion (anti-blowout system) and permits flexibility in mounting by retaining AISI 304 nuts (standard) or AISI 304 bolts (optional) in either dual ISO patterns, or to customer dimensions.*
- *Supply: air (lubricated if possible), hydraulic oil or water, min 2 Bar (30 PSI) and max 8 Bar (120 PSI).*
- *Standard working temperature: -20°C +80°C (-4°F +176°F).*

M-Series



12V / 24V

Model No.	Torque (lb.-in.)	Speed (90°)	Motor Power	Motor Speed		12V DC/AC			24V DC/AC		
				12V	24V	Run	Start	Lock	Run	Start	Lock
M10	310	15 s	10W	3600/min	3600/min	0.5A	3.0A	3.0A	0.6A	0.8A	1.4A
M15	443	20 s	10W	3600/min	3600/min	0.5A	3.0A	3.0A	0.7A	0.8A	1.4A
M20	797	15 s	70W	1800/min	1800/min	3.4A	5.0A	8.5A	3.0A	5.0A	13.0A
M30	1328	22 s	70W	1800/min	1800/min	3.4A	5.0A	8.5A	3.0A	5.0A	13.0A
M40	3540	16 s	180W	1800/min	1800/min	12.0A	8.5A	30.0A	6.0A	8.0A	30.0A
M50	4420	22 s	180W	1800/min	1800/min	13.0A	8.5A	30.0A	6.5A	8.0A	30.0A
M60	5735	28 s	180W	1800/min	1800/min	14.0A	8.5A	30.0A	7.5A	8.0A	30.0A

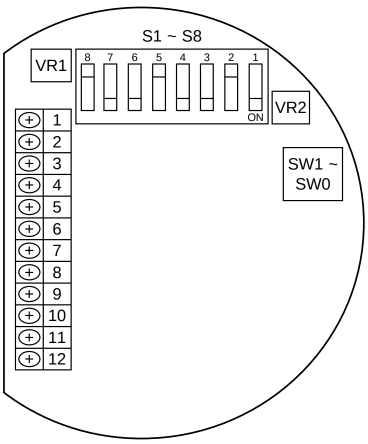
Single-Phase

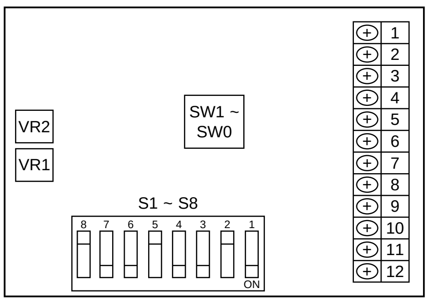
Model No.	Torque (lb.-in.)	Speed (90°)		Motor Power	Motor Speed		110V Current			220V-240V Current		
		60 Hz	50 Hz		60 Hz	50 Hz	Run	Start	Lock	Run	Start	Lock
M10	310	12 s	13 s	10W	3600/min	3000/min	0.5A	1.5A	0.6A	0.3A	1.0A	0.5A
M15	443	20 s	24 s	10W	3600/min	3000/min	0.5A	1.5A	0.6A	0.3A	1.0A	0.5A
M20	797	15 s	17 s	40W	1720/min	1450/min	1.3A	3.0A	1.8A	0.5A	1.5A	0.9A
M25	1062	8 s	10 s	40W	1720/min	1450/min	1.0A	3.0A	1.8A	0.5A	1.5A	0.9A
M30	1328	22 s	26 s	40W	1720/min	1450/min	1.0A	3.0A	1.8A	0.5A	1.5A	0.9A
M40	3540	16 s	18 s	120W	1720/min	1420/min	1.3A	3.1A	3.6A	0.6A	1.5A	1.8A
M50	4420	22 s	25 s	120W	1720/min	1450/min	1.5A	3.0A	3.6A	0.7A	1.5A	1.8A
M60	5735	28 s	31 s	120W	1720/min	1450/min	1.8A	3.0A	3.6A	0.8A	1.5A	1.8A

Three-Phase

Model No.	Torque (lb.-in.)	Speed (90°)		Motor Power	Motor Speed		220V Current			380V Current			440V Current		
		60 Hz	50 Hz		60 Hz	50 Hz	Run	Start	Lock	Run	Start	Lock	Run	Start	Lock
M20	797	15 s	17 s	40W	1720/min	1450/min	0.6A	1.8A	1.1A	0.3A	1.0A	0.7A	0.4A	1.3A	0.7A
M25	1062	8 s	10 s	40W	1720/min	1450/min	0.6A	1.8A	1.1A	0.3A	1.0A	0.7A	0.4A	1.3A	0.7A
M30	1328	22 s	26 s	40W	1720/min	1450/min	0.6A	1.8A	1.1A	0.3A	1.0A	0.7A	0.4A	1.3A	0.7A
M40	3540	16 s	18 s	120W	1720/min	1450/min	1.0A	3.0A	3.5A	0.7A	2.2A	2.0A	0.8A	2.5A	2.0A
M50	4420	22 s	25 s	120W	1720/min	1450/min	1.0A	3.0A	3.5A	0.7A	2.2A	2.0A	0.8A	2.5A	2.0A
M60	5735	28 s	31 s	120W	1720/min	1450/min	1.0A	3.0A	3.5A	0.7A	2.2A	2.0A	0.8A	2.5A	2.0A

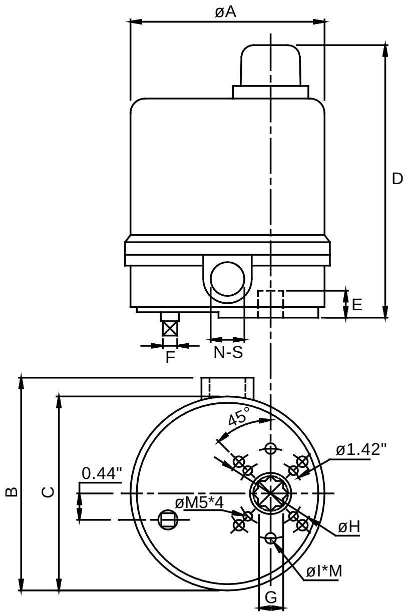
Modulating Control Board for M20 ~ M60



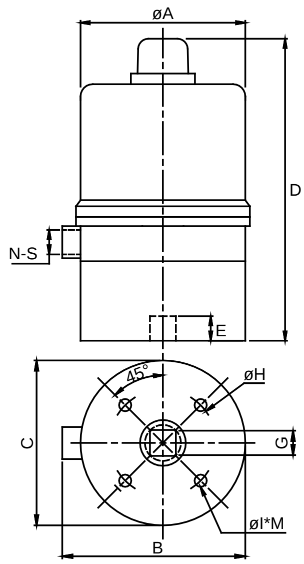


Modulating Control Board for M10, M15

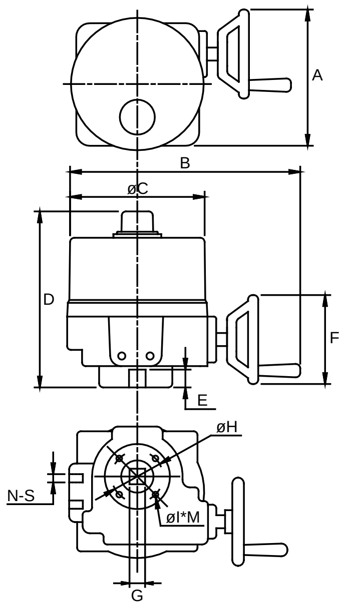
M10



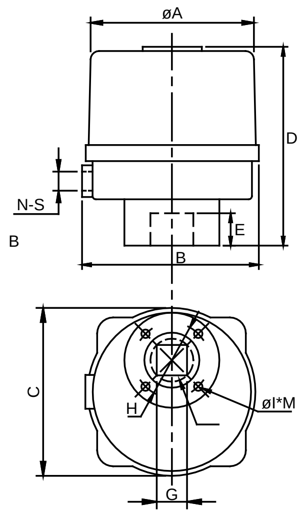
M15



M20



M25

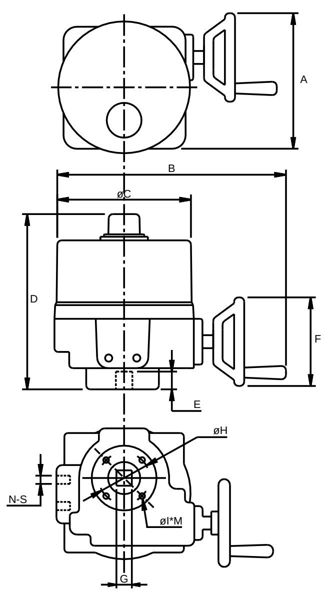


Specifications						
	Output Torque (lb.-in.)	Cycle Time (sec.)	Duty Cycle (%)	Optional Ext. Ext. Duty Cycle (%)*	Ext. Duty Cycle Time (sec.)	Lock Rotor Current (amp.)
M10	310	12	25	75	15	0.6
M15	443	20	25	75	24	0.6
M20	797	15	25	75	15	1.8
M25	1063	8	25	-	-	1.8

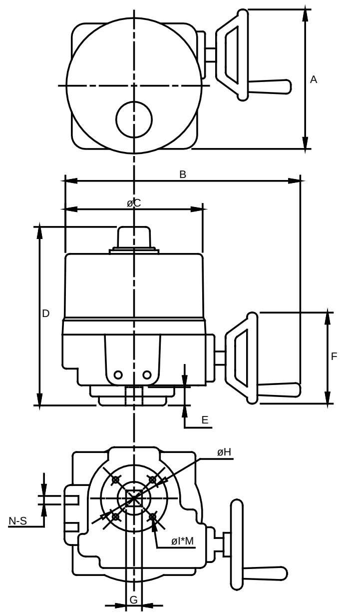
*** For 75% duty cycle, please request wiring diagram from the factory**

Dimensions (Inches)														
Model	A	B	C	D	E	F	G	H	I	M	N	S	Flange Type	Weight (lbs)
M10	4.25	4.80	4.25	6.10	0.59	0.31	0.55	1.97	M6	6	1	1/2	F03 / F05	4.40
M15	4.25	4.80	4.25	7.99	0.63	-	0.67	2.76	M8	4	1	1/2	F07	6.60
M20	7.87	12.99	7.87	10.04	1.18	4.92	0.87	2.76	M8	4	2	1/2	F07	24.40
M25	6.06	6.30	6.06	7.56	1.18	-	0.87	2.76	M8	4	1	1/2	F07	9.90

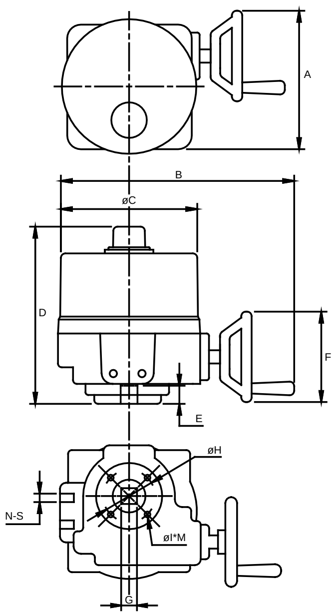
M30



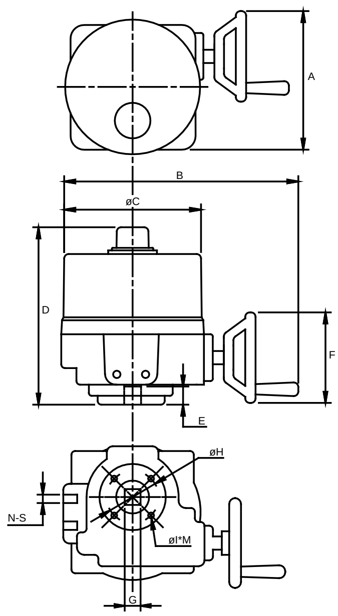
M40



M50



M60



Specifications

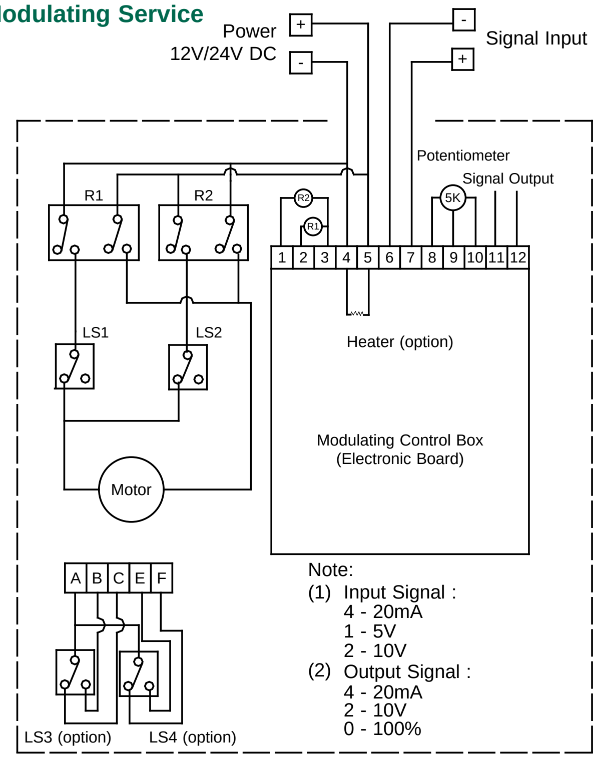
	Output Torque (lb.-in.)	Cycle Time (sec.)	Duty Cycle (%)	Optional Ext. Ext. Duty Cycle (%)*	Ext. Duty Cycle Time (sec.)	Lock Rotor Current (amp.)
M30	1328	22	25	75	22	1.8
M40	3540	16	25	75	16	3.6
M50	4420	22	25	75	22	3.6
M60	5735	28	25	75	28	3.6

*** For 75% duty cycle, please request wiring diagram from the factory**

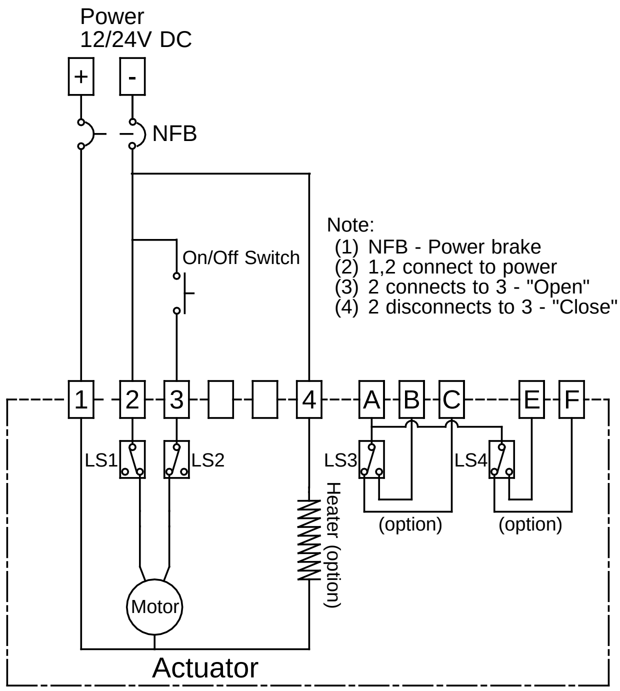
Dimensions (Inches)

Model	A	B	C	D	E	F	G	H	I	M	N	S	Flange Type	Weight (lbs)
M30	7.87	12.99	7.87	10.04	1.18	4.92	0.87	2.76	M8	4	2	1/2	F07	24.40
M40	11.81	14.96	9.21	12.40	1.57	7.68	1.42	4.02	M10	4	2	1/2	F10	48.40
M50	11.81	14.96	9.21	12.40	1.57	7.68	1.42	4.02	M10	4	2	1/2	F10	48.40
M60	11.81	14.96	9.21	12.40	1.57	7.68	1.42	4.02	M10	4	2	1/2	F10	48.40

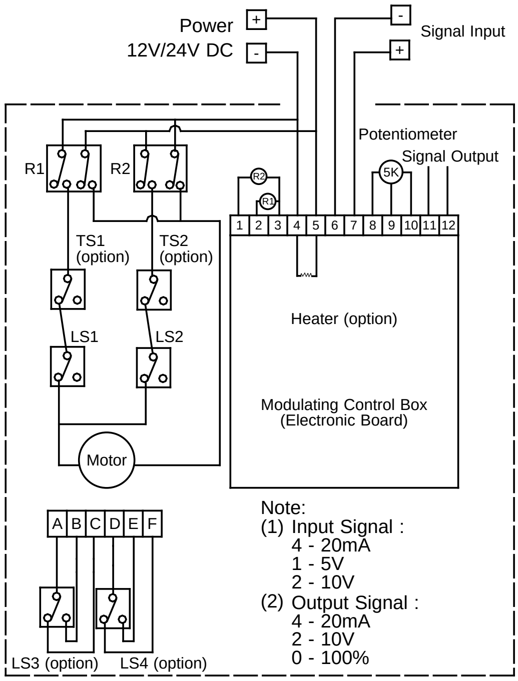
Wiring Diagram
M-10 & M-15 12V/24V DC
Modulating Service



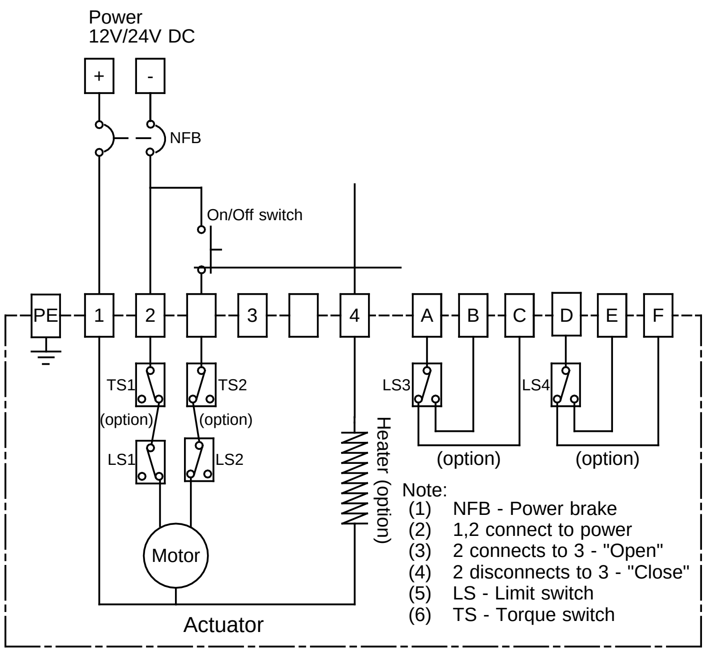
Wiring Diagram
M-10 & M-15 12V/24V DC
Two Positions



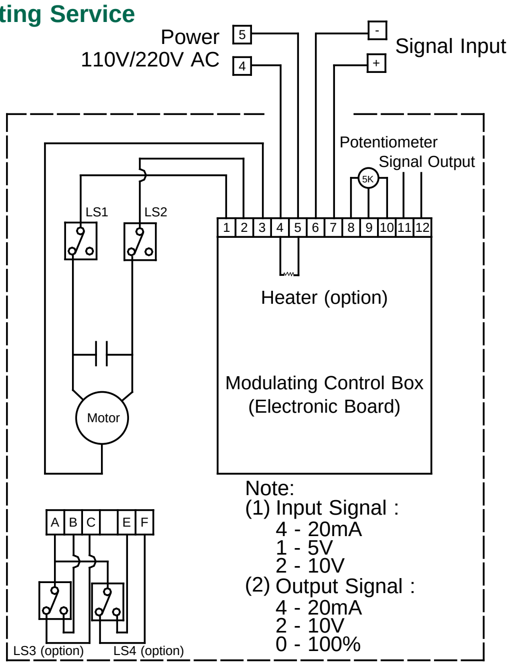
Wiring Diagram
M-20 ~ M-60 12V/24V DC
Modulating Service



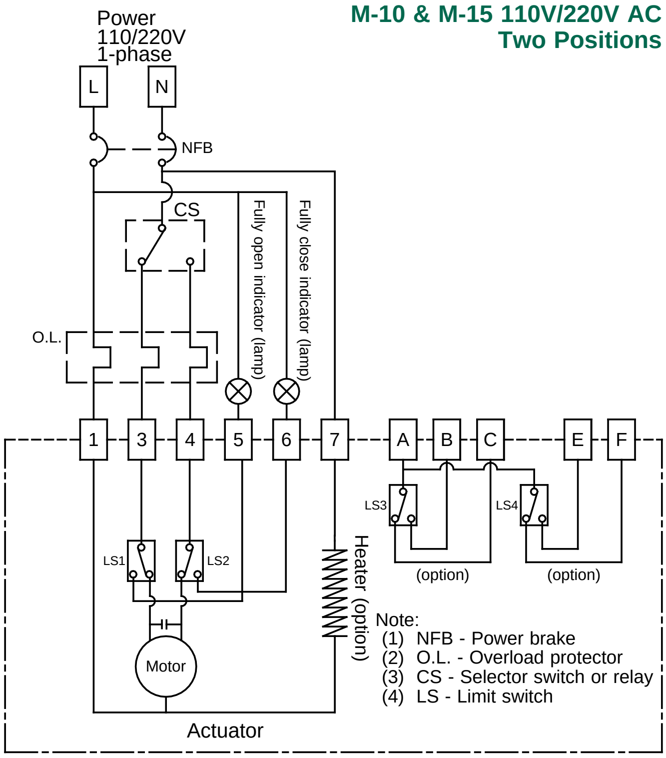
Wiring Diagram
M-20 & M-60 12V/24V DC
Two Positions



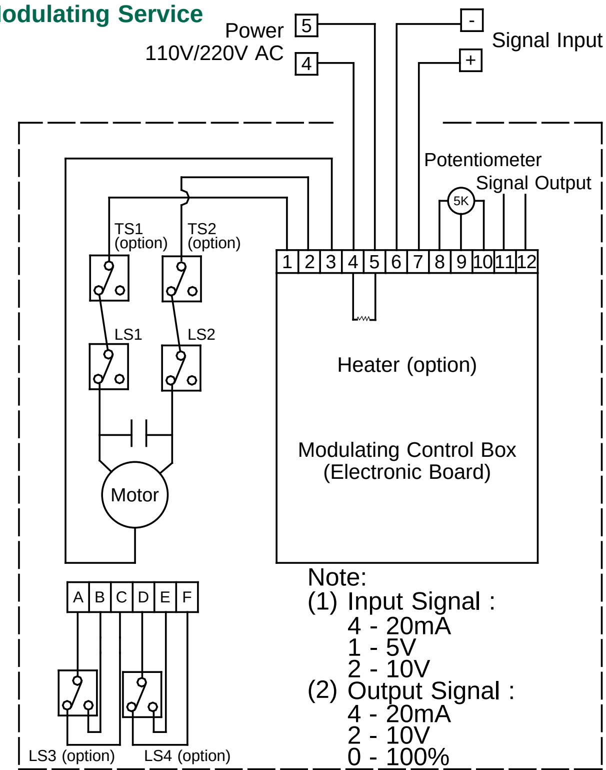
Wiring Diagram
M-10 & M-15 110V/220V AC
Modulating Service



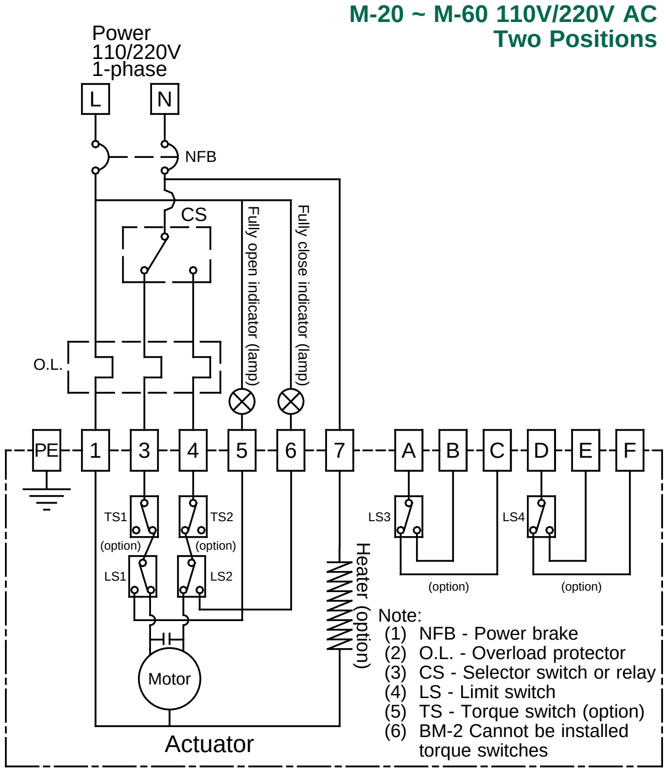
Wiring Diagram
M-10 & M-15 110V/220V AC
Two Positions



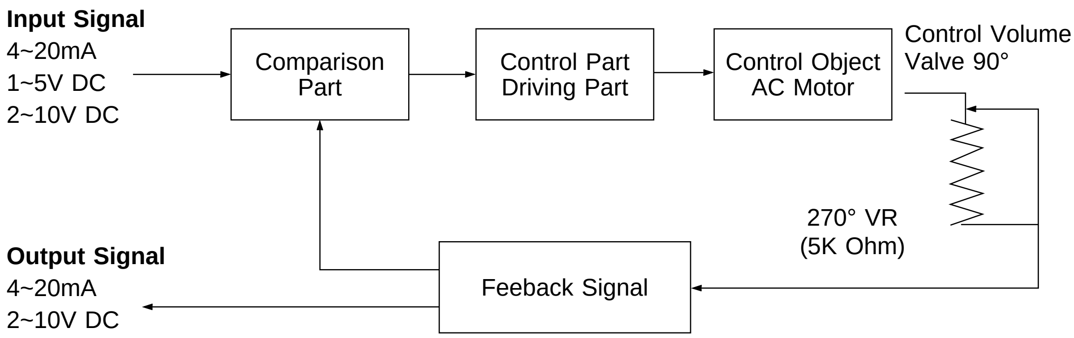
Wiring Diagram
M-20 ~ M-60 110V/220V AC
Modulating Service



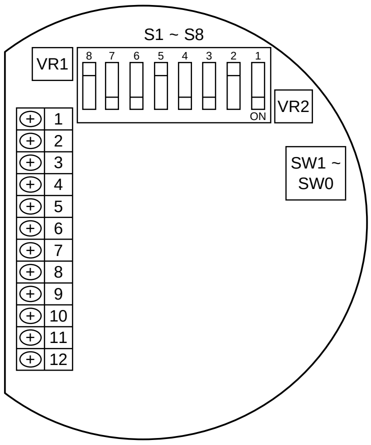
Wiring Diagram
M-20 ~ M-60 110V/220V AC
Two Positions

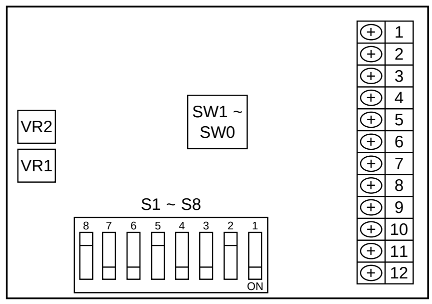


Modulating Control Board



Modulating Control Board for M20 ~ M60





Modulating Control Board for M10, M15

*** ATTENTION: TURN POWER OFF BEFORE CHANGING THE FOLLOWING SETTINGS:**

S1,2: INPUT SIGNAL SELECT
" 4~20mA " set 1-ON / 2-OFF
" 1~5V " set 1-OFF / 2-OFF
" 2~10V " set 1-OFF / 2-ON

S3,4,5: OUTPUT SIGNAL SELECT
"2-10V" set 3-ON / 4-OFF / 5-ON
"4-20mA" set 3-OFF / 4-ON / 5-OFF

S6: Valve is fully-open when the input signal is 4mA, 2V or 1V and valve is fully-closed when the input signal is 20mA, 10V or 5V, set 6-ON
Valve is fully-closed when the input signal is 4mA, 2V or 1V and valve is fully-open when the input signal is 20mA, 10V or 5V, set 6-OFF

S7,8: POSITION SELECT (when the feedback signal fails)
"valve fully-closed" set 7-OFF / 8-ON
"valve fully-open" set 7-ON / 8-OFF
"valve stops" set 7-ON / 8-ON

SW1~0: Sensitivity Switch
When switch to "1", the 0~90° can be divided up around 80 times movement
When switch to "0", the 0~90° can be divided up around 17 times movement
The sensitivity decreases 7 times movement by sectors from SW1 to SW2, SW2 to SW3, SW3 to SW4 and so on

SUPPLIED VOLTAGE: 24V DC/AC, 110V/220V AC 1-PH **WORKING TEMP.:** -10°C ~ +60°C

TROUBLE SHOOTING

Conditions	Possibilities	Solutions
Motor Does Not Operate	1. Is the supplied power and voltage correct? 2. Any blisters on the capacitor? 3. Are the gear trains free?	1. Checking by meter 2. If so replace 3. Remove motor to check
Motor Stops Running	1. Is power supply short circuited? 2. Any foreign objects in flow stream?	1. Check wiring 2. Check for obstructions
Unable to Fully Open/Close	1. Loose/Misaligned cam? 2. Bent valve stem? 3. Mechanical stop adjustment incorrect?	1. Adjust/Tighten using spanner 2. Replace valve stem 3. Check position of stops
Valve Stops Operating When Motor is Running	1. Gear worn out? 2. Sleeve adapter worn out or broken? 3. Broken valve stem or actuator transmission shaft?	1. Replace gear 2. Replace sleeve adapter 3. Replace valve stem or actuator transmission shaft
Abnormal Control for Operating Two or More Actuators Simultaneously	1. Controlling circuit connects in tandem or parallel?	1. Please refer to the wiring diagram
Motor Overheats	1. Is the voltage correct? 2. Is valve too tight to operate? 3. High working frequency? 4. Is motor stem or bearing binding?	1. Checking by meter 2. Replace valve 3. Check duty cycle 4. Replace the binding parts
Abnormal On/Off Angle on 3-Phase Voltage	1. Wrong phase wiring?	1. Change phase wiring
Occasional On/Off Actuator Failure	1. Simultaneous input power on/off	1. Check if the selection switch is normal

LIMIT SWITCH BOX

Disponibili ATEX II 3D e ATEX II 2GD
ATEX II 3D *ATEX II 2GD available*

La serie di Box Fine Corsa MAX-AIR rappresenta una nuova generazione nei box indicatori per gli attuatori. Costruiti in diversi materiali e con diversi gradi di protezione, rappresentano la miglior scelta anche per ambienti nocivi

Semplicità regolazione Cammes
La posizione degli interruttori può essere cambiata in modo semplice grazie alla presenza di cammes con zigrinatura a passo fine, che possono pertanto essere regolate manualmente ed in modo indipendente senza il bisogno di attrezzi, in modo elettricamente sicuro in quanto il cablaggio delle morsettiere e dei fine corsa sono isolate.

Design Compatto
I box indicatori della Max-Air hanno un design compatto e dimensioni contenute, minimizzando gli ingombri complessivi dell'assieme valvola + box.

Semplicità di collegamento
I box MAX-AIR sono equipaggiati con uno o due ingressi M20x1.5 (1/2" NPT a richiesta) e morsettiera angolata per facilitare il cablaggio.

Staffe di Montaggio
Fornite come standard in tecnopolimero o acciaio inossidabile, si adattano alla foratura NAMUR sul corpo dell'attuatore, 80 mm per 30 mm. Le staffe consentono l'accoppiamento del Box Indicatore con attuatori aventi pignoni sporgenti NAMUR h = 30 mm e h = 20 mm, quest'ultima grazie all'utilizzo di una prolunga in tecnopolimero.
Disponibile inoltre una nuova staffa universale in acciaio inossidabile, aggiustabile, che consente il montaggio su NAMUR 80x30 H30 e H20 e 130x30 H50.

Indicatore Tridimensionale
Consente una chiara lettura ed identificazione dello stato corrente della valvola. Disponibile anche per valvole a 3 vie (L o T) o a freccia.

The MAX-AIR series of Limit Switch Boxes represent a completely new dimension in limit switches for actuators. Manufactured in various materials, these very compact units are the best choice for the most arduous environments.

Quick Set Cams
The operating position of the switches can be easily changed by adjusting the high resolution spline cams manually and independently with the need for additional tools. The cams are spring backed and will not be affected by normal vibration.

Compact Design
The Max-Air switch box is a very compact limit switch box, thereby allowing maintenance of a smaller valve envelope size.

Easy Wiring
MAX-AIR boxes are equipped as standard with one or two conduit entries, M20x1.5 (1/2" NPT on request) and angled terminal strip to allow for easy wiring.

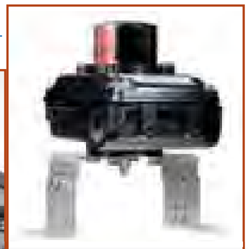
Mounting Bracket
Each Max-Air box comes standard with mounting bracket either in techno-polymer or stainless steel for NAMUR top-mounting hole spacing 80 mm per 30mm. The bracket allows the use of standard NAMUR stem height 30 mm and also 20 mm with a techno-polymer coupling.
Now available also a new adjustable UNIVERSAL bracket that allows to mount the switch box onto NAMUR 80x30 H30 and H20 and 130x30 H50.

High Visibility Indicator
The Max-Air box comes standard with a high visibility beacon, offering clear location of the current valve position.
Now available for 3 way indication (L or T) or arrow shape.



SPECIAL INDICATORS for Aluminium & stainless steel LSB

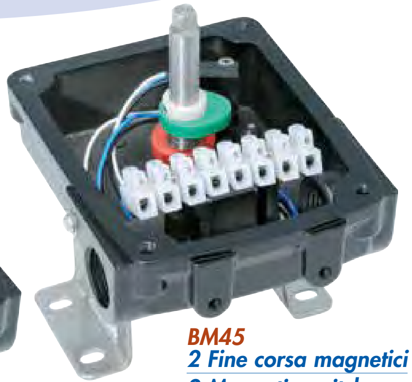
180° INDICATOR
for technopolymer LSB



Nuova staffa universale in acciaio inox
New stainless steel universal bracket

AVAILABLE SWITCH BOXES MODELS *aluminum and stainless steel boxes*

BE45
2 Fine corsa meccanici
2 Mechanical switches



BM45
2 Fine corsa magnetici
2 Magnetic switches

Disponibili ATEX II 3D e ATEX II 2GD
ATEX II 3D *ATEX II 2GD available*

BS45
Sensori di prossimità
Proximity sensors

Tutti disponibili in ACCIAIO INOX
All available in STAINLESS STEEL

BOX IN TECNOPOLIMERO
TECHNOPOLYMER SWITCH BOX

BS42
Sensori di prossimità
Proximity sensors

BE41
2 Fine corsa meccanici
2 Mechanical switches

NAMUR SOLENOID VALVE

Disponibili in versione ALTA TEMPERATURA
Available in HIGH TEMPERATURE

EV61
IP65

ATEX II 3GD

EV61X

EExia

ATEX II 2G

EV71
INTRINSICALLY SAFE

EExm

ATEX II 2GD

EV81
EXPLOSION PROOF

EV91
EXPLOSION PROOF
NEMA 7

VP
PILOTA PNEUMATICO
PNEUMATIC PILOT

ACCESSORI
ACCESSORIES

CARATTERISTICHE E VANTAGGI

- Progettate secondo le NORME NAMUR VDI/VDE 3845
- Funzionamento universale a 3 vie/2 posizioni oppure 5 vie/2 posizioni con una piastrina inclusa (per la 3/2)
- Alimentazione e scarichi filettati ¼" GAS
- Dispositivo per il comando manuale standard, tipo PUSH
- Grado di protezione IP65 come standard, a richiesta:
  - Certificate ATEX II 3 G D
  - A sicurezza intrinseca EExia – ATEX approved
  - Antideflangrante EExm – ATEX approved
  - Antideflangrante NEMA 7
- Varianti: ogni elettrovalvola è disponibile in versione monostabile, bistabile o a 3 Posizioni (centri aperti, centri chiusi e centri in pressione)

FEATURES & BENEFITS:

- *Design according NAMUR VDI/VDE 3845*
- *Universal application 3/2 or 5/2 ways selectable with a plate included (for 3/2)*
- *Port sizes: pressure in and exhaust ¼" GAS (optional ¼" NPT)*
- *Manual override as standard, PUSH type*
- *Protection class IP65 as standard (according to IEC 144 with connector and O Ring). Available:*
  - *ATEX II 3 G D approved*
  - *"Intrinsically safe EExia" – ATEX approved*
  - *"Explosion proof EExm" – ATEX approved*
  - *"Explosion proof NEMA 7"*
- *Multiple configurations: each valve is available in single coil, dual coil and 3 position configuration (open centers, closed centers, or center in pressure).*

Tutte le EV disponibili anche BISTABILI
All configurations shown are available with DUAL COILS

E36
3 POSIZIONI
3 POSITION

Disponibili anche a 3 posizioni
Also available 3 position versions

EV62

ROTARY VALVE POSITIONERS



I posizionatori **MAX-AIR** sono unità a semplice e doppio effetto con segnale in entrata 4-20 mA e 3-15 PSI per il controllo proporzionale di attuatori rotanti.
Il Posizionatore opera sulla base del principio di equilibrio delle forze.
L' apparecchio confronta il segnale proveniente dall'unità regolante con l'angolo di rotazione dello stelo inviando un segnale amplificato che agisce sulle camere dell'attuatore. Disponibile anche in versione Antideflagrante EEx md certificato ATEX II 2 G

***Max-Air** offers both single & Double Acting Valve Positioners, with input signals of 4-20 mA and 3-15 psi configurations, for proportional control of rotary actuators. The Positioners operate on the force-balance principal by comparing the standard signal transmitted from a pneumatic or an Electro-Pneumatic device and the angular rotation of the operating stem, and conveys a Positioning amplified pressure to the valve actuator. Available also in explosion proof EEx md version ATEX II 2 G approved*


TRASMETTITORE DI POSIZIONE

POSITION TRANSMITTER

Emme Technology offre un trasmettitore di posizione (PTM01) ed un trasmettitore di posizione con fine corsa interni (PTM02)

Max-Air offers a stand-along direct mount Position Transmitter (PTM01) and a stand-alone Position Transmitter with internal Limit Switches (PTM02).

AVAILABLE POSITIONER MODELS

POSIZIONATORE PNEUMATICO CON MANOMETRI
PNY01 – 3-15 PSI, MTG Universale

POSIZIONATORE ELETTRO-PNEUMATICO CON MANOMETRI
PEY01 – 4-20 mA, MTG Universale
PEY02 – 4-20 mA, MTG Universale, Anti-deflangrante EEx md
PEY04 – 4-20 mA, MTG Universale, LS
PEY05 – 4-20 mA, MTG Universale, LS+PTM

PNEUMATIC POSITIONERS WITH GAUGES
PNY01 – 3-15 PSI, Universal MTG

ELECTRO-PNEUMATIC POSITIONER WITH GUAGE
PEY01 – 4-20 mA, Universal MTG
PEY02 – 4-20 mA, Universal MTG, Explosion proof EEx md
PEY04 – 4-20 mA, Universal MTG, LS
PEY05 – 4-20 mA, Universal MTG, LS+PTM

POSIZIONATORE ELETTRO-PNEUMATICO IN ACCIAIO INOSSIDABILE CON MANOMETRI

Legenda
LS= Fine Corsa, PTM= Trasmettitore di posizione

STAINLESS STEEL ELECTRO-PNEUMATIC POSITIONERS

Legend
LS= Limit Switch, PTM= Position Transmitter

SMART

POSIZIONATORE SMART
A sicurezza Intrinseca EEx ia Certif. ATEX II 2 G

SMART

SMART POSITIONERS
Intrinsically Safe EEx ia - ATEX II 2 G approved

POSIZIONATORE SMART IN ACCIAIO INOSSIDABILE

SMART POSITIONERS – STAINLESS STEEL

POSIZIONATORE SMART ANTI DEFLAGRANTE
EEx d IIB T6 Certificato ATEX II 2 G

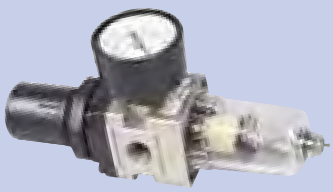
Smart Positioners – Opzioni disponibili
Trasmettitore di posizione per Smart
Protocollo Hart per Smart
Fine corsa per Smart

SMART POSITIONERS – EXPLOSION PROOF
EEx d IIB T6 ATEX II 2 G Approved

Smart Positioners – Optional Features
Smart Position Transmitter Adder
Smart Hart Protocol Adder
Smart Limit Switch Adder

NOTA
L'utilizzo di un filtro regolatore è raccomandato per un miglior e duraturo funzionamento del posizionatore!

NOTE
Important Suggestion: Use of filter regulator is the key to long life performance!



DECLUTCHABLE GEAR BOX
with unlocking system for emergency control

CARATTERISTICHE E VANTAGGI

- Riduttore manuale di dimensioni contenute e leggero in peso
- Dotato di flangia integrata con foratura secondo ISO5211 per il montaggio diretto dell'attuatore
- Riduttore con doppio quadro secondo norme ISO 5211, anche per accoppiamento diretto di steli delle valvole a 45°
- Costruiti in ghisa
- Ampio range di coppe disponibili, da 300 Nm a 6000 Nm

FEATURES & BENEFITS:

- *Small in volume, light weight*
- *Equipped with integral mounting flange according to ISO5211 for an easy and cost effective actuator assembly*
- *Double Square connection according to ISO 5211, allowing for easy and direct mounting also for valves with square stem at 45°*
- *Made in Cast Iron*
- *Wide torque range from 300 Nm to 6000 Nm*

Riduttori disponibili anche per Alta e Bassa Temperatura

Declutch able gear boxes also available in High and Low Temperature

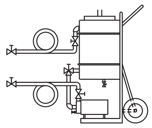
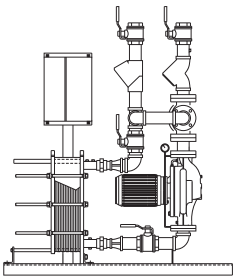
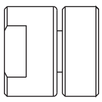
ACCESSORI
ACCESSORIES

RIDUZIONI *ADAPTERS*	FILTRI RIDUTTORI *FILTRI REHOLATORS*	STAFFE E PROLUNGHE *BRACKET & COUPLINGS*
		

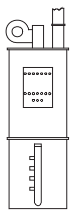
Hot Water

Water Heaters and Water Temperature Controls ID Charts

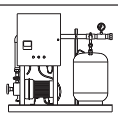
Water Heaters and Accessories

Illustration	Type	Fluid	Connection Type	Max. Allow. Press.	TMA °F	Body Material	Model	Max. Oper. Press.	Connection Size	Located on Page
	**Clean-In-Place** Scale Removal System	Rite-Qwik Scale Solvent	NPT	Atmospheric	140	Teflon Coated Cast Iron (Pump) Polypropylene (Tank) PVC (Pipe & Hose)	CIP	Atmospheric	1"	For additional information, please visit our website at **armstrong**international.com or contact your local Armstrong representative.
	**Flo-H_2O™ Water to Water** Instantaneous Water Heater (Single-Walled Plate and Frame Exchanger)	Boiler Water and Domestic Water	NPT	125 psi	200	Bronze (Valve)	40	125	2" Boiler 2" Domestic 1-1/4" Recirc.	
			NPT			Brass (Piping) Stainless Steel (Heat Exchanger Plates)	70	125	2-1/2" Boiler 2" Domestic 1-1/4" Recirc.	
			NPT			Cast Iron (Actuator)	100	125	3" Boiler 3" Domestic 1-1/4" Recirc.	
	Flo-H_2O™ Water to Water Instantaneous Water Heater (Double-Walled Plate and Frame Exchanger)	Boiler Water and Domestic Water	NPT	125 psi	200	Bronze (Valve)	40	125	2" Boiler 2" Domestic 1-1/4" Recirc.	
			NPT			Brass (Piping) Stainless Steel (Heat Exchanger Plates)	70	125	2-1/2" Boiler 2" Domestic 1-1/4" Recirc.	
			NPT			Cast Iron (Actuator)	100	125	3" Boiler 3" Domestic 1-1/4" Recirc.	
	**MS-6 Noiseless Heater**	Steam	NPT	100 psi	190	304 Stainless Steel	MS-6	100	1/2", 3/4", 1", 1-1/4", 1-1/2", 2"	549

Flo-Direct®

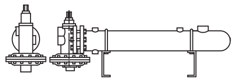
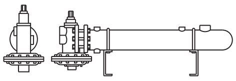
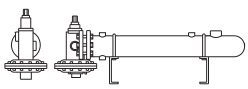
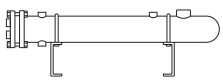
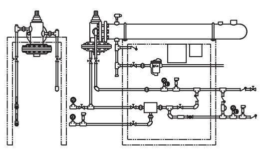
Illustration	Type	Fluid	Conn. Type		Body Material	Model	Gas Conn.	Water Conn.	
			Gas	Water					
	**Flo-Direct** Direct Fired Water Heater	Natural Gas and Water	NPT	NPT	Stainless Steel	1000	1"	1"	524
						1500	1"	1"	
						3000	1-1/2"	1-1/2"	
						5000	2"	2-1/2"	
						7000	2"	3"	
						9000	2-1/2"	3"	
				ANSI 150# Flanged		11000	3"	4"	
						15000	3"	4"	
						18000	3"	4"	
			Buttweld			25000	4"	6"	

VFD Pump Package

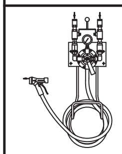
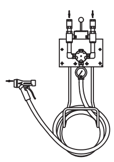
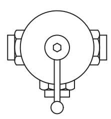
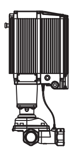
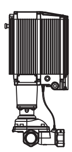
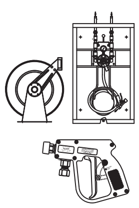
Illustration	Type	Fluid	Conn. Type		Body Material	Model	Water Conn.		
			Gas	Water			Inlet	Outlet	
	**VFD** Pump Package	Water	ANSI 150# Flanged	NPT	Cast Iron/ Bronze Fitted	VFD-50	1-1/2"	2"	531
						VFD-100	3"	2 1/2"	
						VFD-175	3"	3"	
				ANSI 150# Flanged		VFD-250	3"	4"	

Water Heaters and Water Temperature Controls ID Charts

Flo-Rite-Temp™

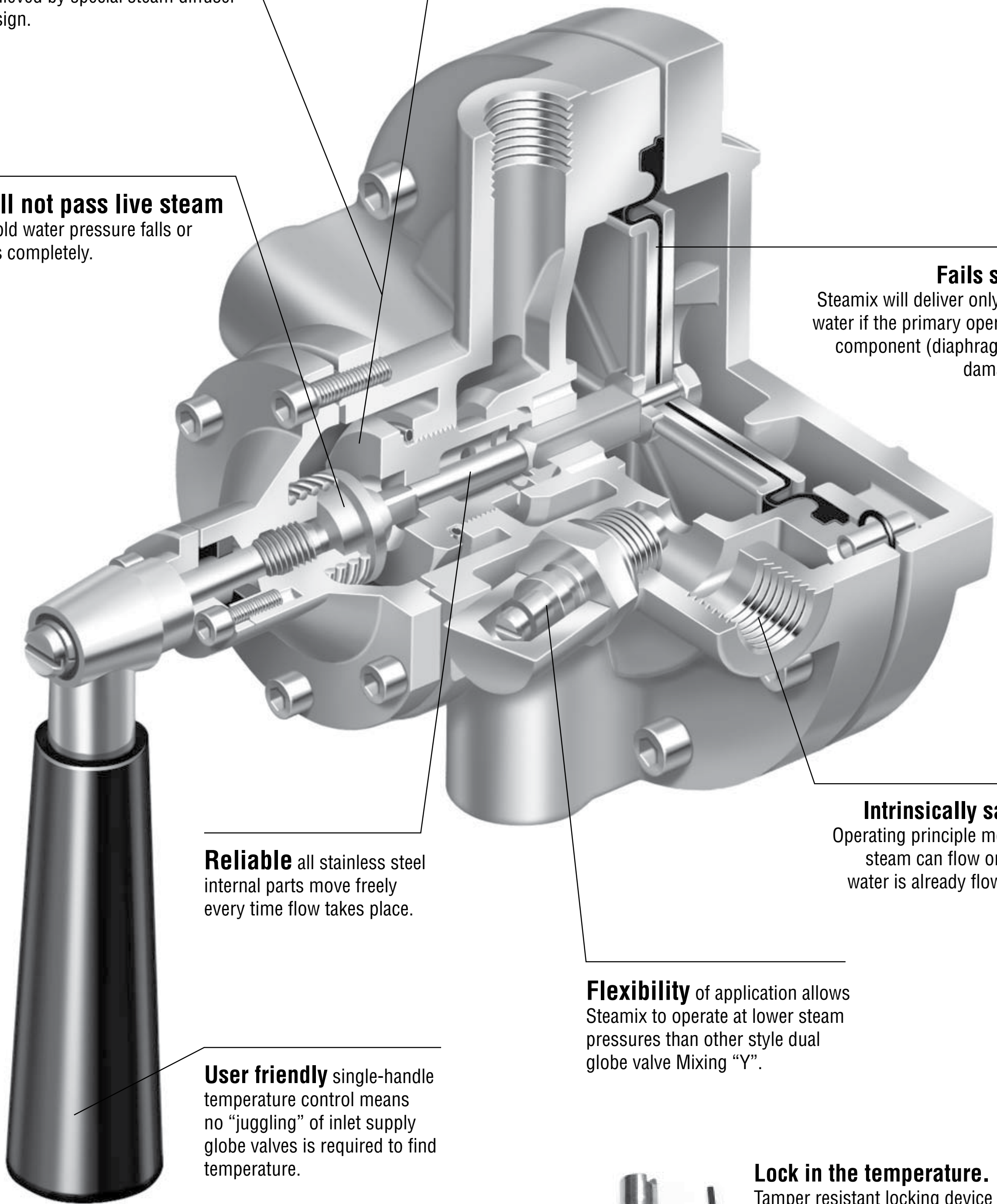
Illustration	Type	Fluid	Connection Type	Max. Allow. Press.	TMA °F	Body Material	Model	Max. Oper. Press.	Connection Size	Located on Page
	**Flo-Rite-Temp Steam to Water** Instantaneous Water Heater (Single-Walled Exchanger)	Steam and Water	NPT	150 psi (Steam) 225 psi (Water)	300	Bronze (Valve) Carbon Steel Shell with Admiralty Brass Tube Bundle (Heat Exchanger)	415	125	1" Water	For additional information, please visit our website at **armstrong**international.com or contact your local Armstrong representative.
								15	2" Steam	
			NPT				535	125	1-1/2" Water	
								15	2-1/2" Steam	
			NPT				665	125	2" Water	
								15	3" Steam	
			NPT (Water) ANSI 150 (Steam)				8120	125	3" Water	
								15	4" Steam	
	**Flo-Rite-Temp Steam to Water** Instantaneous Water Heater (Double-Walled Exchanger)	Steam and Water	NPT	150 psi (Steam) 225 psi (Water)	300	Bronze (Valve) Carbon Steel Shell with Copper Tube Bundle (Heat Exchanger)	415DW	125	1" Water	
								15	2" Steam	
			NPT				535DW	125	1-1/2" Water	
								15	2-1/2" Steam	
			NPT				665DW	125	2" Water	
								15	3" Steam	
			NPT (Water) ANSI 150 (Steam)				8120DW	125	3" Water	
								15	4" Steam	
	**Flo-Rite-Temp Steam to Water** Instantaneous Water Heater (Single-Walled, All Stainless Steel Wetted Parts)	Steam and Water	NPT	150 psi (Steam) 225 psi (Water)	300	316 Stainless Steel (Valve) Carbon Steel Shell with 316L Stainless Steel Tube Bundle (Heat Exchanger)	665 SS	125	2" Water	
								15	3" Steam	
			NPT (Water) ANSI 150 (Steam)				8120 SS	125	2" Water	
								15	4" Steam	
	**Flo-Rite-Temp Shell and Tube** Steam to Water Instantaneous Heat Exchanger	Steam and Water	NPT	150 psi (Steam) 225 psi (Water)	375	Cast Iron (Stainless Optional) (Head) Carbon Steel Shell with Admiralty Brass Tube Bundle (Stainless Optional) (Heat Exchanger)	442ST	225	1-1/4" Water	
								150	2" Steam	
			NPT				552ST	225	1-1/2" Water	
								150	2-1/2" Steam	
			NPT				662ST	225	2" Water	
								150	3" Steam	
			NPT (Water) ANSI 150 (Steam)				862ST	225	3" Water	
								150	4" Steam	
	**Flo-Rite-Temp with The Brain and Complete Building Automation System Interface Solution (BASIS)**	Steam and Water	NPT	150 psi (Steam) 225 psi (Water)	300	Bronze (Valve) Carbon Steel Shell with Admiralty Brass Tube Bundle (Heat Exchanger)	415	125	1" Water	
								15	2" Steam	
							535	125	1-1/2" Water	
								15	2-1/2" Steam	
							665	125	2" Water	
								15	3" Steam	
			NPT (Water) ANSI 150 (Steam)				8120	125	3" Water	
								15	4" Steam	

Industrial Sanitation, Safety & Process Control ID Charts

Illustration	Type	Connections NPT	Body Material	Model	Max. Flow Rate gpm	Max. Inlet Press. psig	Check Valves	Flow Controls	Hose Rack	Spray Nozzle	Shutdown Feature	Hose	Located on Page
STEAMIX® Hose Stations and Mixing Units													
	Steam & Water Mixing Unit	3/4"	Bronze/ Nickel Plated	VE/VES	9*	150		●	▲	▲	●	▲	539
				2030/2030S							●		
				2031/2031S				●			●		
	Steam & Water Hose Station			2032/2032S				●	●		●		
				2033/2033S				●	●	●	●	●	
Hot & Cold Hose Stations and Mixing Units													
	Hot & Cold Water Mixing Unit	3/4"	Chrome Plated Brass	3031/3031S	24†	150	S only	●			●		540
	Hot & Cold Water Hose Station			3032/3032S				●	●		●		
				3033/3033S				●	●	●	●	●	
				3401			●	●			●		
				3403			●	●	●	●	●	●	
Steam/Water Mixing Valves													
	Steam/Water Mixing Valves	1" x 1-1/4"	Chrome Plated Brass	A55	19*	100		●					For additional information, please visit our website at **armstronginternational**.com or contact your local Armstrong representative.
		1-1/2"		566	62*			●					
		2"		TS202	86*			●					
MegaMix™ Water Temperature Mixing Unit													
	Electronically Actuated Water Temperature Mixing Units	3/4" x 1"	Stainless Steel	E20W	36**	145					●		
		1" x 1-1/4"		E25W	56**						●		
		1-1/2" x 1-1/2"		E40W	88**						●		
		2" x 2-1/2"		E50W	213**						●		
		3" ASME B16.5 Class 150 Flg.		E80W	644**	232					●		
MegaMix™ Steam/Water Temperature Mixing Unit													
	Electronically Actuated Steam/Water Temperature Mixing Units	1" x 1-1/4"	Stainless Steel	E25S	36**	145					●		
		1-1/2" x 1-1/2"		E40S	60**						●		
		2" x 2-1/2"		E50S	119**						●		
Accessory Products													
	Washdown Equipment & Accessories	3/4"	Stainless Steel	F/SMCD Cabinet Assembly	—	—	●	●	●	●	●	●	
		1/2"	See Specification	038 Spray Nozzle	16	150				●			
		3/4" x 1/2"		035 Washdown Hose	—							●	
		3/4"	Enameled Steel/ Stainless Steel	047 Hose Reel	—								

▲ Possible additions for VE units.
*Valve only at 100°F
**Cold Water Capacity @ 20 psi drop.
† 45 psi pressure drop to open outlet

Steamix® - Will Not Pass Live Steam



Whisper quite operation is achieved by special steam diffuser design.

Rugged steam valve seat is made from new high-temperature-resistant polymer.

Will not pass live steam if cold water pressure falls or fails completely.

Fails safe. Steamix will deliver only cold water if the primary operating component (diaphragm) is damaged.

Intrinsically safe. Operating principle means steam can flow only if water is already flowing.

Reliable all stainless steel internal parts move freely every time flow takes place.

Flexibility of application allows Steamix to operate at lower steam pressures than other style dual globe valve Mixing "Y".

User friendly single-handle temperature control means no "juggling" of inlet supply globe valves is required to find temperature.

Lock in the temperature. Tamper resistant locking device option allows Steamix to be preset to a desired temperature and locked. Discourages adjustments by unauthorized personnel.

2-year warranty on mixing unit wetted components.

Steamix® - Steam & Water Hose Stations - Standard

Steamix - Standard

The Steamix – Standard series is supplied fully assembled and pressure tested in the following configurations.

Steamix Model 2030 - is a steam/water mixing valve of brass/stainless steel construction.

Steamix Model 2031 - is a steam/water mixing valve of brass/stainless steel construction. The valve is supplied as standard with 3/4" inlet union connections with integral strainers, an outlet ball valve for flow control and an outlet dial thermometer.

Steamix Model 2032 - is a steam/water mixing valve of brass/stainless steel construction. The valve is supplied as standard with 3/4" inlet union connections with integral strainers, an outlet ball valve for flow control and an outlet dial thermometer. The unit is supplied installed on a stainless steel hose rack.

Steamix Model 2033 (shown) - is supplied as above and also includes 25 feet of "safety yellow" washdown hose, a rubber cushioned spray nozzle with, swivel adapter and a stainless steel nozzle hook.

Steamix® - Steam & Water Hose Stations - Premium

Steamix - Premium

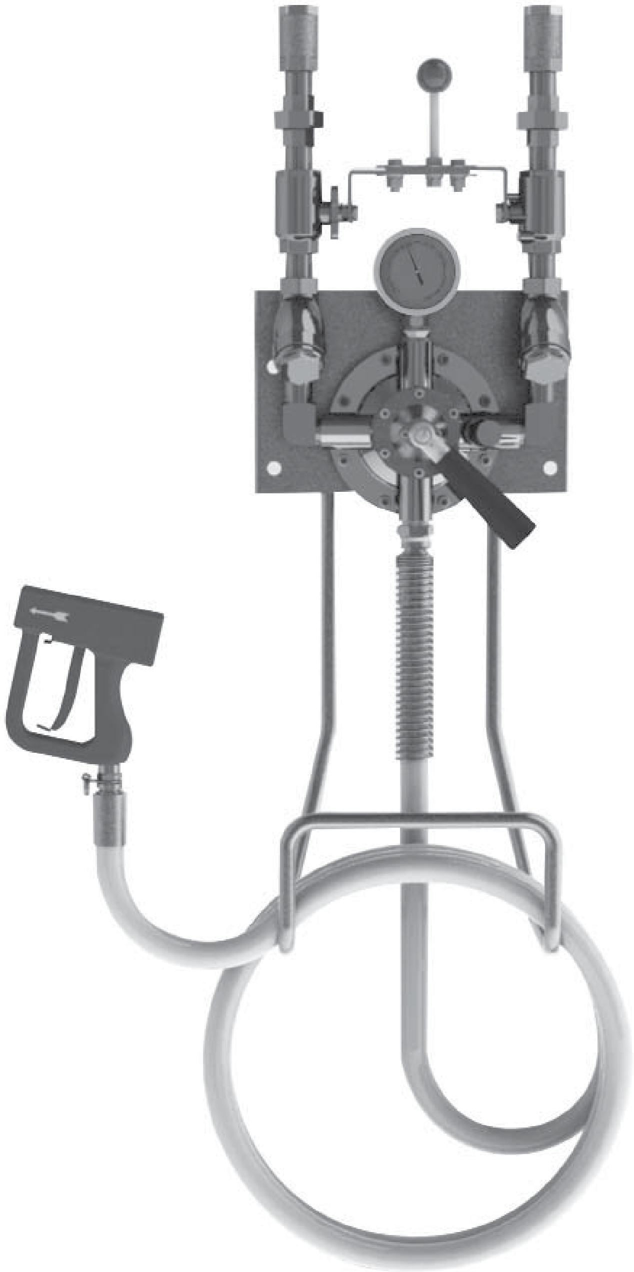
The Steamix – Premium series is supplied fully assembled and pressure tested in the following configurations.

Steamix Model 2031P - is a steam/water mixing valve of brass/stainless steel construction. The valve is supplied as standard with integral inlet supply risers comprising 3/4" Y-type strainers and 3/4" ball valves cross-linked by a stainless steel bridge piece and lever for simultaneous on/off control of both inlet supplies. The unit is supplied with stainless steel dual scale top mount Thermometer and Inlet Check Valves.

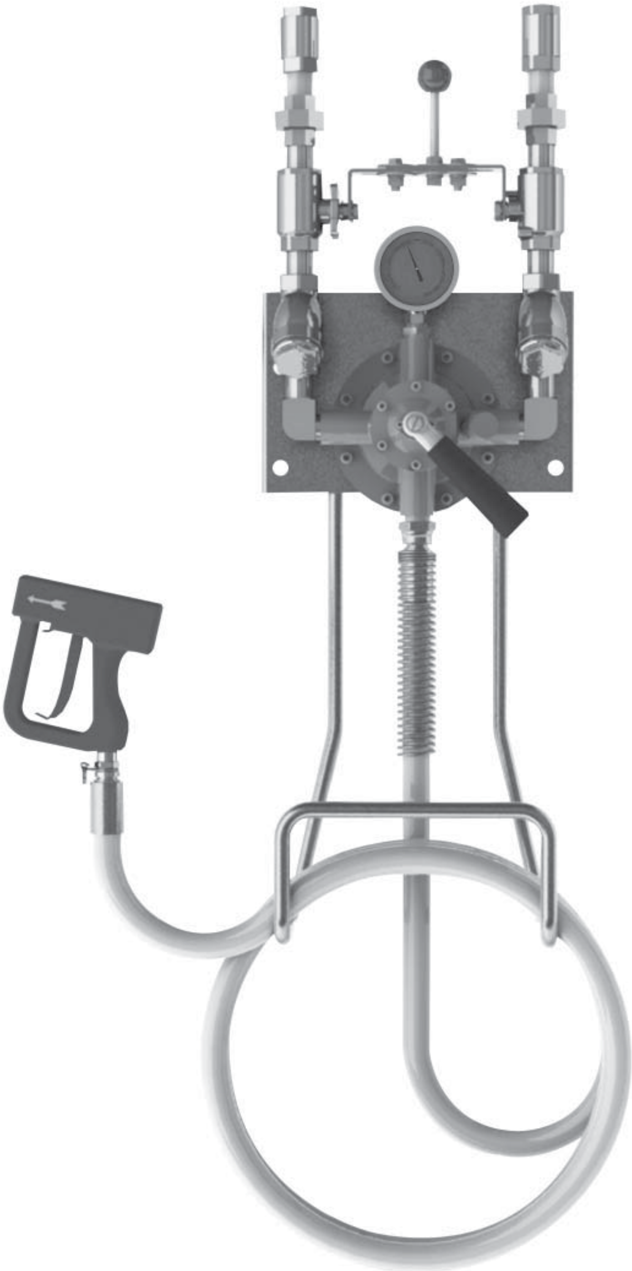
Steamix Model 2032P - is a steam/water mixing valve of brass/stainless steel construction. The valve is supplied as standard with integral inlet supply risers comprising 3/4" Y-type strainers and 3/4" ball valves cross-linked by a stainless steel bridge piece and lever for simultaneous on/off control of both inlet supplies. The unit is supplied with a stainless steel hose rack. Stainless Steel dual scale top mount Thermometer and Inlet Check Valves.

Steamix Model 2033P (shown) - is a steam/water mixing valve of brass/stainless steel construction. The valve is supplied as standard with integral inlet supply risers comprising 3/4" Y-type strainers and 3/4" ball valves cross-linked by a stainless steel bridge piece and lever for simultaneous on/off control of both inlet supplies. The unit is supplied with a stainless steel hose rack. Stainless Steel dual scale top mount Thermometer and Inlet Check Valves.

Steamix Model 2033P also includes 25 feet of “safety yellow” washdown hose rated, low-heat-transfer polymer spray nozzle with trigger guard, swivel adapter and a stainless steel nozzle hook.



Steamix® - Steam & Water Hose Stations - Stainless Steel



Steamix - Stainless Steel

The Steamix – Stainless Steel series is supplied fully assembled and pressure tested in the following configurations.

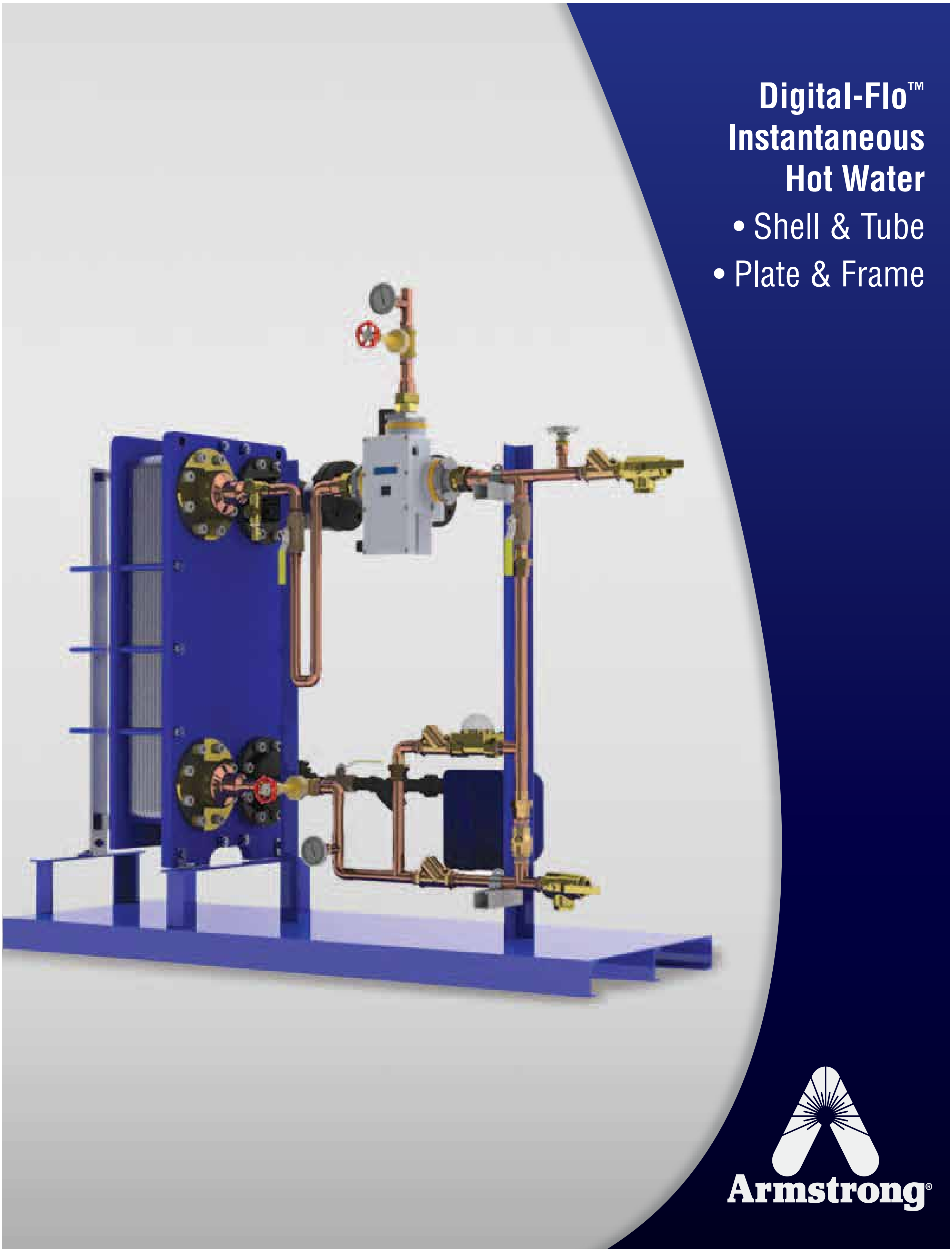
Steamix Model 2030SS - is a steam/water mixing valve of Type 304 stainless steel construction.

Steamix Model 2031SS - is a steam/water mixing valve of Type 304 stainless steel construction. The valve is supplied as standard with all stainless steel (SS) integral inlet supply risers comprising 3/4" Y-type strainers and 3/4" ball valves cross-linked by a stainless steel bridge piece and lever for simultaneous on/off control of both inlet supplies. Stainless Steel dual scale top mount Thermometer and Stainless Steel Inlet Check Valves.

Steamix Model 2032SS - is a steam/water mixing valve of Type 304 stainless steel construction. The valve is supplied as standard with all stainless steel (SS) integral inlet supply risers comprising 3/4" Y-type strainers and 3/4" ball valves cross-linked by a stainless steel bridge piece and lever for simultaneous on/off control of both inlet supplies. The unit is supplied with a stainless steel hose rack. Stainless Steel dual scale top mount Thermometer and Stainless Steel Inlet Check Valves.

Steamix Model 2033SS (shown) - is a steam/water mixing valve of Type 304 stainless steel construction. The valve is supplied as standard with all stainless steel (SS) integral inlet supply risers comprising 3/4" Y-type strainers and 3/4" ball valves cross-linked by a stainless steel bridge piece and lever for simultaneous on/off control of both inlet supplies. The unit is supplied with a stainless steel hose rack. Stainless Steel dual scale top mount Thermometer and Stainless Steel inlet Check Valves.

The STEAMIX Model 2033SS also includes 25 feet of "safety yellow" washdown hose, SS rubber cushioned spray nozzle with SS swivel adapter and a stainless steel nozzle hook.

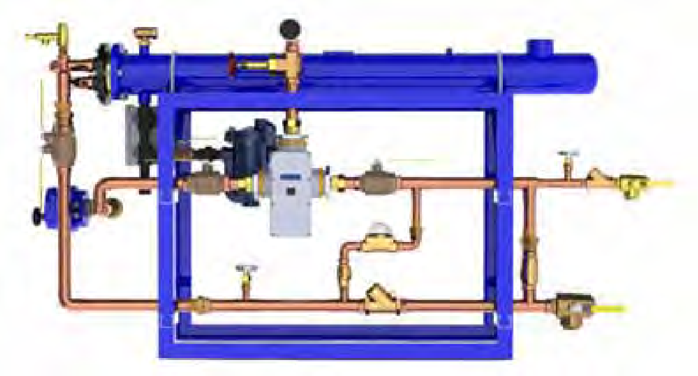

Digital-Flo™
Instantaneous
Hot Water
• Shell & Tube
• Plate & Frame
Armstrong®

Digital-Flo™ Instantaneous Hot Water

Armstrong blends revolutionary digital water temperature control technology with instantaneous heat exchanger design to deliver Digital-Flo™, an industry changing series of water heaters.

Digital-Flo Instantaneous Water Heaters refine hot water system temperature accuracy to a level previously deemed unattainable. By constantly monitoring the digital re-circulating valve (DRV 80) inlet hot, inlet cold and system return water temperatures, Digital-Flo previews the hot water system dynamics to increase the speed of response to changes in demand.

Capable of maintaining +/- 2°F/1°C temperature at system draw off between 0 and 165GPM, Digital-Flo delivers a "plug and play" hot water generation packaged solution which places efficiency, energy savings and legionella risk reduction at the forefront of hot water system design, operation and maintenance.



Digital Steam/Water - Shell & Tube

Armstrong Digital Technology

- Powered by low voltage electronics
- Faster response times eliminate the need for pneumatic controls
- Programmable high/low temperature alert function
- Programmable hot water system safety shutdown
- Component self-diagnostics
- Performance monitoring, data logging and reporting
- Integral building management system connectivity
- Simplified system commissioning

Armstrong Heat Exchange Technology

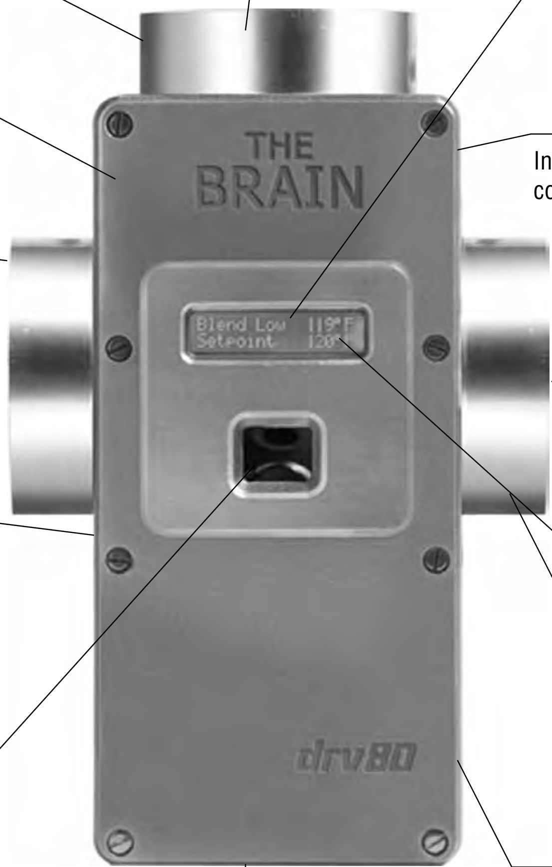
- Constant steam pressure prevents stall - no pump trap
- Low surface temperature option for hard water applications
- Instantaneous - No Storage
- Water raised above Legionella survival temperature

Digital Steam/Water - Plate & Frame
Digital Water/Water - Plate & Frame

All dimensions and weights are approximate. Use certified print for exact dimensions. Design and materials are subject to change without notice.

Digital-Flo™ Instantaneous Hot Water

Digital Controller (DRV80)



Outlet Temperature to system +/- 2°F/1°C

ASSE 1017 CSA B125 and CE certified

Self diagnostics. Digital valve runs internal component check and reports out of specification performance on display

4-20mA Connection Port

Integral relay for auxiliary connection (alarm, solenoid)

Hot water shutoff upon power failure

Port to port travel in 2.6 seconds

Serial data port for BAS Module (BrainScan™) connectivity. Transmits/receives all field programmable and LED display features

LED Display

Indicates
Set point °C or °F
Operating Temp °C or °F

IRDA Port for PC programming

Field programmable
- Set point
- High temperature alert
- High temperature hot water shutoff
- Thermal disinfection

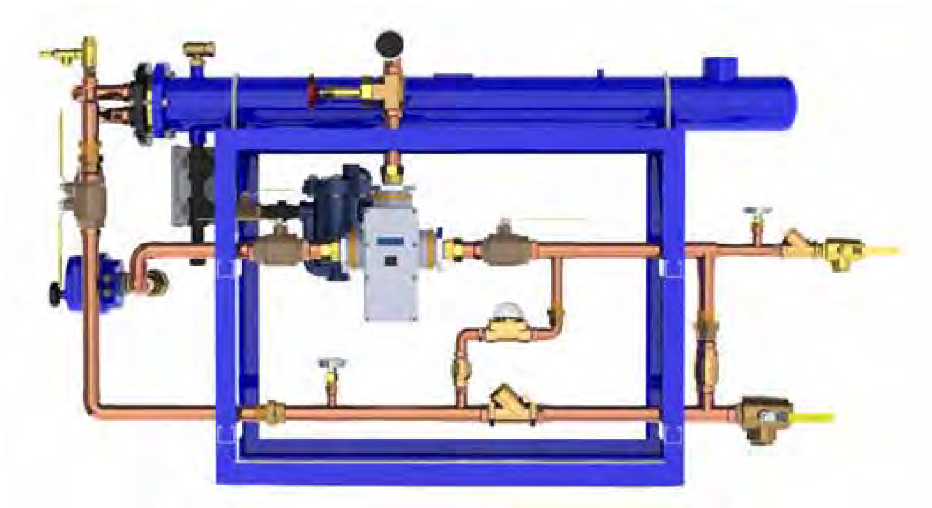
316L Stainless steel construction

Battery back-up for emergency shutdown and default setting retention

Single integral digital control valve (DRV80) REPLACES:

- Steam Control Valve
- PID Controller
- High Temperature Limit Thermostat
- High Temperature Limit Controller
- Cold Water Injection Valve
- Internal Circulating Pump
- Compressed Air Requirement

Digital-Flo™ Shell & Tube Heat Exchanger



Digital Shell & Tube

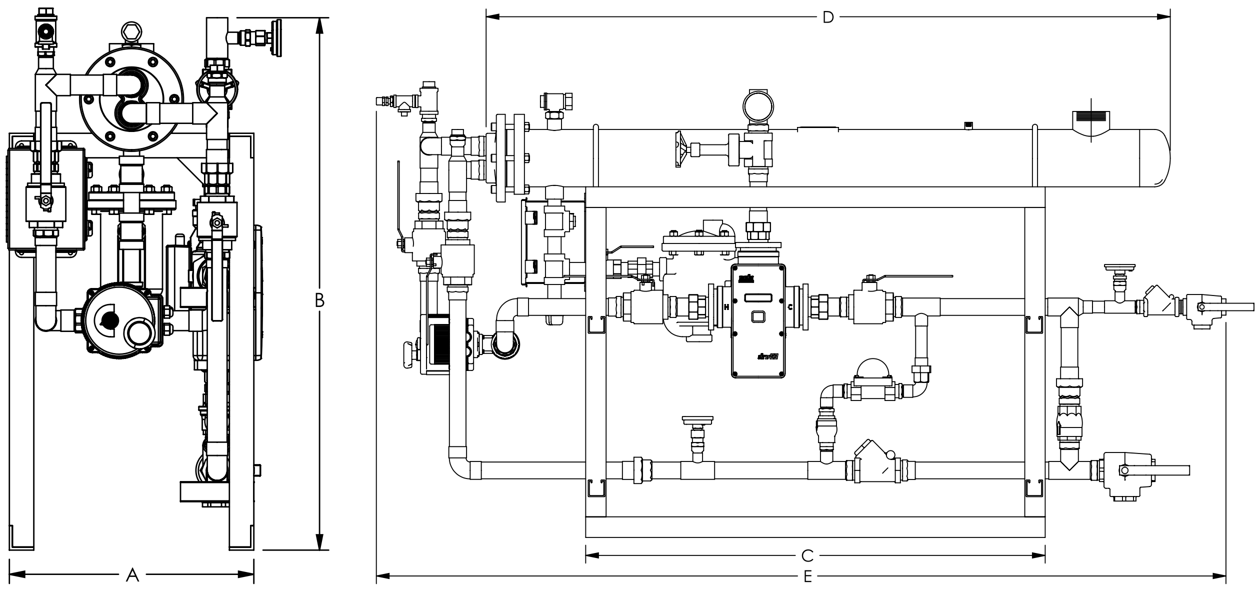
Model	Part Number	Certified Drawing	Water Side			Steam Side		
			Connections @ 7.5 ft/sec (2.3 m/s)		Flow @ 7.5 ft/sec (2.3 m/s)	Connections		Capacity @ 15 psi (1 bar)
			Hot/Cold	Recirc.	Capacity @ 100°F (55°C) Delta T	Steam Inlet	Condensate Outlet	
D535	D21983	CD2493	1.5" (40 mm)	1" (25 mm)	41.3 gpm (9.4 m3/hr)	2.5" (63.5 mm)	1" (25 mm)	2,185 lb/hr (991 kg/hr)
D535 P	D21981	CD2499	2" (50 mm)	1" (25 mm)	73.4 gpm (16.7 m3/hr)	2.5" (63.5 mm)	1" (25 mm)	3,883 lb/hr (1,761 kg/hr)
D665	D21979	CD2494	2" (50 mm)	2" (50 mm)	73.4 gpm (16.7 m3/hr)	3" (80 mm)	1.25" (32 mm)	3,883 lb/hr (1,761 kg/hr)
D665 P	D21722	CD2500	3" (80 mm)	2" (50 mm)	165.2 gpm (37.5 m3/hr)	3" (80 mm)	1.25" (32 mm)	8,741 lb/hr (3,965 kg/hr)
D8120	D21977	CD2495	3" (80 mm)	2" (50 mm)	165.2 gpm (37.5 m3/hr)	4" (102 mm)	2" (50 mm)	8,741 lb/hr (3,965 kg/hr)
D8120 P	D21640	CD2501	3" (80 mm)	2" (50 mm)	165.2 gpm (37.5 m3/hr)	4" (102 mm)	2" (50 mm)	8,741 lb/hr (3,965 kg/hr)

Digital Shell & Tube Double Wall

Model	Part Number	Certified Drawing	Water Side			Steam Side		
			Connections @ 7.5 ft/sec (2.3 m/s)		Flow @ 7.5 ft/sec (2.3 m/s)	Connections		Capacity @ 15 psi (1 bar)
			Hot/Cold	Recirc.	Capacity @ 100°F (55°C) Delta T	Steam Inlet	Condensate Outlet	
D535 DW	D21984	CD2496	1.5" (40 mm)	1" (25 mm)	41.3 gpm (9.4 m3/hr)	2.5" (63.5 mm)	1" (25 mm)	2,185 lb/hr (991 kg/hr)
D535 DW-P	D21982	CD2502	2" (50 mm)	1" (25 mm)	73.4 gpm (16.7 m3/hr)	2.5" (63.5 mm)	1" (25 mm)	3,883 lb/hr (1,761 kg/hr)
D665 DW	D21980	CD2497	2" (50 mm)	2" (50 mm)	73.4 gpm (16.7 m3/hr)	3" (80 mm)	1.25" (32 mm)	3,883 lb/hr (1,761 kg/hr)
D665 DW-P	D22000	CD2503	3" (80 mm)	2" (50 mm)	165.2 gpm (37.5 m3/hr)	3" (80 mm)	1.25" (32 mm)	8,741 lb/hr (3,965 kg/hr)
D8120 DW	D21978	CD2498	3" (80 mm)	2" (50 mm)	165.2 gpm (37.5 m3/hr)	4" (102 mm)	2" (50 mm)	8,741 lb/hr (3,965 kg/hr)
D8120 DW-P	D21975	CD2504	3" (80 mm)	2" (50 mm)	165.2 gpm (37.5 m3/hr)	4" (102 mm)	2" (50 mm)	8,741 lb/hr (3,965 kg/hr)

Maximum Allowable Steam Pressure = 15.0 psi (1 bar), Maximum Allowable Water Pressure = 150 psi (10 bar), Maximum Allowable Setpoint = 158°F (70°C)

Digital-Flo™ Shell & Tube Heat Exchanger



Dimensions and Weight						
Model	Dimensions in (mm)					Weight
	A	B	C	D	E	
D535	20.0 (508)	43.4 (1103)	45.0 (1143)	67.0 (1702)	81.2 (2062)	804
D535 DW	20.0 (508)	43.4 (1103)	45.0 (1143)	76.7 (1947)	87.4 (2220)	1080
D535 P	20.0 (508)	76.1 (1933)	45.0 (1143)	67.0 (1702)	84.6 (2149)	1234
D535 DW-P	20.0 (508)	76.1 (1933)	45.0 (1143)	76.7 (1947)	84.8 (2154)	1317
D665	30.0 (762)	45.4 (1154)	57.0 (1448)	80.0 (2032)	100.7 (2558)	1094
D665 DW	30.0 (762)	45.4 (1154)	57.0 (1448)	88.7 (2252)	101.5 (2578)	1373
D665 P	30.0 (762)	73.3 (1863)	57.0 (1448)	80.0 (2032)	100.3 (2547)	1835
D665 DW-P	30.0 (762)	73.3 (1863)	57.0 (1448)	88.7 (2252)	100.2 (2545)	1892
D8120	34.0 (864)	46.8 (1189)	57.0 (1448)	83.5 (2121)	112.8 (2865)	1507
D8120 DW	34.0 (864)	46.8 (1189)	57.0 (1448)	77.8 (1976)	113.7 (2888)	1550
D8120 P	34.0 (864)	75.9 (1929)	57.0 (1448)	83.5 (2121)	104.5 (2654)	3011
D8120 DW-P	34.0 (864)	75.9 (1929)	57.0 (1448)	77.8 (1976)	98.8 (2509)	3050

Standard Components

- Thermometers
- DRV80 Digital Recirculating Valve
- Steam Trap
- Automatic Hot Water Safety Shut Off Valve
- Sight Flow Indicator
- Check Valves
- Inlet Strainer(s)
- Isolation Valves
- Air Vent

Digital-Flo™ Plate & Frame Steam/Water Heat Exchanger

Digital Plate & Frame Steam to Water

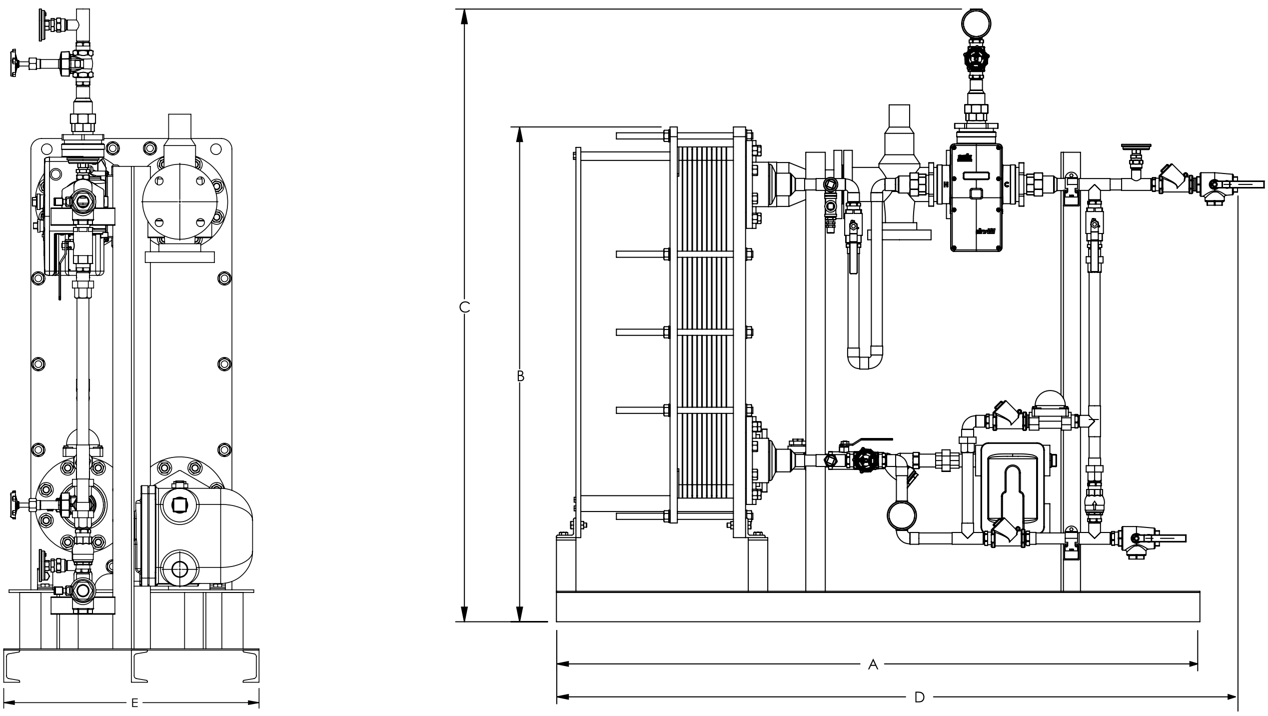
Model	Part Number	Certified Drawing	Secondary Side			Primary Side		
			Connections @ 7.5 ft/sec (2.3 m/s)		Flow @ 7.5 ft/sec (2.3 m/s)	Connections		Capacity @ 15 psi (1 bar)
			Hot/Cold	Recirc.	Capacity @ 100°F (55°C) Delta T	Steam Inlet	Condensate Outlet	
D1S	D27593	CD2508	1" (25 mm)	1" (25 mm)	18.4 gpm (4.2 m3/hr)	2.5" (63.5 mm)	1" (25 mm)	973 lb/hr (441 kg/hr)
D2S	D27594	CD2509	1.5" (40 mm)	1" (25 mm)	41.3 gpm (9.4 m3/hr)	3" (80 mm)	1.5" (40 mm)	2,185 lb/hr (991 kg/hr)
D3S	D27595	CD2510	2" (50 mm)	2" (50 mm)	73.4 gpm (16.7 m3/hr)	3" (80 mm)	1.5" (40 mm)	3,883 lb/hr (1,761 kg/hr)
D4S	D27596	CD2511	3" (80 mm)	2" (50 mm)	165.2 gpm (37.5 m3/hr)	6" (153 mm)	2" (50 mm)	8,741 lb/hr (3,965 kg/hr)

Digital Plate & Frame Steam to Water Double Wall

Model	Part Number	Certified Drawing	Secondary Side			Primary Side		
			Connections @ 7.5 ft/sec (2.3 m/s)		Flow @ 7.5 ft/sec (2.3 m/s)	Connections		Capacity @ 15 psi (1 bar)
			Hot/Cold	Recirc.	Capacity @ 100°F (55°C) Delta T	Steam Inlet	Condensate Outlet	
D1S DW	D27603	CD2518	1" (25 mm)	1" (25 mm)	18.4 gpm (4.2 m3/hr)	2.5" (63.5 mm)	1" (25 mm)	973 lb/hr (441 kg/hr)
D2S DW	D27604	CD2519	1.5" (40 mm)	1" (25 mm)	41.3 gpm (9.4 m3/hr)	3" (80 mm)	1.5" (40 mm)	2,185 lb/hr (991 kg/hr)
D3S DW	D27605	CD2520	2" (50 mm)	2" (50 mm)	73.4 gpm (16.7 m3/hr)	3" (80 mm)	1.5" (40 mm)	3,883 lb/hr (1,761 kg/hr)
D4S DW	D27606	CD2521	3" (80 mm)	2" (50 mm)	165.2 gpm (37.5 m3/hr)	6" (153 mm)	2" (50 mm)	8,741 lb/hr (3,965 kg/hr)

Maximum Allowable Steam Pressure = 15.0 psi (1 bar), Maximum Allowable Water Pressure = 150 psi (10 bar), Maximum Allowable Setpoint = 158°F (70°C)

Digital-Flo™ Plate & Frame Steam/Water Heat Exchanger



Dimensions and Weight

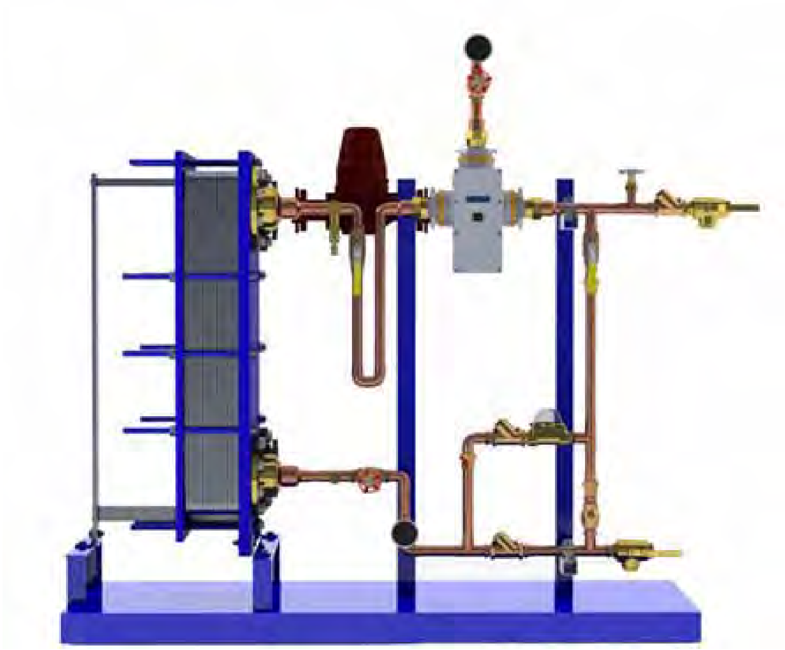
Model	Dimensions in (mm)					Weight
	A	B	C	D	E	
D1S*	66.0 (1676)	50.7 (1288)	62.8 (1595)	62.8 (1595)	24.0 (610)	Consult Factory
D2S*	66.0 (1676)	50.7 (1288)	62.8 (1595)	69.0 (1752)	24.0 (610)	Consult Factory
D3S*	66.0 (1676)	50.7 (1288)	62.8 (1595)	77.0 (1956)	24.0 (610)	Consult Factory
D4S*	78.0 (1981)	50.7 (1288)	63.5 (1613)	87.0 (2210)	24.0 (610)	Consult Factory

*Consult factory for Double Wall (DW) dimensional changes.

Standard Components

- Thermometers
- DRV80 Digital Recirculating Valve
- Steam Trap
- Automatic Steam Safety Shut Off Valve
- Sight Flow Indicator
- Check Valves
- Inlet Strainer(s)
- Isolation Valvves

Digital-Flo™ Plate & Frame Water/Water Heat Exchanger



Digital Plate & Frame Water to Water

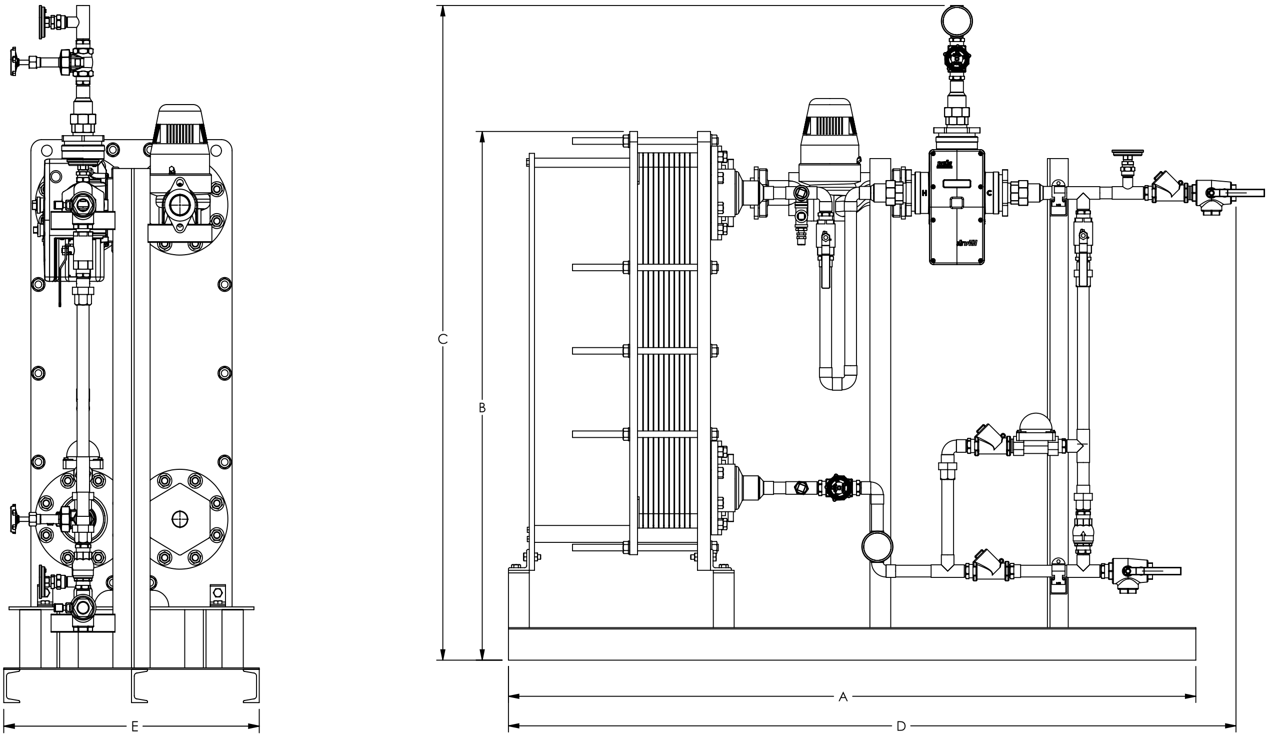
Model	Part Number	Certified Drawing	Secondary Side			Primary Side		
			Connections @ 7.5 ft/sec (2.3 m/s)		Flow @ 7.5 ft/sec (2.3 m/s)	Connections		Capacity @ 50°F (27.8°C) Delta T
			Hot/Cold	Recirc.	Capacity @ 100°F (55°C) Delta T	Boiler Inlet	Boiler Outlet	
D1W	D27598	CD2513	1" (25 mm)	1" (25 mm)	18.4 gpm (4.2 m3/hr)	1.5" (40 mm)	1.5" (40 mm)	36.8 gpm (8.4 m3/hr)
D2W	D27599	CD2514	1.5" (40 mm)	1" (25 mm)	41.3 gpm (9.4 m3/hr)	2" (50 mm)	2" (50 mm)	82.6 gpm (18.7 m3/hr)
D3W	D27600	CD2515	2" (50 mm)	2" (50 mm)	73.4 gpm (16.7 m3/hr)	3" (80 mm)	3" (80 mm)	146.8 gpm (33.3 m3/hr)
D4W	D27601	CD2516	3" (80 mm)	2" (50 mm)	165.2 gpm (37.5 m3/hr)	3" (80 mm)	3" (80 mm)	330.4 gpm (75.0 m3/hr)

Digital Plate & Frame Water to Water Double Wall

Model	Part Number	Certified Drawing	Secondary Side			Primary Side		
			Connections @ 7.5 ft/sec (2.3 m/s)		Flow @ 7.5 ft/sec (2.3 m/s)	Connections		Capacity @ 50°F (27.8°C) Delta T
			Hot/Cold	Recirc.	Capacity @ 100°F (55°C) Delta T	Boiler Inlet	Boiler Outlet	
D1W DW	D27608	CD2523	1" (25 mm)	1" (25 mm)	18.4 gpm (4.2 m3/hr)	1.5" (40 mm)	1.5" (40 mm)	36.8 gpm (8.4 m3/hr)
D2W DW	D27609	CD2524	1.5" (40 mm)	1" (25 mm)	41.3 gpm (9.4 m3/hr)	2" (50 mm)	2" (50 mm)	82.6 gpm (18.7 m3/hr)
D3W DW	D27610	CD2525	2" (50 mm)	2" (50 mm)	73.4 gpm (16.7 m3/hr)	3" (80 mm)	3" (80 mm)	146.8 gpm (33.3 m3/hr)
D4W DW	D27611	CD2526	3" (80 mm)	2" (50 mm)	165.2 gpm (37.5 m3/hr)	3" (80 mm)	3" (80 mm)	330.4 gpm (75.0 m3/hr)

Maximum Allowable Boiler Water Temperature = 250°F (121°C), Maximum Allowable Water Pressure = 150 psi (10 bar), Maximum Allowable Setpoint = 158°F (70°C)

Digital-Flo™ Plate & Frame Water/Water Heat Exchanger



Dimensions and Weight						
Model	Dimensions in (mm)					Weight
	A	B	C	D	E	
D1W*	66.0 (1676)	50.7 (1288)	62.8 (1595)	62.8 (1595)	24.0 (610)	Consult Factory
D2W*	66.0 (1676)	50.7 (1288)	62.8 (1595)	69.0 (1752)	24.0 (610)	Consult Factory
D3W*	66.0 (1676)	50.7 (1288)	64.3 (1633)	77.0 (1956)	24.0 (610)	Consult Factory
D4W*	78.0 (1981)	50.7 (1288)	67.4 (1711)	87.0 (2210)	24.0 (610)	Consult Factory

*Consult factory for Double Wall (DW) dimensional changes.

Standard Components

- Thermometers
- DRV80 Digital Recirculating Valve
- Primary Side Pump
- Sight Flow Indicator
- Check Valves
- Inlet Strainer(s)
- Isolation Valves

Digital-Flo™ Shell & Tube Steam/Water Packaged Solutions

Using quality Armstrong components, Armstrong Digital-Flo™ Heat exchangers can be packaged to meet your specific requirements. Armstrong can configure a solution for virtually any application. Best of all, Armstrong Digital-Flo Water Heating Packaged Solutions are supplied fully assembled, pressure tested and performance guaranteed.

Hot water system assessments, full turn-key installation, system optimization and financing options are also available. Contact your Armstrong representative for more information.

Shell & Tube Packaged Solutions Performance Matched Options

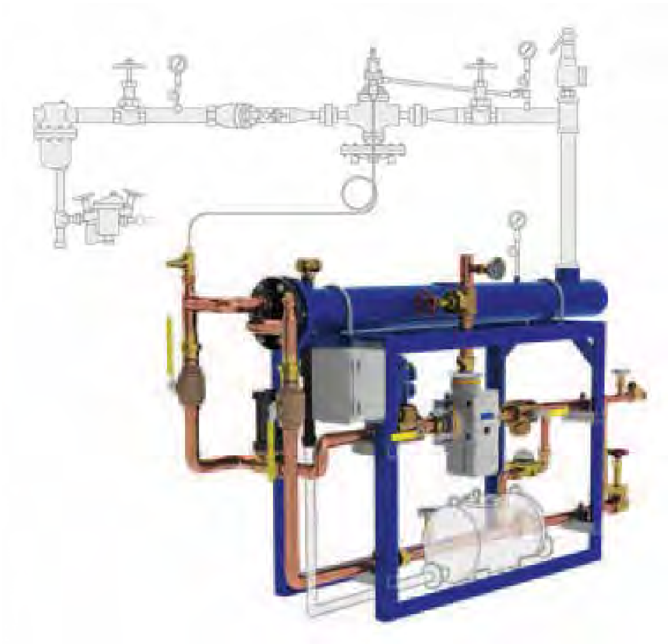
Pre-piped Pressure Reducing Station

BrainScan™ - Web-Enabled and BAS Compatible - Hot Water System Monitoring

Double Wall Tube Bundle

ASTM B 111 Brass (Standard) or 316L Stainless Steel Tube Bundle

Constant Steam Pressure



Modulating Steam Pressure

Shell & Tube Packaged Solutions Performance Matched Options

Low Surface Temperature - Modulated Steam Pressure

Pre-piped Steam Modulation Assembly

Carbon Steel (Standard) or 316L Stainless Steel Shell

Copper/Brass (Standard) or 316 Stainless Steel Pipe, Valve and Fittings

Mechanical or Electric Condensate Pumps

Digital-Flo™ Plate & Frame Steam/Water Packaged Solutions

Plate & Frame Packaged Solutions Performance Matched Options

Gasketed (Standard) or Braised Plate and Frame Module

Pre-piped Pressure Reducing Station

BrainScan™ - Web-Enabled and BAS Compatible - Hot Water System Monitoring

Constant Steam Pressure

Modulating Steam Pressure

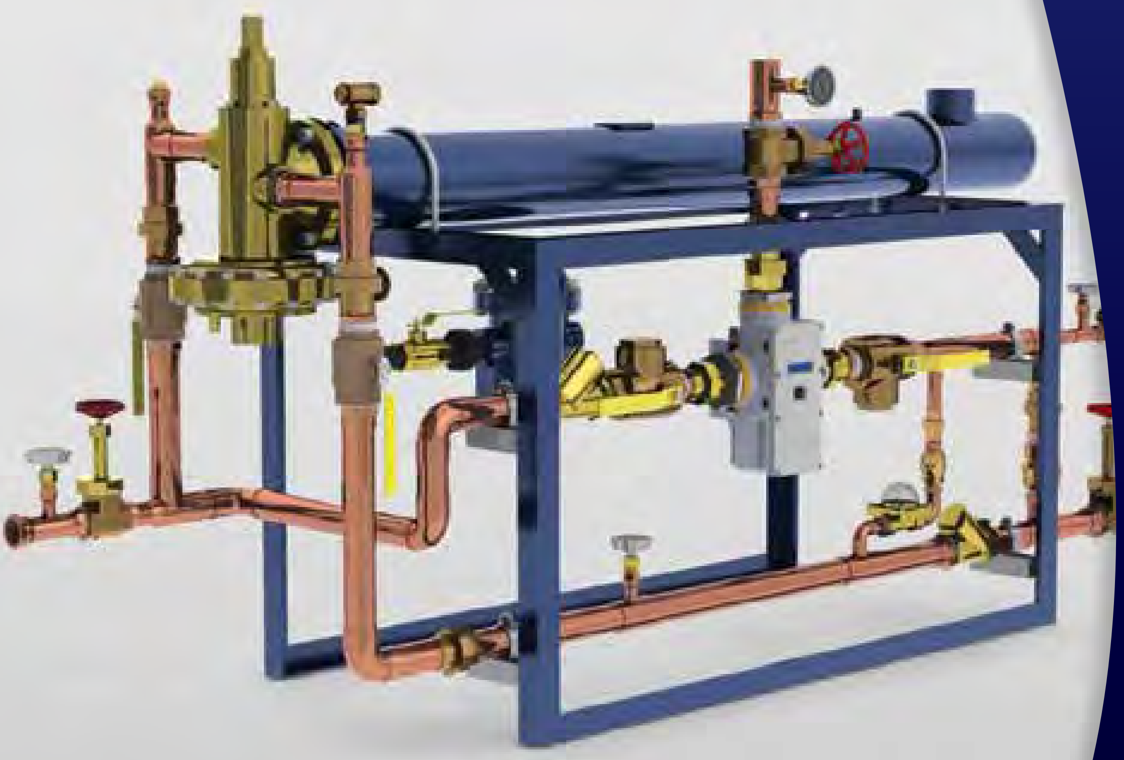
Plate & Frame Packaged Solutions Performance Matched Options

Low Surface Temperature - Modulated Steam Pressure

Double Wall Plate and Frame Module

Copper/Brass (Standard) or 316 Stainless Steel Pipe, Valve and Fittings

Mechanical or Electric Condensate Pumps



Water Heating & Water Temperature Control

- Feed Forward
- Digital

Armstrong®

Flo-Rite-Temp® Instantaneous Steam/Water Heater

Steam/Water Heaters

Steam/water heaters are typically classified as instantaneous, semi-instantaneous and tank-type. Temperature control can be defined as either feed-forward or feedback.

Feedback systems are error-driven and rely upon an outlet or downstream thermostatic temperature-sensing device to detect a temperature change requirement and then modulate the steam to effect the heat exchange in an attempt to recover the heater set-point. Feedback systems are reactive, and a significant concern is their speed of response to system and application temperature control requirements.

Tank-Type Steam/Water Heaters (feedback)

Tank-type steam/water heaters typically include a temperature sensing element or coil immersed in a storage vessel with a separate, remote steam control valve. As a function of their integral and often significant storage capability, the poor response times often associated with the relationship of temperature-sensing device and steam control valve are less of an issue.

Tank-Type Steam/Water Heaters are a less attractive option for the following reasons:

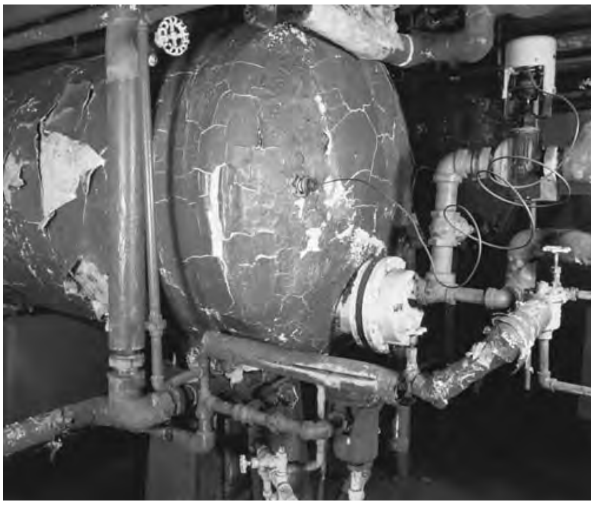
- They consume a large amount of valuable mechanical-room real estate.
- Identified as amplification and colonization points for Legionella bacteria.
- Significant leak potential over time.
- Tank repair is difficult, and tank replacement often requires mechanical room/building structural modifications.
- They consume energy to heat and maintain what is effectively a reserve hot water supply.
- Separate steam control valves, requires ongoing maintenance.
- Thermostatic element/sensors have a tendency to wear and eventually rupture under a heavy cycle load.
- They are slow to recover and may run out of hot water during peak load periods.

Tankless Instantaneous Steam/Water Heaters (feedback)

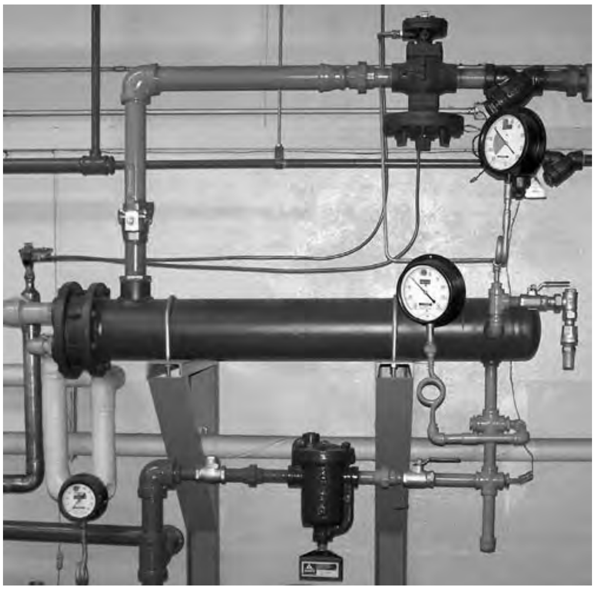
Tankless instantaneous steam/water heaters, often referred to as shell and tube heat exchangers, do not include hot water storage capacity. These models will rely upon either an outlet or downstream temperature-sensing element with a separate steam control valve.

Tankless Instantaneous Steam/Water Heaters are a less attractive option for the following reasons:

- Lag time from message (thermostat) to action (control valve) creates thermal lag and a resulting temperature swing.
- Modulating steam supply can cause condensate evacuation issues, resulting in damage from water hammer and tube bundle corrosion.
- A cycling phenomenon during low- or no-demand periods will cause premature wear to the thermostatic element. Thermostats typically fail in an open position, making overheated, scald-temperature water available to the system.



High-maintenance feedback systems with large storage tank may leak, corrode or rupture a thermostatic control.



Feedback instantaneous systems may suffer from lag time, tube bundle corrosion and problems with thermostatic element deterioration.

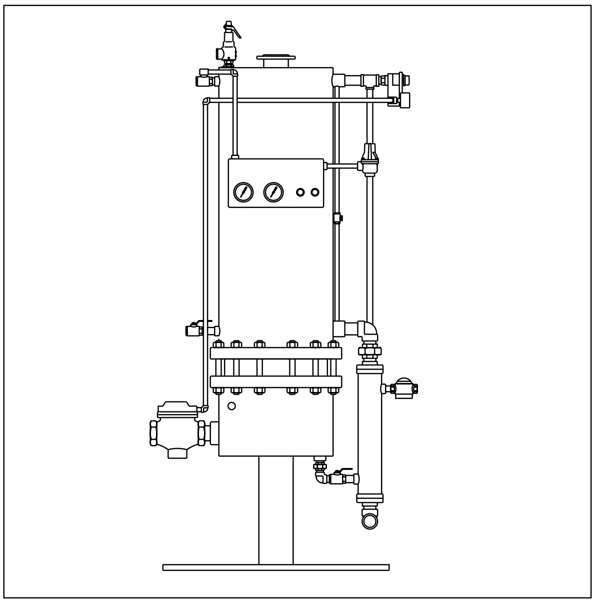
Flo-Rite-Temp® Instantaneous Steam/Water Heater

Semi-Instantaneous Steam/Water Heaters (feedback)

Semi-instantaneous steam/water heaters typically include lower-capacity storage, with an integral steam control valve to deliver the heat exchange through an internally positioned element or coil.

Semi-Instantaneous Steam/Water Heaters are a less attractive option for the following reasons:

- Poor low-flow temperature control creates an accumulation tank requirement.
- Accumulation tank creates recovery-time issues at peak demand.
- Heating element/coil in generation/accumulation tank is susceptible to failure and cross contamination.
- Accumulation tanks have been identified as amplification and colonization points for Legionella bacteria.
- Although a lower-cost option, semi-instantaneous steam/water heaters are a higher-maintenance selection.
- Semi-instantaneous steam/water heaters have a shorter service life before replacement than other choices.



Semi-instantaneous water heaters are subject to poor recovery time at peak demand, inadequate low-flow temperature control and shorter service life.

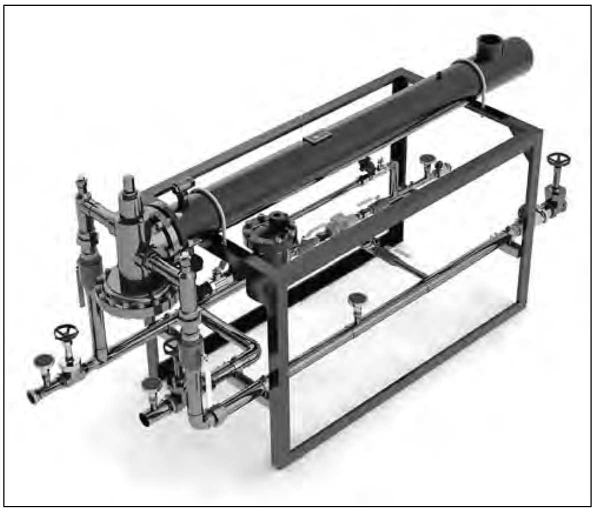
Flo-Rite-Temp® Instantaneous Steam/Water Heaters (feed-forward)

Flo-Rite-Temp® feed-forward instantaneous steam/water heaters offer a simple yet time-proven alternative to traditional feedback instantaneous, semi-instantaneous and tank-type steam-heating methods.

By eliminating the temperature sensing feedback element and relying upon the actual hot water system demand requirement within the system or application, feed-forward systems respond rapidly and are extremely accurate.

Flo-Rite-Temp® Feed-Forward Instantaneous Steam/Water Heater is a more attractive option for the following reasons:

- The constant, non-modulating steam pressure within the shell eliminates cycling wear and tear.
- The system demand or flow feed-forward activation eliminates the requirement for either a steam control valve
  or supplementary thermostatic control device.
- Flo-Rite-Temp® delivers a consistent outlet temperature (+/-4°F of set-point) with no thermal lag and resulting temperature swing.
- Flo-Rite-Temp® is extremely safe because the mixing unit will position to cold water flow upon failure of the primary operating component.



Flo-Rite-Temp® instantaneous steam/water heaters can easily do the work of a storage tank unit many times its size—at lower installed cost and with minimum maintenance. Even the largest capacity Flo-Rite-Temp® requires only 13.5 ft² (4.1 m²) of floor space.

Flo-Rite-Temp® Instantaneous Steam/Water Heater

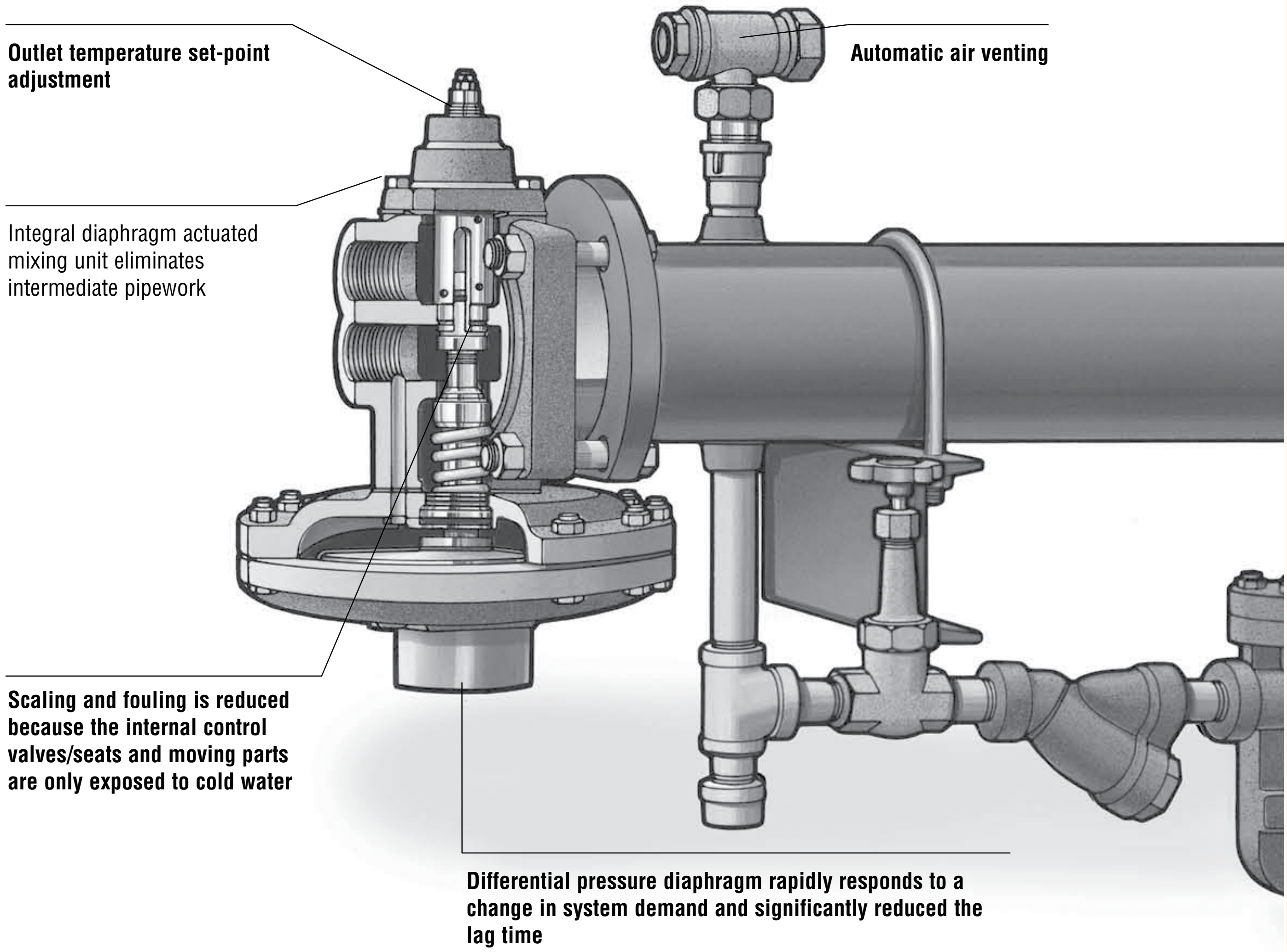
The Flo-Rite-Temp® instantaneous Steam/Water heater has a unique feed forward design which features a differential pressure diaphragm actuated mixing unit integral to a shell and tube heat exchanger.

The Flo-Rite-Temp® mixing unit manages the water flow through the heat exchanger based upon downstream hot water demand and eliminates the requirement for a modulating steam control valve.

Operating on constant low pressure (2-15PSI) steam, the Flo-Rite-Temp® mixing unit supplies water to the heat exchanger where it is overheated and then returned to the mixing unit for proportional re-mixing with cold water to a pre-set outlet temperature.

Speed of response
The differential pressure diaphragm within the mixing unit rapidly responds to a change in system demand and significantly reduces the lag times typically associated with feed back/modulating steam control valve systems.

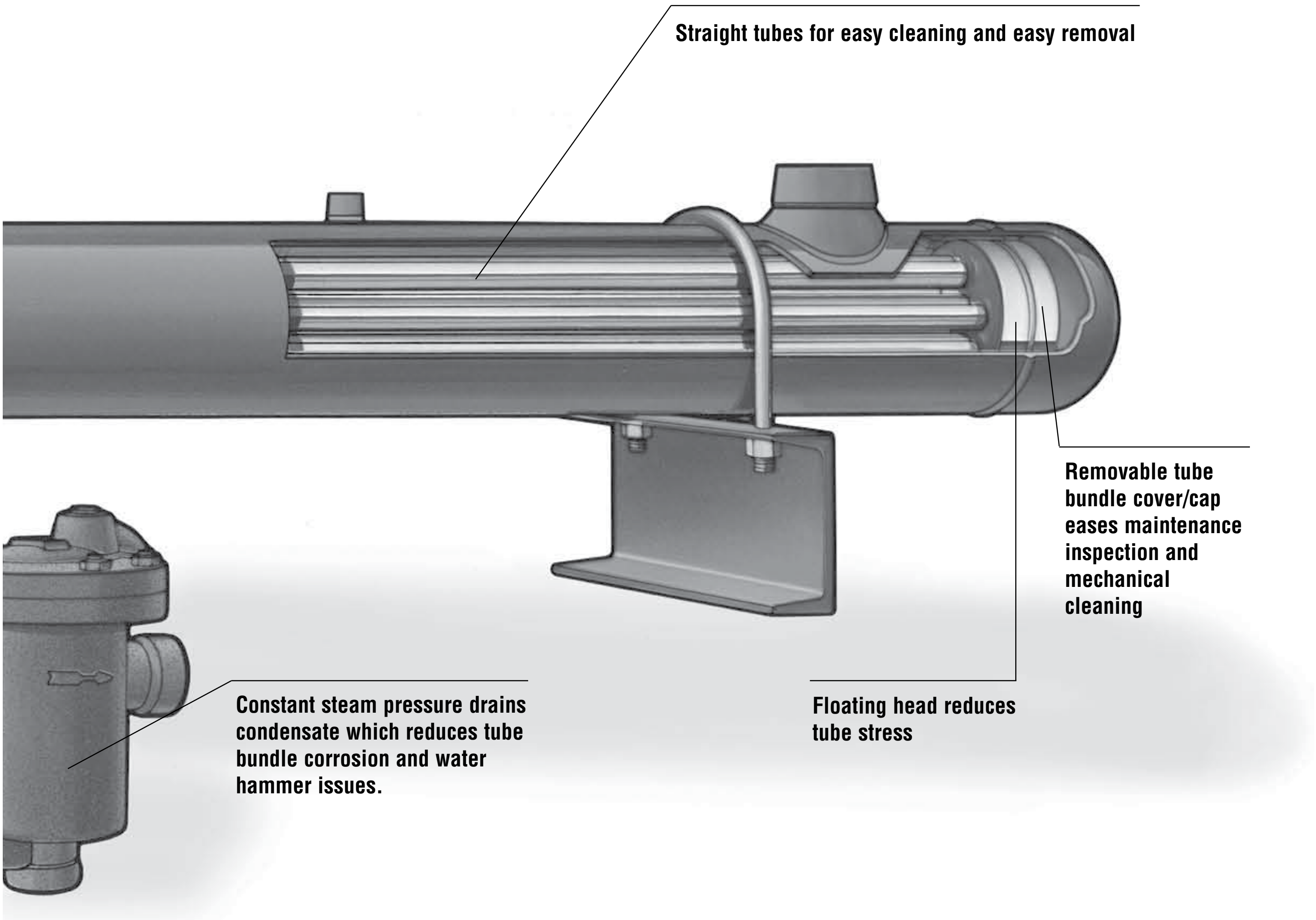
Failure Safe
The Flo-Rite-Temp® mixing units diaphragm actuated design can be described as “failure safe” because in the event of a diaphragm failure the mixing unit will fail with a cold bias and will not allow hot water to exit the heat exchanger.



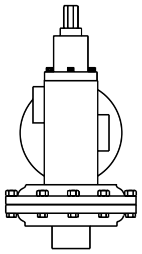
Temperature Control and User Safety
Capable of controlling outlet temperatures +/- 4F, this principal of operation offers the additional relevant benefit of reducing the waterborne bacterial content of the water during the overheating process. In addition, with no water storage requirement, Flo-Rite-Temp® water heaters are a sensible selection as a component of a broader system design initiative for Legionella risk reduction.

Ease of Maintenance
Accessible “non helical” admiralty brass straight tubes inside the carbon steel shell available mechanical cleaning and visual inspection. Non modulating constant steam pressure ensures condensate drainage and removes the potential for water hammer damage and corrosion. There in no steam control valve to maintain and typically no supplemental condensate return equipment required.

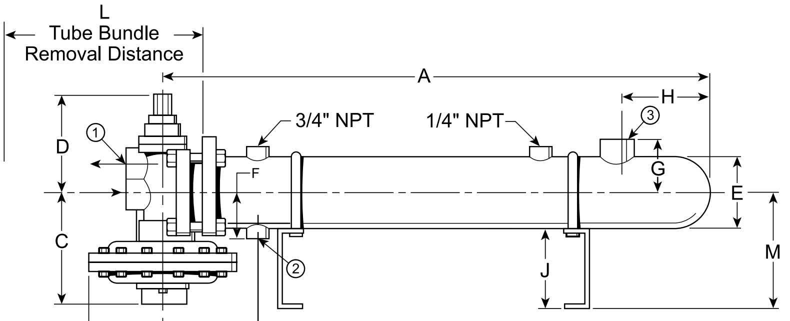
Ease of Installation
No storage tank, small footprint, access via a standard doorway and pre-piped packaged solutions reduce installation time, space and expenditure.



Flo-Rite-Temp® Instantaneous Steam/Water Heater



Model 665 and 8120 Valve



Model 415 and 535 profile shown; 665 and 8120 profile shows that connections for water inlet and outlet are on opposite sides of the valve body.

Dimensions

Model	A		B		C		D		E		F		G		H		J		K		L		M	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
415	54	1,372	4-1/2	114	7-1/2	190	7	178	4-1/2	114	3-5/16	84	3	76	7	178	6	152	6-1/4	159	50	1,270	7-1/2	190
535	67-1/2	1,715	5-1/4	133	8-5/8	219	9	229	5-9/16	141	4	102	3-11/16	94	7-7/8	200	7	178	7-1/2	191	62	1,575	9	229
665	82	2,083	5-3/4	146	10-3/8	264	10-3/8	264	6-5/8	168	4-5/8	117	4-9/16	116	9-1/4	235	8	203	8-3/4	222	74	1,880	11	280
8120	85	2,159	5-3/4	146	11-3/4	299	12	305	8-5/8	219	6	152	8-7/8	225	9-1/2	241	8	203	9-1/2	241	74	1,880	12-3/8	314

Connections and Weights

Model	Connections			Weight	
	1	2	3		
	in (mm)	in (mm)	ib (mm)	lb	kg
415	1 (25) NPT	3/4 (20) NPT	2 (50) NPT	133	60
535	1-1/2 (40) NPT	1 (25)NPT	2-1/2 (65) NPT	235	107
665	2 (50) NPT*	1-1/4 (32) NPT	3 (80) NPT	358	162
8120	3 (80) NPT*	2 (50) NPT	4 (100) 150# ANSI	585	265

*665 and 8120 connections for water inlet and outlet are on opposite sides of the valve body.

Specifications

Application	Steam Supply Pressure	Water Supply Pressure	Maximum Water Pressure Drop
Steam to Water	2 - 15 psig (0.14 - 1.0 bar)	20-150 psig (1.4 - 1.0 bar)	10 psig (0.7 bar)

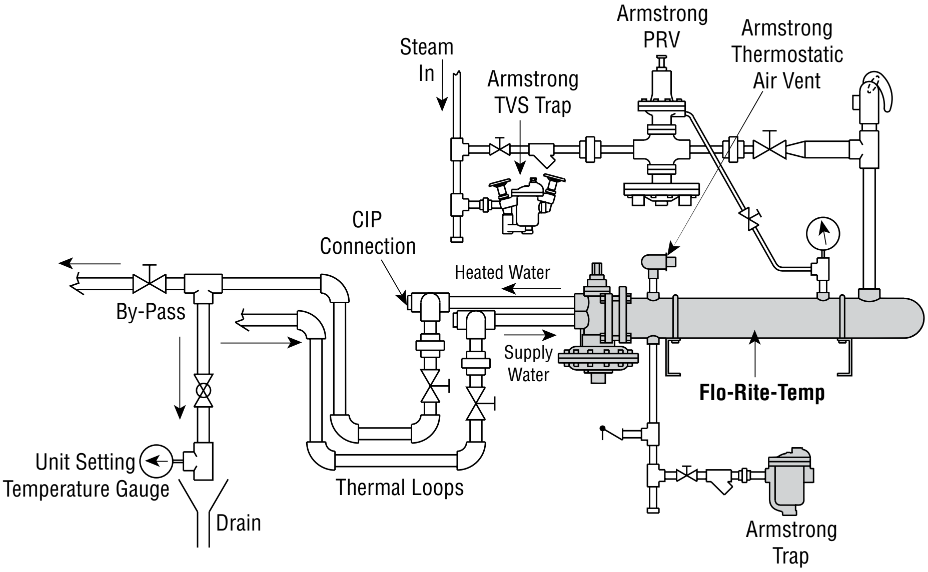
NOTE: Reusable insulation wraps available.

Materials

Body	Valve	Valve Seats	Diaphragm	Heat Exchanger Shell	Heat Exchanger Tubles	Tube Sheets	Tube Bundle End Cap
Bronze	(415) 303 Stainless Steel w/ Teflon Inserts	(415/535) 303 Stainless Steel	Viton® GF Reinforced w/Nomex® Fiber	Carbon Steel ASTM SA 106-B ASME "U" Stamped	5/8" 16 BWG Admiralty Brass	Brass	Brass
	(535/665/8120) Brass	(665/8120) Brass					

NOTE: Units are NSF-61 certified.

Flo-Rite-Temp® Instantaneous Steam/Water Heater

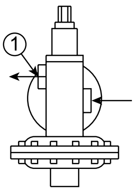


Water Heater Installation Detail

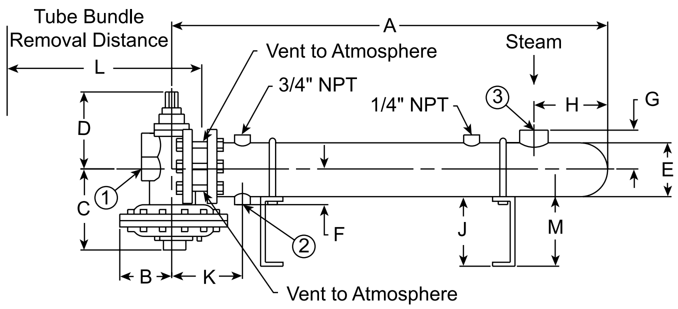
The Flo-Rite-Temp® models identified in the submittal table below are provided, as standard, with an Armstrong steam trap and thermostatic air vent (shaded). All other items indicated, are shown for water heater installation detail only. For pre-piped packaged Flo-Rite-Temp® water heater assemblies, refer to pages 14-26.

For submittal drawing refer to:		
Model 415	Single Wall	S5640
Model 415DW	Double Wall	S5641
Model 535	Single Wall	S5642
Model 535 DW	Double Wall	S5643
Model 665	Single Wall	S5644
Model 665DW	Double Wall	S5645
Model 665SS	Stainless Steal	S5646
Model 8120	Single Wall	S5647
Model 8120DW	Double Wall	S5648
Model 8120SS	Stainless Steel	S5649

Flo-Rite-Temp® Instantaneous Steam/Water Heater Double Wall



Model 665DW and 8120DW Valve



Model 415DW and 535DW Profile

The DW (double wall) version of the Flo-Rite-Temp® instantaneous water heater uses a double-wall tube to provide positive separation of the steam and water in the heat exchanger. The area between the walls of the tubes vents to atmosphere so you can detect tube failure without cross-contaminating either the steam or water. The Flo-Rite-Temp® DW is well suited for all hot water applications where steam is available and plumbing codes or safety requirements prevent the heating medium and the potable water supply from being cross-contaminated.

Specifications

Application	Steam Supply Pressure	Water Supply Pressure	Maximum Water Pressure Drop
Steam to Water	2 - 15 psig (0.14 - 1.0 bar)	20 - 150 psig (1.4 - 10.3 bar)	10 psig (0.7 bar)

Connections and Weights

Model	Connections			Tube Bundle Removal		Weight	
	1	2	3				
	in (mm)	in (mm)	in (mm)	in	mm	lb	kg
415DW	1 (25) NPT	3/4 (20) NPT	2 (50) NPT	75	1,905	199	90
535DW	1-1/2 (40) NPT	1 (25) NPT	2-1/2 (65) NPT	75	1,905	270	122
665DW	2 (50) NPT*	1-1/4 (32) NPT	3 (80) NPT	87	2,210	444	201
8120DW	3 (80) NPT*	2 (50)	4 (100) 150# ANSI	75	1,905	665	302

*665 and 8120 connections for water inlet and outlet are on opposite sides of the valve body.

Materials

Body	Valve	Valve Seats	Diaphragm	Heat Exchanger Shell	Heat Exchanger Tubes	Tube Sheets*
Bronze	(415DW) 303 Stainless Steel w/Teflon Inserts	(415DW/535DW) 303 Stainless Steel	Viton® GF Reinforced w/ Nomex® GF	Carbon Steel ASTM SA 106-B ASME "U" Stamped	5/8" Copper Inner Tube 3/4" ID Grooved Copper Outer Tube	Steam Side Steel Water Side Brass
	(535DW/665DW/812DW) Brass	(665DW/8120DW) Brass				

*There is an open vent to atmosphere between the tube sheets to detect tube failure.

Dimensions

Model	A		B		C		D		E		F		G		H		J		K		L		M	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
415DW	76-1/8	1,934	4-1/2	114	7-1/2	191	7	178	4-1/2	114	3-3/8	86	3-3/4	95	10-1/2	267	6	152	6-7/8	175	75	1,905	7-1/2	190
535DW	77-3/8	1,965	5-1/4	133	8-5/8	219	9	229	5-9/16	141	4	102	4-1/4	108	11-1/2	292	7	178	8-1/8	206	75	1,905	9	229
665DW	90-5/8	2,302	5-3/4	146	10-3/8	264	10-3/8	264	6-5/8	168	7-3/4	121	5	127	11-3/4	298	8	203	9-3/4	248	87	2,210	11	280
8120DW	79-7/8	2,029	5-3/4	146	11-3/4	198	12	305	8-5/8	219	6	152	8-3/4	222	12-5/8	321	8	203	11-5/8	295	75	1,905	12-3/8	314

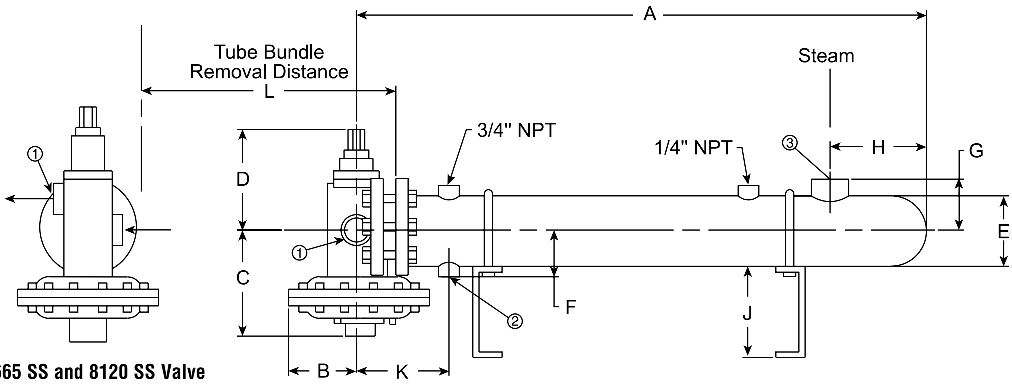
Flo-Rite-Temp® Instantaneous Steam/Water Heater
Single Wall and Double Wall Sizing Chart

Water and Steam Capacities

Inlet Temp.	Set Temp.	Standard								Inlet Temp.	Set Temp.	Metric								Model
		Hot Water Capacities*				Steam Capacities						Hot Water Capacities*				Steam Capacities				
		Steam Pressure				Steam Pressure						Steam Pressure				Steam Pressure				
		psig				psig						bar				bar				
°F	°F	2	5	10	15	2	5	10	15	°C	°C	0.14	0.35	0.7	1	0.14	0.35	0.7	1	
		gpm				lbs/hr						m³/h				kg/h				
40	120	17	18	20	20	714	767	839	901	4	49	3.8	4.1	4.5	4.5	323	347	379	407	415
		37	40	43	43	1,543	1,657	1,814	1,946			8.4	9.1	9.8	10.2	697	749	820	880	535
		69	74	80	80	2,855	3,067	3,356	3,601			15.7	16.8	18.2	18.2	1,290	1,386	1,517	1,628	665
		142	145	145	145	5,680	6,160	6,760	7,160			32.2	32.9	32.9	32.9	2,576	2,794	3,066	3,248	8120
	130	15	16	17	18	681	734	807	868		54	3.4	3.6	3.8	4.1	308	332	365	392	415
		32	34	37	39	1,472	1,587	1,743	1,876			7.3	7.7	8.4	8.8	665	717	788	848	535
		58	63	68	73	2,723	2,936	3,226	3,472			13.2	17.3	15.4	16.6	1,230	1,327	1,458	1,569	665
		112	122	136	145	5,040	5,490	6,120	6,705			25.4	27.7	30.9	32.9	2,286	2,490	2,776	3,041	8120
	140	12	13	15	16	646	700	773	835		60	2.7	3.0	3.4	3.6	292	316	349	377	415
		27	29	32	34	1,397	1,513	1,671	1,804			6.1	6.6	7.3	7.7	631	684	755	815	535
		50	54	59	63	2,585	2,799	3,091	3,338			11.3	12.2	13.3	14.3	1,168	1,265	1,397	1,509	665
		88	97	109	120	4,400	4,850	5,450	6,000			20.0	22.0	24.7	27.2	1,996	2,200	2,472	2,722	8120
	160	9	10	11	12	572	627	702	765		71	2.0	2.3	2.5	2.7	259	283	317	346	415
		20	22	24	26	1,235	1,355	1,517	1,652			4.5	5.0	5.5	5.9	558	612	686	747	535
		37	40	45	48	2,286	2,508	2,806	3,057			8.4	9.1	10.2	10.9	1,033	1,134	1,268	1,382	665
		69	83	89	95	4,140	4,980	5,340	5,700			15.6	18.8	20.2	21.6	1,878	2,259	2,422	2,585	8120
	180	5	5	6	7	344	386	441	487		82	1.1	1.1	1.4	1.6	156	175	200	221	415
		12	13	15	16	861	966	1,104	1,219			2.7	3.0	3.4	3.6	390	438	501	553	535
		23	26	29	32	1,663	1,866	2,134	2,355			5.2	5.9	6.6	7.3	754	846	968	1,068	665
		43	47	52	59	3,010	3,290	3,640	4,130			9.7	10.7	11.8	13.4	1,363	1,492	1,651	1,873	8120
50	120	19	20	20	20	692	745	816	877	10	49	4.3	4.5	4.5	4.5	313	337	369	396	415
		41	44	45	45	1,495	1,609	1,764	1,896			9.3	10.0	10.2	10.2	676	727	797	857	535
		76	80	80	80	2,767	2,977	3,264	3,508			17.3	18.2	18.2	18.2	1,251	1,346	1,475	1,586	665
		145	145	145	145	5,740	6,090	6,580	7,035			32.2	32.2	32.2	32.2	2,603	2,762	2,985	3,191	8120
	130	16	17	19	20	660	712	785	846		54	3.6	3.8	4.3	4.5	298	322	355	382	415
		34	37	40	43	1,425	1,539	1,695	1,827			7.7	8.4	9.1	9.8	644	696	766	826	535
		64	68	75	80	2,637	2,848	3,137	3,381			14.5	15.4	17.0	18.2	1,192	1,287	1,418	1,528	665
		127	138	145	145	5,080	5,520	6,120	6,760			28.8	31.3	32.2	32.2	2,304	2,504	2,776	3,066	8120
	140	13	14	16	17	626	679	752	813		60	2.9	3.2	3.6	3.8	283	307	340	367	415
		29	31	34	37	1,352	1,467	1,624	1,756			6.6	7.0	7.7	8.4	611	663	734	794	535
		54	58	64	68	2,502	2,715	3,005	3,250			12.2	13.2	14.5	15.4	1,131	1,227	1,358	1,474	665
		99	108	121	134	4,455	4,860	5,445	6,030			22.5	24.5	27.5	30.4	2,021	2,204	2,470	2,735	8120
	160	10	11	12	13	553	608	682	744		71	2.3	2.5	2.7	3.0	250	275	308	336	415
		21	23	25	28	1,194	1,313	1,473	1,607			4.7	5.2	5.7	6.4	540	593	665	726	535
		39	42	47	51	2,210	2,429	2,725	2,974			8.9	9.5	10.7	11.6	999	1,098	1,232	1,344	665
		76	90	95	102	4,180	4,950	5,225	5,610			17.2	20.4	21.6	23.1	1,896	2,245	2,370	2,545	8120
	180	5	6	6	7	332	373	428	473		82	1.1	1.4	1.4	1.6	151	169	194	214	415
		12	14	16	17	831	934	1,071	1,185			2.7	3.2	3.6	3.9	377	424	486	537	535
		24	27	30	33	1,605	1,805	2,069	2,289			5.4	6.1	6.8	7.5	728	819	938	1,037	665
		49	55	63	72	3,185	3,575	4,095	4,680			11.1	12.5	14.3	16.3	1,445	1,622	1,857	2,123	8120
60	130	18	19	20	20	638	690	762	822	16	54	4.1	4.3	4.5	4.5	288	312	344	372	415
		38	41	45	45	1,378	1,491	1,646	1,777			8.7	9.3	10.2	10.2	623	674	744	803	535
		70	76	80	80	2,550	2,760	3,046	3,288			15.9	17.3	18.2	18.2	1,152	1,247	1,377	1,486	665
		145	145	145	145	5,110	5,465	6,090	6,510			32.2	32.2	32.2	32.2	2,318	2,524	2,762	2,953	8120
	140	15	16	17	19	605	658	729	790		60	3.4	3.6	3.8	4.3	273	297	330	357	415
		32	34	38	40	1,307	1,421	1,576	1,708			7.3	7.7	8.6	9.1	591	642	712	772	535
		58	63	69	75	2,418	2,629	2,917	3,160			13.2	14.3	15.7	17.0	1,093	1,188	1,318	1,428	665
		111	123	137	145	4,440	4,920	5,480	6,080			25.2	27.9	31.1	32.2	2,014	2,232	2,486		8120
	160	10	11	13	14	533	588	661	723		71	2.3	2.5	2.9	3.2	241	266	299	327	415
		22	24	27	30	1,152	1,270	1,428	1,561			5.0	5.5	6.1	6.8	521	574	645	706	535
		41	45	50	55	2,132	2,349	2,642	2,889			9.3	10.2	11.3	12.5	964	1,062	1,194	1,306	665
		85	99	104	115	4,250	4,950	5,200	5,750			19.3	22.5	23.6	26.1	1,928	2,245	2,359	2,608	8120
	180	5	6	7	7	320	360	414	459		82	1.1	1.4	1.6	1.6	145	163	188	208	415
		13	14	16	18	800	902	1,037	1,150			3.0	3.2	3.6	4.1	363	409	470	522	535
		25	28	32	35	1,546	1,743	2,004	2,221			5.7	6.4	7.3	7.9	701	791	909	1,007	665
		59	67	80	90	3,540	4,020	4,800	5,400			13.4	15.2	18.1	20.4	1,606	1,823	2,177	2,449	8120

*Units may be piped in parallel when desired capacities exceed that of a single unit.
NOTES: Minimum water temperature increase is 60°F (33°C). Consult factory if less than 60°F (33°C) increase is required or a set temperature below 120°F (49°C) is required.

Flo-Rite-Temp® Instantaneous Steam/Water Heater Stainless Steel



Model 665 SS and 8120 SS Valve

The Flo-Rite-Temp® SS is a compact, steam to water, instantaneous water heater with all wetted metal parts of type 316 stainless steel. Because of its construction materials, this heater is well-suited for heating most corrosive liquids, such as demineralized, deionized or reverse osmosis water commonly used by manufacturers of electronic equipment, pharmaceutical and food.

Features

- Feed-forward control provides accurate temperature control on demand even when demand fluctuates abruptly.
- Feed-forward operation ensures that the heater will fail safely in the closed (cold) position to prevent overheating.
- Straight, non-U-bend tube bundle with removable end cover provides for easy tube cleaning along with the capability to visually inspect all tubes.
- Constant steam pressure on heat exchanger at all times means positive condensate evacuation, avoiding damage to the exchanger due to water hammer.
- Heavy duty 5/8'' tubes of 16 gauge 316L stainless steel ensure long life and maintainability backed up by a 10-year tube bundle warranty against workmanship and material defects.
- Control valve is mounted integral to the heat exchanger, thus eliminating intermediate piping leaks.

Specifications

Application	Steam Supply Pressure	Water Supply Pressure	Maximum Water Pressure Drop
Steam to Water	2 - 15 psig (0.14 - 1.0 bar)	20 - 150 psig (1.4 - 10.3 bar)	10 psig (0.7 bar)

Materials

Body	Valve	Valve Seats	Diaphragm	Heat Exchanger Shell	Heat Exchanger Tubes	Heat Exchanger Tube Sheets
T-316 Stainless Steel			Viton® GF Reinforced w/ Nomex® Fiber	Carbon Steel (Standard) T-316 Staineless Steel (Optional)	T-316L Stanless Steel	T-316 Stainless Steel

Dimensions and Weights

Model		Dimensions											Connections			Weight	
		A	B	C	D	E	F	G	H	J	K	L	1	2	3		
665 SS	in	82-3/4	5-3/4	10-3/8	10-3/8	6-5/8	4-3/4	5-1/2	9-1/4	8	8-3/4	74	2 NPT	1-1/4 NPT	3 NPT	lb	335
	mm	2,102	146	264	264	168	121	140	235	191	222	1,880	50	32	80	kg	152
8120 SS	in	90	5-3/4	10-3/8	10-3/8	8-5/8	8-1/8	8-7/8	9-1/2	8	14-1/2	74	2 NPT	2 NPT	4 150# ANSI	lb	670
	mm	2,286	146	264	264	219	156	225	203	368	1,880	50	50		100	kg	298

Flo-Rite-Temp® Instantaneous Steam/Water Heater Stainless Steel Sizing Chart

Capacities and Steam Loads

Inlet Temp. °F	Set Temp. °F	Standard								Inlet Temp. °C	Set Temp. °C	Metric								Model
		Hot Water Capacities*				Steam Capacities						Hot Water Capacities*				Steam Capacities				
		Steam Pressure psig				Steam Pressure psig						Steam Pressure bar				Steam Pressure bar				
		2	5	10	15	2	5	10	15			0.14	0.35	0.7	1	0.14	0.35	0.7	1	
		gpm				lbs/hr						m³/h				kg/h				
40	120	41	44	47	51	1,695	1,821	1,993	2,138	4	49	9.3	10	10.7	11.6	769	826	904	970	665 SS
		84	89	97	103	3,351	3,720	4,100	4,368			19.1	20.2	22	23.4	1,520	1,687	1,860	1,981	8120 SS
	130	35	37	41	43	1,617	1,743	1,915	2,061		54	7.9	8.4	9.3	9.8	733	791	869	935	665 SS
		66	72	80	86	2,974	3,239	3,611	3,956			15	16.4	18.2	19.5	1,349	1,469	1,638	1,794	8120 SS
	140	30	32	35	37	1,535	1,662	1,836	1,982		60	6.8	7.3	7.9	8.4	696	754	833	899	665 SS
		52	57	64	71	2,596	2,862	3,216	3,540			11.8	12.9	14.5	16.1	1,178	1,298	1,459	1,606	8120 SS
	160	17	18	19	21	1,011	1,110	1,242	1,353		71	3.9	4.1	4.3	4.8	459	503	563	614	665 SS
		44	48	53	57	2,726	2,990	3,346	3,646			10	10.9	12	12.9	1,237	1,356	1,518	1,654	8120 SS
	180	12	13	15	17	860	964	1,103	1,217		82	2.7	3	3.4	3.9	390	437	500	552	665 SS
		32	35	40	44	2,316	2,598	2,971	3,280			7.3	7.9	9.1	10	1,051	1,178	1,348	1,488	8120 SS
50	120	45	48	53	56	1,643	1,768	1,938	2,083	10	49	10.2	10.9	12	12.7	745	802	879	945	665 SS
		91	97	105	113	3,300	3,550	3,892	4,183			20.7	22	23.8	25.7	1,497	1,610	1,765	1,897	8120 SS
	130	38	41	44	47	1,566	1,691	1,862	2,007		54	8.6	9.3	10	10.7	710	767	845	910	665 SS
		75	81	89	95	2,997	3,257	3,740	4,031			17	18.4	20.2	21.6	1,359	1,477	1,696	1,828	8120 SS
	140	32	34	38	41	1,486	1,612	1,784	1,930		60	7.3	7.7	8.6	9.3	674	731	809	875	665 SS
		58	64	71	79	2,628	2,867	3,212	3,558			13.2	14.5	16.1	17.9	1,192	1,300	1.457	1,614	8120 SS
	160	17	19	21	23	978	1,075	1,206	1,316		71	3.9	4.3	4.8	5.2	444	488	547	597	665 SS
		46	51	56	61	2,635	2,896	3,249	3,545			10.4	11.6	12.7	13.9	1,195	1,314	1,474	1,608	8120 SS
	180	12	14	16	18	830	993	1,070	1,183		82	2.7	3.2	3.6	4.1	376	423	485	537	665 SS
		33	37	42	47	2,235	2,513	2,882	3,188			7.5	8.4	9.5	10.7	1,014	1,140	1,307	1,446	8120 SS
60	120	51	55	60	64	1,590	1,713	1,883	2,027	16	49	11.6	12.5	13.6	14.5	721	777	854	919	665 SS
		71	104	122	130	3,247	3,500	3,846	4,139			16.1	23.6	27.7	29.5	1,473	1,588	1,745	1,877	8120 SS
	130	42	45	49	53	1,514	1,639	1,808	1,952		54	9.5	10.2	11.1	12	687	743	820	885	665 SS
		86	92	100	108	3,093	3,347	3,694	3,988			19.5	20.9	22.7	24.5	1,403	1,518	1,676	1,809	8120 SS
	140	35	37	41	44	1,436	1,561	1,732	1,876		60	7.9	8.4	9.3	10	651	708	786	851	665 SS
		66	73	81	87	2,620	2,903	3,233	3,703			15	16.6	18.4	19.8	1,188	1,317	1,466	1,680	8120 SS
	160	18	20	22	24	943	1,040	1,170	1,279		71	4.1	4.5	5	5.5	428	472	531	580	665 SS
		49	54	60	65	2,543	2,801	3,151	3,445			11.1	12.3	13.6	14.8	1,154	1,271	1,429	1,563	8120 SS
	180	13	14	17	19	799	901	1,035	1,148		82	3	3.2	3.9	4.3	362	409	469	521	665 SS
		35	39	44	49	2,152	2,427	2,791	3,093			7.9	8.9	10	11.1	976	1,101	1,266	1,403	8120 SS

*Units may be piped in parallel when desired capacities exceed that of a single unit.

NOTES: Minimum water temperature increase is 60°F (33°C). Consult factory if less than 60°F (33°C) increase is required or a set temperature below 120°F (49°C) is required.

Flo-Rite-Temp® Instantaneous Steam/Water Heater

Non-Recirculating Hot Water Systems

Pre-Piped Single Temperature

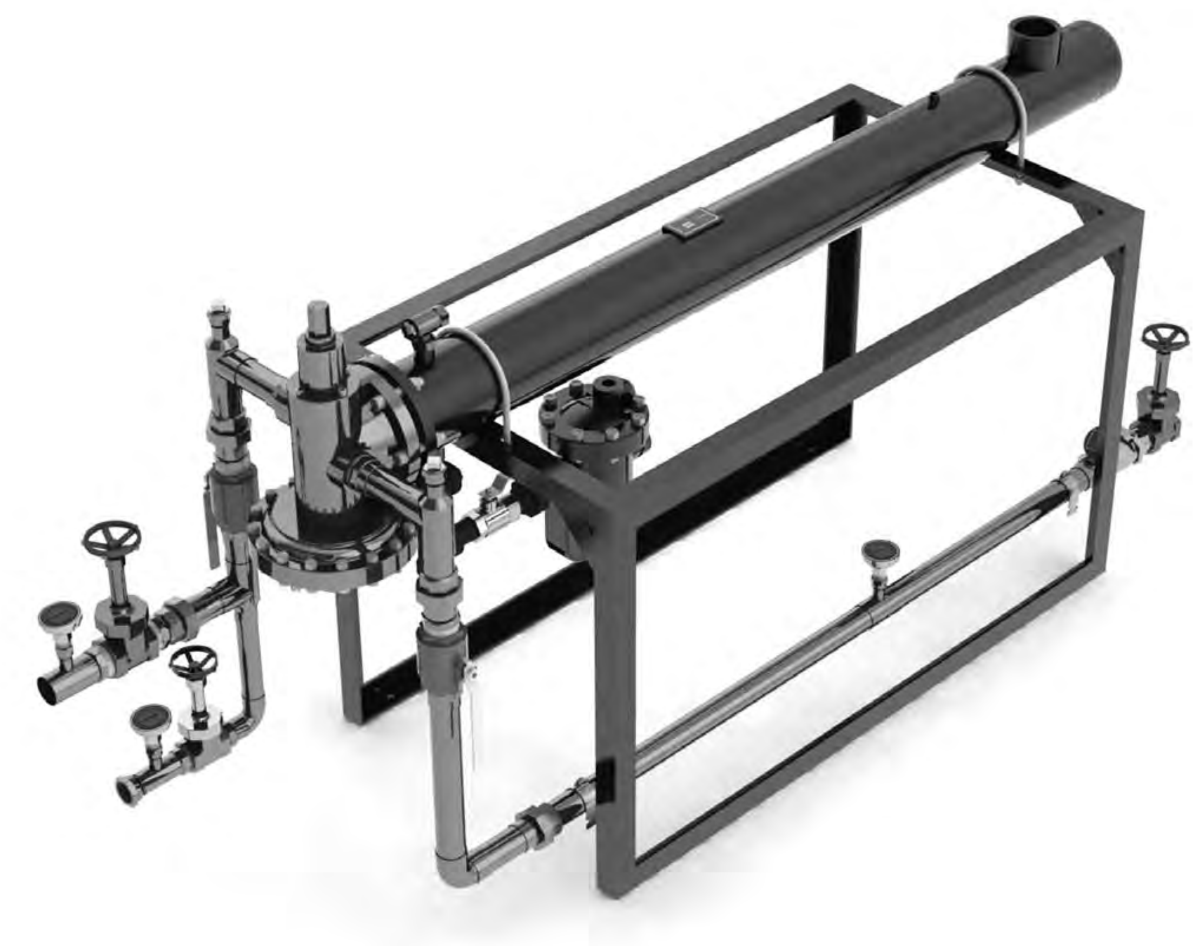
Flo-Rite-Temp® Instantaneous Steam/Water Heaters-Non Recirculating Hot Water Systems feature four single heat exchanger and four double (parallel) heat exchanger pre-piped single temperature packaged assemblies.

Parallel heat exchangers offer increased flow rates and/or system redundancy within the same footprint and allows for tube bundle and control valve servicing while the water heater remains online.

Flo-Rite-Temp® Pre-Piped Single Temperature Systems are fully assembled and include the following installation components:

- Steam Trap
- Air Vent
- Thermometers
- CIP connection port
- Flow Control/Isolation Valves

Ideal for both new construction and retrofit installation within an existing building infrastructure. Flo-Rite-Temp® Pre-Piped Single Temperature Systems are designed to fit through a standard 32” doorway (Model 8120 36” doorway).



Flo-Rite-Temp® Instantaneous Steam/Water Heater

Non-Recirculating Hot Water Systems

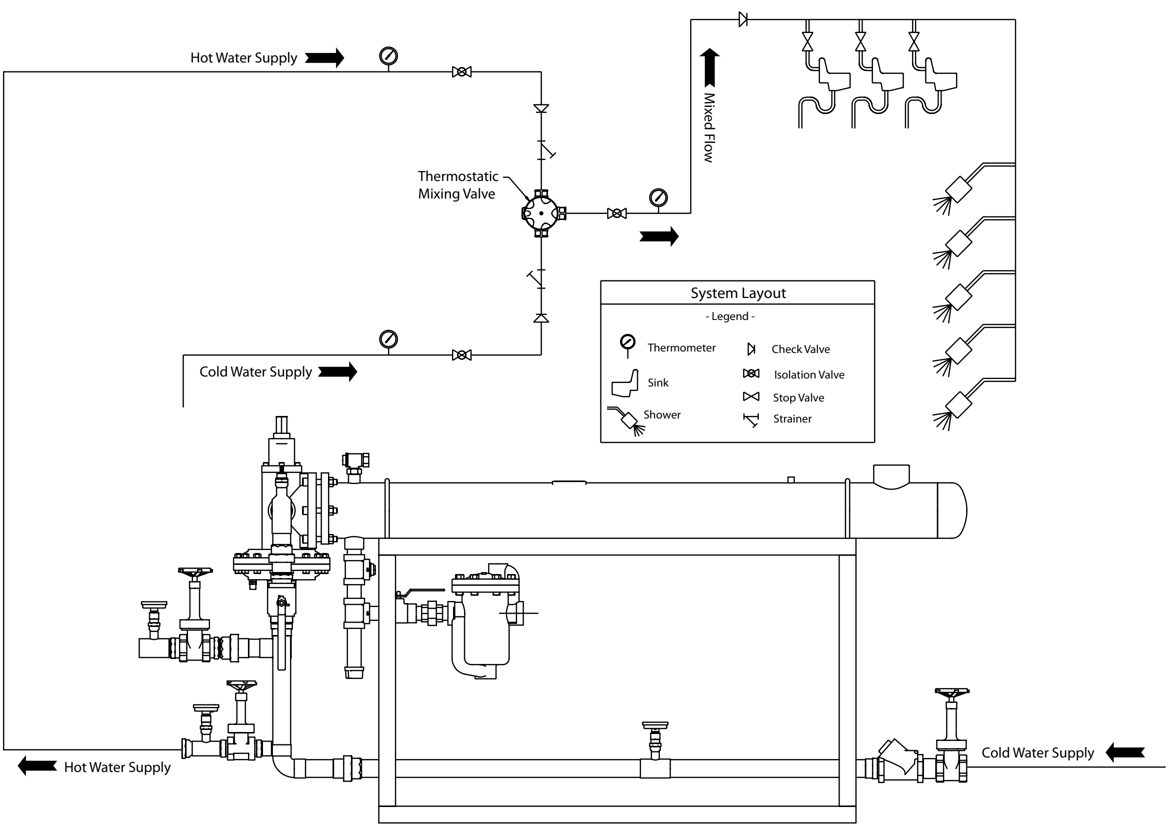
Pre-Piped Single Temperature

Armstrong Flo-Rite-Temp® Instantaneous Steam/Water Heater pre-piped packages are available in standard configurations per the specification matrix on page 26.

Customized Hot Water System Solutions are our specialty. Multiple orientations, configurations and options are available.

Hot Water System Solutions which include condensate recovery, circulating pumps, additional mixed water temperature controls/loops and varied other components can be application engineered specifically to meet the projects requirements.

Additionally, where appropriate, Armstrong can integrate engineering services, turn key installation and project management, system assessment and optimization along with energy conservation measure (ECM) capability through Armstrong Service Incorporated.



Flo-Rite-Temp® Instantaneous Steam/Water Heater

Non-Recirculating Hot Water Systems

Pre-Piped Single Temperature (P-P)

Flo-Rite-Temp® Instantaneous Steam/Water Heater for Non-Recirculating Hot Water Systems feature four heat exchanger options offered as pre-piped single temperature packaged assemblies.

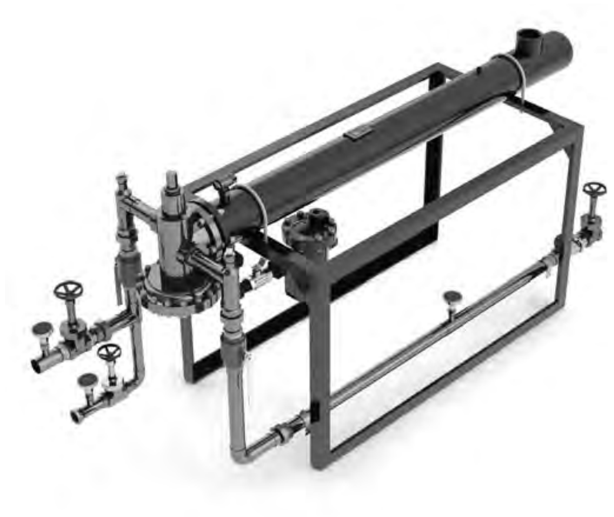
Flo-Rite-Temp® Pre-Piped (P-P) Single Temperature Systems are fully assembled and include the following installation components:

- Steam Trap
- Air Vent
- Thermometers
- CIP connection port
- Flow Control/Isolation Valves

Ideal for both new construction and retrofit installation within an existing building infrastructure. Flo-Rite-Temp® Pre-Piped (P-P) Single Temperature Systems are designed to fit through a standard 32" doorway (Model 8120 36" doorway). Armstrong Flo-Rite-Temp® Instantaneous Steam/Water Heater pre-piped packages are available in standard configurations per the specification matrix on pages 26.

Customized Hot Water System Solutions are our specialty. Multiple orientations, configurations and options are available.

Hot Water System Solutions which include condensate recovery, circulating pumps, additional mixed water temperature controls/loops and varied other components can be application engineered specifically to meet the projects requirements.



For submittal drawing refer to:		
Model 415P-P	Single Wall	S5453
Model 415DWP-P	Double Wall	S5499
Model 535P-P	Single Wall	S5454
Model 535DWP-P	Double Wall	S5500
Model 665P-P	Single Wall	S5455
Model 665DWP-P	Double Wall	S5501
Model 8120P-P	Single Wall	S5456
Model 812DWP-P	Double Wall	S5502

Flo-Rite-Temp™ Instantaneous Steam/Water Heater						
Model	Entering Water Temperature	Outlet Temperature				
		120	130	140	160	180
415P-P	40	20	18	16	12	7
	50	20	20	17	13	7
	60	-	20	19	14	7
535P-P	40	45	39	34	26	16
	50	45	43	37	28	17
	60	-	45	40	30	18
665P-P	40	80	73	63	48	32
	50	80	80	68	51	33
	60	-	80	75	55	35
8120P-P	40	145	145	120	95	59
	50	145	145	134	102	72
	60	-	145	145	115	90

NOTE: All flow rates in gallons per minute and using 15 PSIG steam.

Flo-Rite-Temp® Instantaneous Steam/Water Heater

Non-Recirculating Hot Water Systems

Parallel/Redundant Pre-piped Single Temperature (PP-P)

Flo-Rite-Temp® Instantaneous Steam/Water Heater for Non-Recirculating Hot Water Systems feature four heat exchanger options offered as pre-piped parallel single temperature packaged assemblies.

Flo-Rite-Temp® Pre-Piped (P-P) Parallel (P) Single Temperature Systems are fully assembled and include the following installation components:

- Steam Trap
- Air Vent
- Thermometers
- CIP connection port
- Flow Control/Isolation Valves

Ideal for both new construction and retrofit installation within an existing building infrastructure. Flo-Rite-Temp® Pre-Piped (P-P) Parallel (P) Single Temperature Systems are designed to fit through a standard 32” doorway (Model 8120 36” doorway).

Armstrong Flo-Rite-Temp® Instantaneous Steam/Water Heater pre-piped packages are available in standard configurations per the specification matrix on page 26.

Customized Hot Water System Solutions are our specialty. Multiple orientations, configurations and options are available.

Hot Water System Solutions which include condensate recovery, circulating pumps, additional mixed water temperature controls/loops and varied other components can be application engineered specifically to meet the projects requirements.

For submittal drawing refer to:		
Model 415PP-P	Single Wall	S5457
Model 415DWPP-P	Double Wall	S5503
Model 535PP-P	Single Wall	S5458
Model 535DWPP-P	Double Wall	S5504
Model 665PP-P	Single Wall	S5459
Model 665DWPP-P	Double Wall	S5505
Model 8120PP-P	Single Wall	S5460
Model 812DWPP-P	Double Wall	S5506

If unit is operated in parallel then double flow rate given for total available capacity.

Flo-Rite-Temp™ Instantaneous Steam/Water Heater

Model	Entering Water Temperature	Outlet Temperature				
		120	130	140	160	180
415PP-P	40	20	18	16	12	7
	50	20	20	17	13	7
	60	-	20	19	14	7
535PP-P	40	45	39	34	26	16
	50	45	43	37	28	17
	60	-	45	40	30	18
665PP-P	40	80	73	63	48	32
	50	80	80	68	51	33
	60	-	80	75	55	35
8120PP-P	40	145	145	120	95	59
	50	145	145	134	102	72
	60	-	145	145	115	90

NOTE: All flow rates in gallons per minute and using 15 PSIG steam.

Flo-Rite-Temp® Instantaneous Steam/Water Heater

Recirculating Hot Water Systems

Pre-Piped Single Temperature

Flo-Rite-Temp® Instantaneous Steam/Water Heaters for Recirculating Hot Water Systems feature four single heat exchanger and four double (parallel) heat exchanger pre-piped single temperature packaged assemblies.

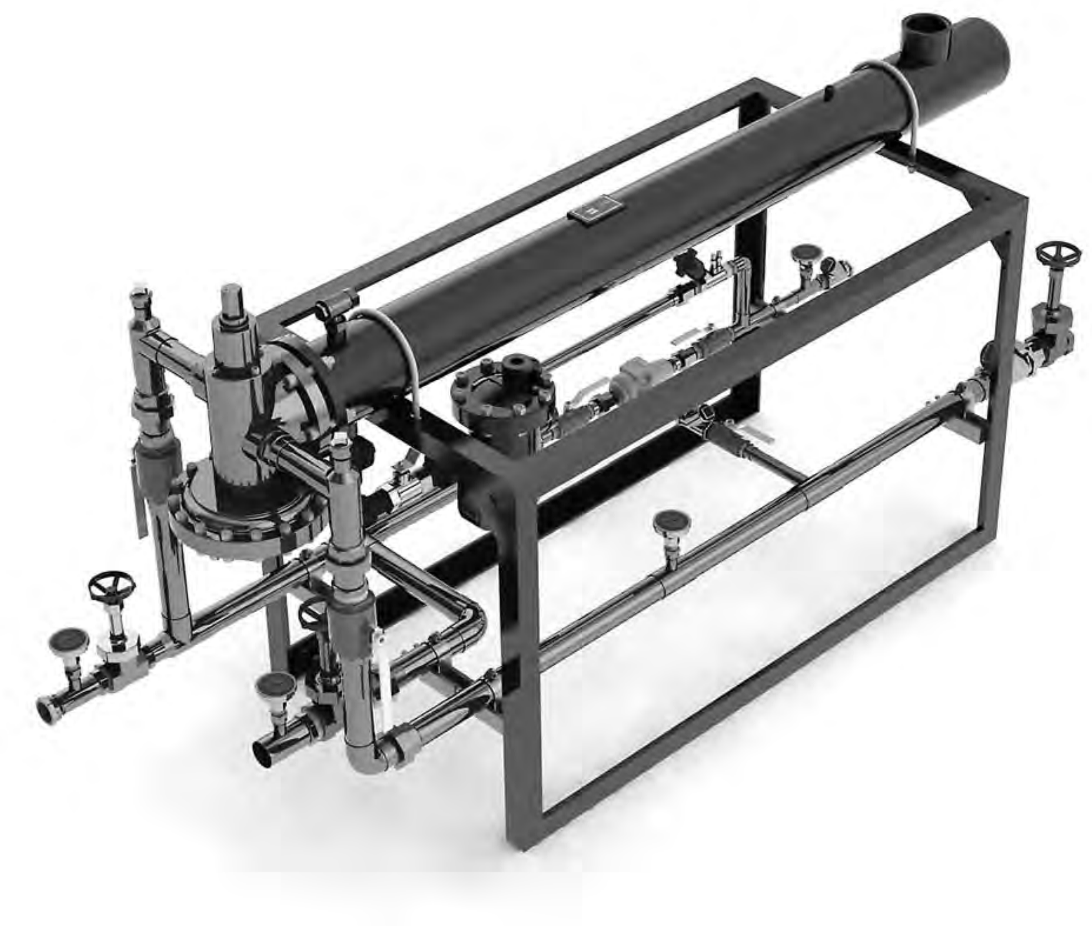
Parallel heat exchangers offer increased flow rates and/or system redundancy within the same footprint and allows for tube bundle and control valve servicing while the water heater remains online.

Flo-Rite-Temp® Pre-Piped Single Temperature Systems are fully assembled and include the following installation components:

- Steam Trap
- Air Vent
- Thermometers
- CIP connection port
- Flow Control/Isolation Valves
- Thermostatic Diverting Valve*

Ideal for both new construction and retrofit installation within an existing building infrastructure. Flo-Rite-Temp® Pre-Piped Single Temperature Systems are designed to fit through a standard 32” doorway (Model 8120 36” doorway).

Flo-Rite-Temp® Instantaneous Steam/Water Heaters Recirculating Hot Water Solutions-for single temperature systems feature an integral thermostatic diverting valve which maintains re-circulating hot water temperatures during zero system draw off “idling” periods.



Flo-Rite-Temp® Instantaneous Steam/Water Heater

Recirculating Hot Water Systems

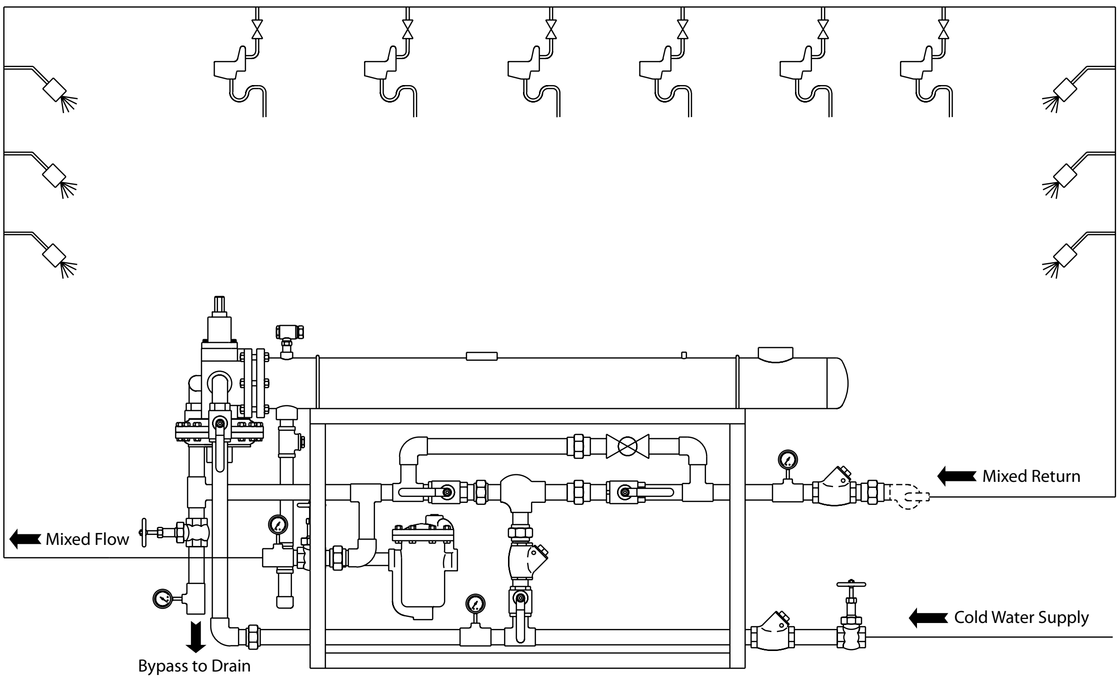
Pre-Piped Single Temperature

Armstrong Flo-Rite-Temp® Instantaneous Steam/Water Heater pre-piped packages are available in standard configurations per the specification matrix on page 26.

Customized Hot Water System Solutions are out specialty. Multiple orientations, configurations and options are available.

Hot Water System Solutions which include condensate recovery, circulating pumps, additional mixed water temperature controls/loops and varied other components can be application engineered specifically to meet the projects requirements.

Additionally, where appropriate, Armstrong can integrate engineering services, turn key installation and project management, system assessment and optimization along with energy conservation measure (ECM) capability through Armstrong Service Incorporated.



Flo-Rite-Temp® Instantaneous Steam/Water Heater

Recirculating Hot Water Systems

Pre-Piped Single Temperature (P-PR)

Flo-Rite-Temp® Instantaneous Steam/Water Heater for Recirculating Hot Water Systems feature four heat exchanger options offered as pre-piped single temperature packaged assemblies.

Flo-Rite-Temp® Pre-Piped (P-P) Recirculating (R) Single Temperature Systems are fully assembled and include the following installation components:

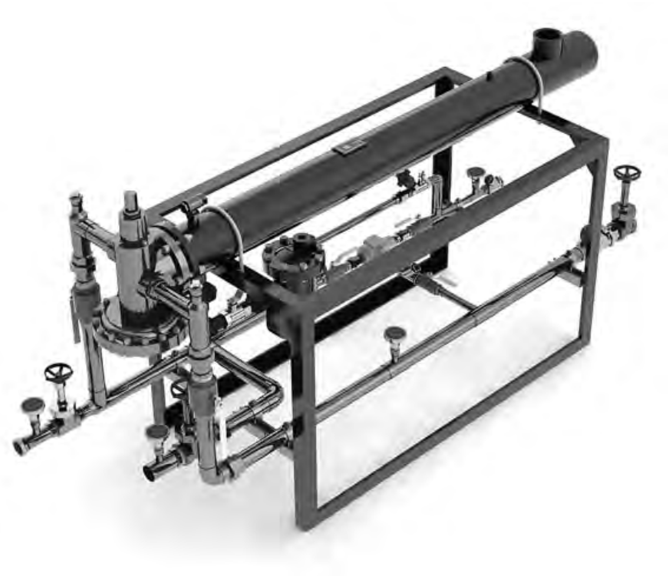
- Steam Trap
- Air Vent
- Thermometers
- CIP connection port
- Flow Control/Isolation Valves
- Amot Thermostatic Diverting Valve

Ideal for both new construction and retrofit installation within an existing building infrastructure. Flo-Rite-Temp® Pre-Piped (P-P) Recirculating (R) Single Temperature Systems are designed to fit through a standard 32" doorway (Model 8120 36" doorway).

Armstrong Flo-Rite-Temp® Instantaneous Steam/Water Heater pre-piped packages are available in standard configurations per the specification matrix on pages 26.

Customized Hot Water System Solutions are our specialty. Multiple orientations, configurations and options are available.

Hot Water System Solutions which include condensate recovery, circulating pumps, additional mixed water temperature controls/loops and varied other components can be application engineered specifically to meet the projects requirements.



For submittal drawing refer to:		
Model 415P-PR	Single Wall	S5468
Model 415DWP-PR	Double Wall	S5514
Model 535P-PR	Single Wall	S5469
Model 535DWP-PR	Double Wall	S5515
Model 665P-PR	Single Wall	S5470
Model 665DWP-PR	Double Wall	S5516
Model 8120P-PR	Single Wall	S5471
Model 812DWP-PR	Double Wall	S5517

Flo-Rite-Temp™ Instantaneous Steam/Water Heater						
Model	Entering Water Temperature	Outlet Temperature				
		120	130	140	160	180
415P-PR	40	20	18	16	12	7
	50	20	20	17	13	7
	60	-	20	19	14	7
535P-PR	40	45	39	34	26	16
	50	45	43	37	28	17
	60	-	45	40	30	18
665P-PR	40	80	73	63	48	32
	50	80	80	68	51	33
	60	-	80	75	55	35
8120P-PR	40	145	145	120	95	59
	50	145	145	134	102	72
	60	-	145	145	115	90

NOTE: All flow rates in gallons per minute and using 15 PSIG steam.

Flo-Rite-Temp® Instantaneous Steam/Water Heater

Recirculating Hot Water Systems

Parallel/Redundant Pre-Piped Single Temperature (PP-PR)

Flo-Rite-Temp® Instantaneous Steam/Water Heater for Recirculating Hot Water Systems feature four heat exchanger options offered as pre-piped parallel single temperature packaged assemblies.

Flo-Rite-Temp® Pre-Piped (P-P) Parallel (P) Recirculating (R) Single Temperature Systems are fully assembled and include the following installation components:

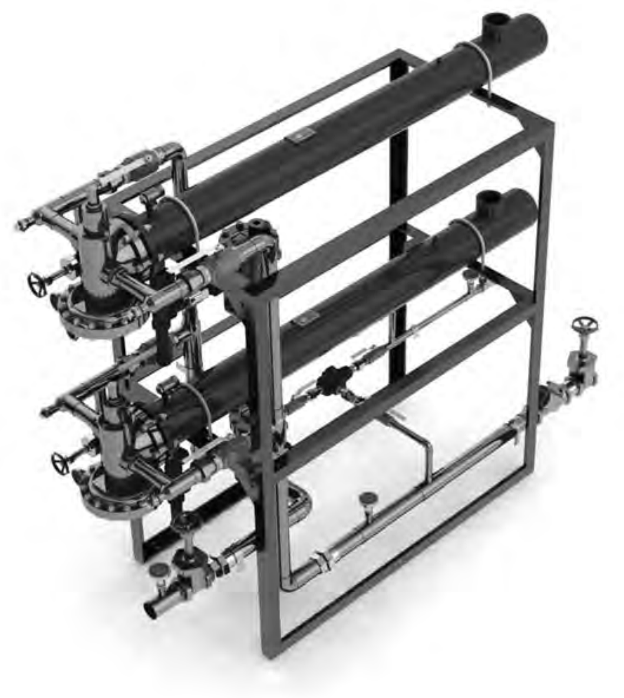
- Steam Trap
- Air Vent
- Thermometers
- CIP connection port
- Flow Control/Isolation Valves
- Amot Thermostatic Diverting Valve

Ideal for both new construction and retrofit installation within an existing building infrastructure. Flo-Rite-Temp® Pre-Parallel (P) Piped (P-P) Recirculating (R) Single Temperature Systems are designed to fit through a standard 32" doorway (Model 8120 36" doorway).

Armstrong Flo-Rite-Temp® Instantaneous Steam/Water Heater pre-piped packages are available in standard configurations per the specification matrix on page 26.

Customized Hot Water System Solutions are our specialty. Multiple orientations, configurations and options are available.

Hot Water System Solutions which include condensate recovery, circulating pumps, additional mixed water temperature controls/loops and varied other components can be application engineered specifically to meet the projects requirements.



For submittal drawing refer to:		
Model 415PP-PR	Single Wall	S5472
Model 415DWPP-PR	Double Wall	S5518
Model 535PP-PR	Single Wall	S5473
Model 535DWPP-PR	Double Wall	S5519
Model 665PP-PR	Single Wall	S5474
Model 665DWPP-PR	Double Wall	S5520
Model 8120PP-PR	Single Wall	S5475
Model 812DWPP-PR	Double Wall	S5521

If unit is operated in parallel then double flow rate given for total available capacity.

Flo-Rite-Temp™ Instantaneous Steam/Water Heater

Model	Entering Water Temperature	Outlet Temperature				
		120	130	140	160	180
415PP-PR	40	20	18	16	12	7
	50	20	20	17	13	7
	60	-	20	19	14	7
535PP-PR	40	45	39	34	26	16
	50	45	43	37	28	17
	60	-	45	40	30	18
665PP-PR	40	80	73	63	48	32
	50	80	80	68	51	33
	60	-	80	75	55	35
8120PP-PR	40	145	145	120	95	59
	50	145	145	134	102	72
	60	-	145	145	115	90

NOTE: All flow rates in gallons per minute and using 15 PSIG steam.

Flo-Rite-Temp® Instantaneous Steam/Water Heater

Recirculating Hot Water Systems

Pre-Piped Tempered Water

Flo-Rite-Temp® Instantaneous Steam/Water Heaters-Recirculating Hot Water Systems feature four single heat exchanger and four double (parallel) heat exchanger pre-piped tempered water packaged assemblies.

Parallel heat exchangers offer increased flow rates and/or system redundancy within the same footprint and allows for tube bundle and control valve servicing while the water heater remains online.

Flo-Rite-Temp® Pre-Piped Tempered Water Systems are fully assembled and include the following installation components:

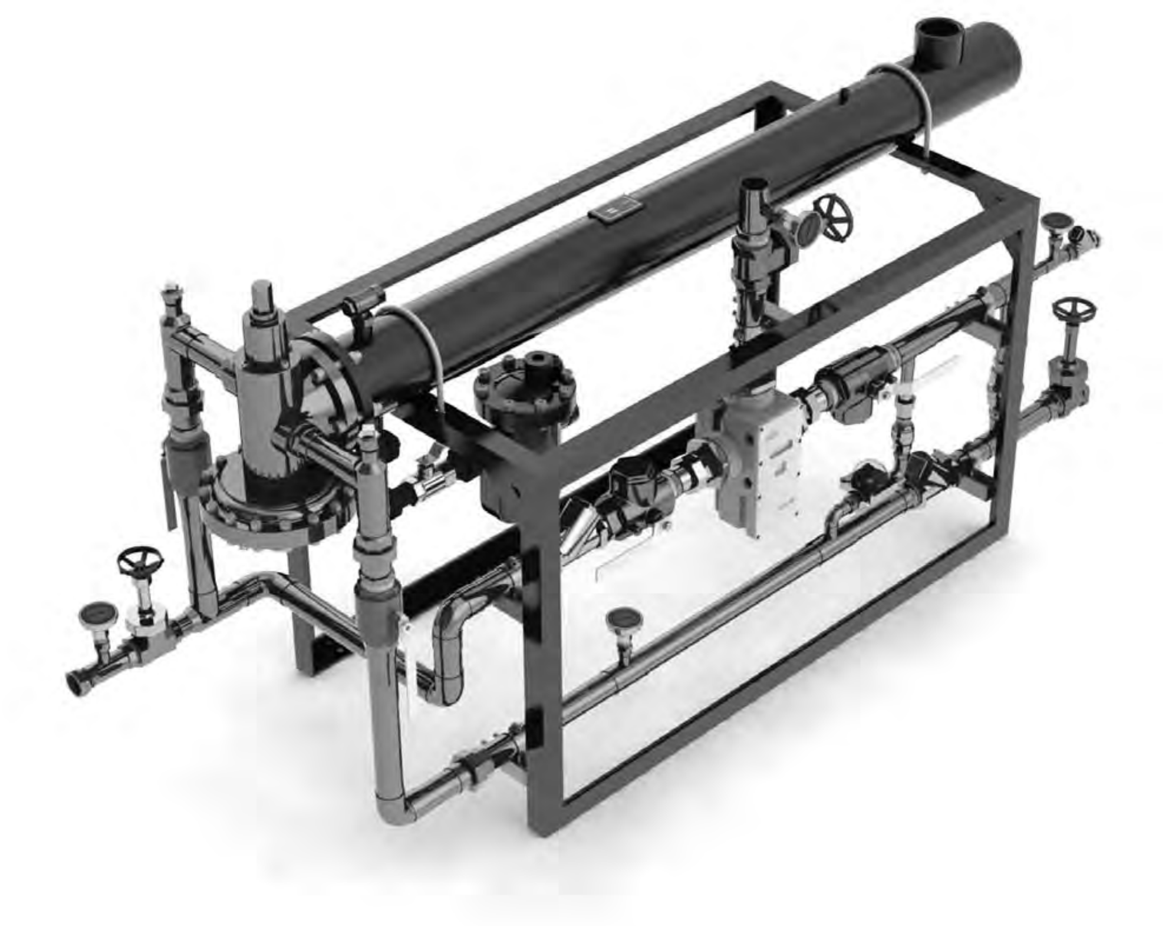
- Steam Trap
- Air Vent
- Thermometers
- CIP connection port
- Flow Control/Isolation Valves
- DRV 80 "The Brain" Digital Recirculating Valve

Ideal for both new construction and retrofit installation within an existing building infrastructure. Flo-Rite-Temp® Pre-Piped Single Temperature Systems are designed to fit through a standard 32" doorway (Model 8120 36" doorway).

Flo-Rite-Temp® Instantaneous Steam/Water Heaters-Recirculating Hot Water Solutions-for tempered water systems feature DRV 80 "The Brain".

DRV 80 delivers +/- 2F temperature control for systems which experience diverse user draw-off between 0-150GPM. DRV80 is provided as standard with an integral mixed water outlet sensor/transmitter and remote set point adjustment capability for "plug and play" communication via PC, LAN or resident Building Automation System (BAS).

More information on DRV 80 is detailed on page 27.



Flo-Rite-Temp® Instantaneous Steam/Water Heater

Recirculating Hot Water Systems

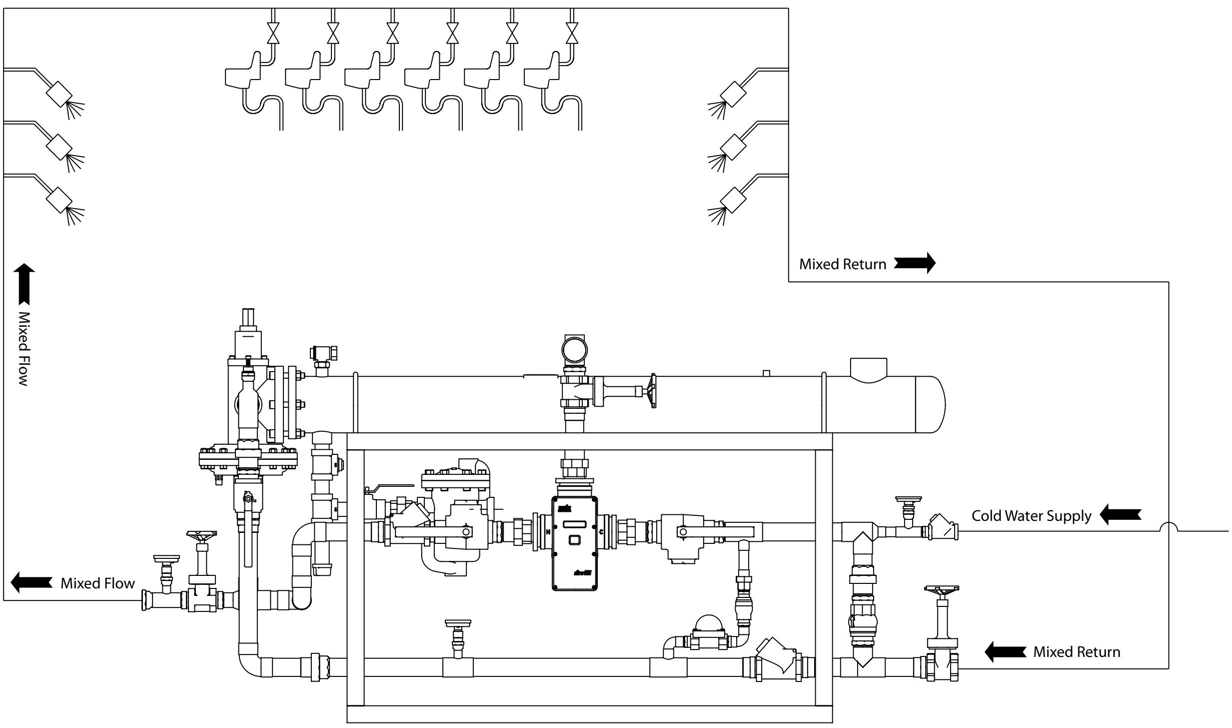
Pre-Piped Tempered Water

Armstrong Flo-Rite-Temp® Instantaneous Steam/Water Heater pre-piped packages are available in standard configurations per the specification matrix on page 26.

Customized Hot Water System Solutions are our specialty. Multiple orientations, configurations and options are available.

Hot Water System Solutions which include condensate recovery, circulating pumps, additional mixed water temperature controls/loops and varied other components can be application engineered specifically to meet the projects requirements.

Additionally, where appropriate, Armstrong can integrate engineering services, turn key installation and project management, system assessment and optimization along with energy conservation measure (ECM) capability through Armstrong Service Incorporated.



Flo-Rite-Temp® Instantaneous Steam/Water Heater

Recirculating Hot Water Systems

Pre-Piped Tempered Water (P-PTW)

Flo-Rite-Temp® Instantaneous Steam/Water Heater for Recirculating Hot Water Systems feature four heat exchanger options offered as pre-piped tempered water packaged assemblies.

Flo-Rite-Temp® Pre-Piped (P-P) Tempered Water (TW) Systems are fully assembled and include the following installation components:

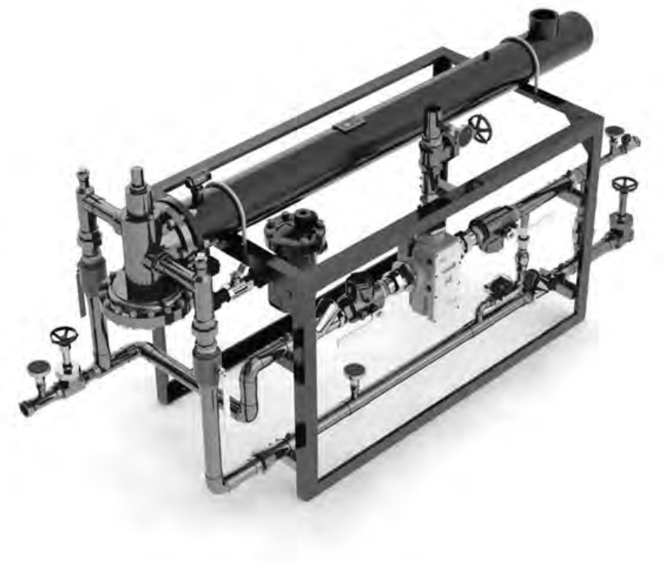
- Steam Trap
- Air Vent
- Thermometers
- CIP connection port
- Flow Control/Isolation Valves
- DRV 80 Digital ReCirculating Valve "The Brain" (DMC 1)

Ideal for both new construction and retrofit installation within an existing building infrastructure. Flo-Rite-Temp® Pre-Piped (P-P) Tempered Water (TW) Systems are designed to fit through a standard 32" doorway (Model 8120 36" doorway).

Armstrong Flo-Rite-Temp® Instantaneous Steam/Water Heater pre-piped packages are available in standard configurations per the specification matrix on page 26.

Customized Hot Water System Solutions are our specialty. Multiple orientations, configurations and options are available.

Hot Water System Solutions which include condensate recovery, circulating pumps, additional mixed water temperature controls/loops and varied other components can be application engineered specifically to meet the projects requirements.



For submittal drawing refer to:		
Model 415P-PTW-EMC1	Single Wall	S5476
Model 415DWP-PTW-EMC1	Double Wall	S5522
Model 535P-PTW-DMC1	Single Wall	S5477
Model 535DWP-PTW-DMC1	Double Wall	S5523
Model 665P-PTW-DMC1	Single Wall	S5478
Model 665DWP-PTW-DMC1	Double Wall	S5524
Model 8120P-PTW-DMC1	Single Wall	S5479
Model812DWP-PTW-DMC1	Double Wall	S5525

**Note – Maximum temperature outlet set-point on digital recirculating valve is 160°F.*

Flo-Rite-Temp™ Instantaneous Steam/Water Heater

Model	Entering Water Temperature	Outlet Temperature				
		120	130	140	160	180*
415P-PTW-EMC1	40	20	18	16	12	7
	50	20	20	17	13	7
	60	-	20	19	14	7
535P-PTW-DMC1	40	45	39	34	26	16
	50	45	43	37	28	17
	60	-	45	40	30	18
665P-PTW-DMC1	40	80	73	63	48	32
	50	80	80	68	51	33
	60	-	80	75	55	35
8120P-PTW-DMC1	40	145	145	120	95	59
	50	145	145	134	102	72
	60	-	145	145	115	90

NOTE: All flow rates in gallons per minute and using 15 PSIG steam.

Flo-Rite-Temp® Instantaneous Steam/Water Heater

Recirculating Hot Water Systems

Parallel/Redundant Pre-Piped Tempered Water (PP-PTW)

Flo-Rite-Temp® Instantaneous Steam/Water Heater for Recirculating Hot Water Systems feature four heat exchanger options offered as pre-piped parallel tempered water packaged assemblies.

Flo-Rite-Temp® Pre-Piped (P-P) Parallel (P) Tempered Water (TW) Systems are fully assembled and include the following installation components:

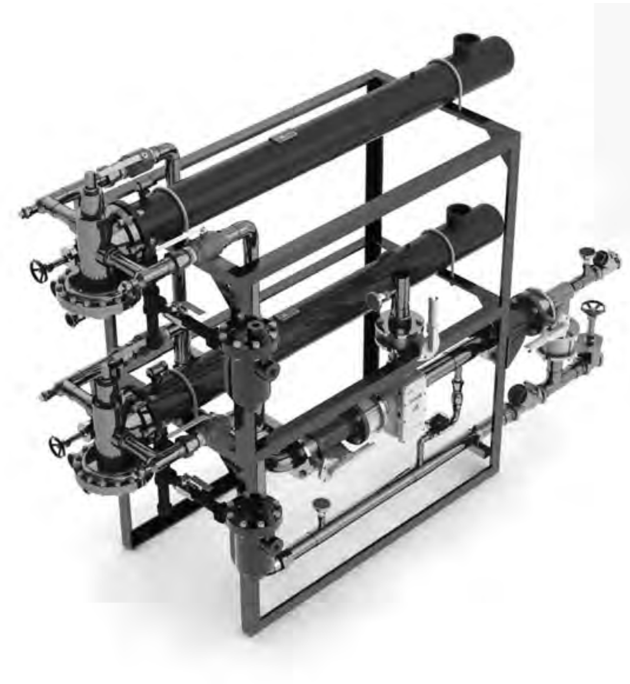
- Steam Trap
- Air Vent
- Thermometers
- CIP connection port
- Flow Control/Isolation Valves
- DRV 80 Digital ReCirculating Valve "The Brain" (DMC 1)

Ideal for both new construction and retrofit installation within an existing building infrastructure Flo-Rite-Temp® Parallel (P) Pre-Piped (P-P) Tempered Water (TW) Systems are designed to fit through a standard 32" doorway (Model 8120 36" doorway).

Armstrong Flo-Rite-Temp® Instantaneous Steam/Water Heater pre-piped packages are available in standard configurations per the specification matrix on page 26.

Customized Hot Water System Solutions are our specialty. Multiple orientations, configurations and options are available.

Hot Water System Solutions which include condensate recovery, circulating pumps, additional mixed water temperature controls/loops and varied other components can be application engineered specifically to meet the projects requirements.



For submittal drawing refer to:		
Model 415PP-PTW-EMC1	Single Wall	S5480
Model 415DWPP-PTW-EMC1	Double Wall	S5526
Model 535PP-PTW-DMC1	Single Wall	S5481
Model 535DWPP-PTW-DMC1	Double Wall	S5527
Model 665PP-PTW-DMC1	Single Wall	S5482
Model 665DWPP-PTW-DMC1	Double Wall	S5528
Model 8120PP-PTW-DMC1	Single Wall	S5483
Model 8120DWPP-PTW-DMC1	Double Wall	S5529

If unit is operated in parallel then double flow rate given for total available capacity.

Flo-Rite-Temp™ Instantaneous Steam/Water Heater						
Model	Entering Water Temperature	Outlet Temperature				
		120	130	140	160	180
415PP-PTW-EMC1	40	20	18	16	12	7
	50	20	20	17	13	7
	60	-	20	19	14	7
535PP-PTW-DMC1	40	45	39	34	26	16
	50	45	43	37	28	17
	60	-	45	40	30	18
665PP-PTW-DMC1	40	80	73	63	48	32
	50	80	80	68	51	33
	60	-	80	75	55	35
*8120PP-PTW-DMC1	40	145	145	120	95	59
	50	145	145	134	102	72
	60	-	145	145	115	90

NOTE: All flow rates in gallons per minute and using 15 PSIG steam.

*NOTE: If a 8120PP-PTW-DMC1 is selected for parallel operation, a second DRV 80 is recommended to increase the flow rate.

Flo-Rite-Temp® Instantaneous Steam/Water Heater

Specification Matrix

Flo-Rite-Temp® water heaters are available in four base models each sized with a prefix that denotes the shell size in inches (**4"**, **5"**, **6"** and **8"**) and a suffix that denotes the flow rate at a 100°F temperature rise (**15** gpm, **35** gpm, **65** gpm and **120** gpm).

Each Flo-Rite-Temp® model's heat exchanger is single wall construction as standard but is optionally available as a Double Wall (suffix **DW**).

Each Flo-Rite-Temp® model is supplied as a shell and tube style heat exchanger with integral mixing valve/head and is also available as a pre-piped "Packaged Solution" (suffix **P-P**).

Flo-Rite-Temp® Packaged Solutions are also available with a second heater (parallel, suffix **PP-P**) and third heater (triplex, suffix **Trip**) for increased flow capacity, redundant installation or both.

Flo-Rite-Temp® Packaged Solutions are supplied for either point of use "dead-leg" applications or can be factory piped for a recirculating hot water system in either a standard configuration with a thermostatic diverting valve (suffix **R**) or as a Tempered Water system (suffix **TW)**.

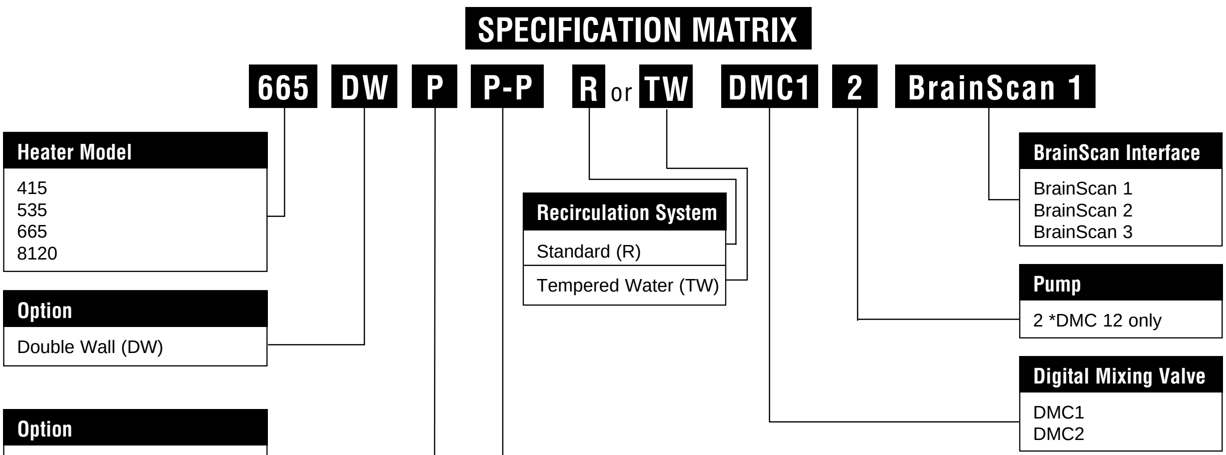
Flo-Rite-Temp® Packaged Solutions designated as Tempered Water Systems (**TW**) include an on board Digital Mixing Center (suffix **DMC**) which features DRV 80 "The Big Brain®"

Higher flow Flo-Rite-Temp® Packaged Solutions and Systems designed with built-in redundancy can include two **DRV 80**. The model code (**DMC**) always includes a trailing suffix which identifies the number of Digital Mixing Valves (**DMC 1**, **DMC 2**, etc.) The Digital Mixing Center can be assembled with a recirculation pump with a "**2**" in the model number following the **DMC**/(**DMC 12 only**).

Flo-Rite-Temp® Packaged Solutions fitted as DMC include a 4-20mA connection as standard on the DRV80. The 4-20mA connection provides the capability to access and transmit the water temperature output from the valves integral Mixed Outlet Water Sensor and allows Remote Set Point adjustment capability for "plug and play" system communication via PC, LAN or resident Building Automation System.

BrainScan® a Digital Hot Water Management System Console can be added by adding the suffix BrainScan with a hyphen. Flo-Rite-Temp® packaged systems fitted as DMC can connect BrainScan® directly to the serial port on the DRV 80.

When Integrated accordingly BrainScan® provides 3 levels of system interrogation options (see page 28) and is configured for most building automation systems which use BacNet™, LonWorks™ and ModBus protocols. BrainScan® also avails LAN and Web Browser connectivity options.



KEY
(DW) = Double Wall
(P) = Parallel
(P-P) = Pre-piped
(P P-P) = Parallel Pre-piped
(Trip) = Triplex
(R) = Recirculation
(TW) = Tempered Water Recirculation

Flo-Rite-Temp® Instantaneous Steam/Water Heater

Digital Water Temperature Control

Flo-Rite-Temp® Pre-Piped (P-P) Single, Parallel (P) Recirculating (R) Single and Multiple Temperature Systems are available with a DRV 80 Digital Recirculating Valve. The DRV 80 "The Brain" is supplied pre-piped as an integral component to the Water Heater assembly in the form of a Digital Mixing Center (DMC).

Model DMC 1 features a single DRV 80 pre-piped and pressure tested complete with isolation valves, strainers, mixed return flow indicator, check valves, thermometers and an optionally selected system circulating pump for systems which experience diverse user draw-off from 0 to 150 GPM.

Remote Control, System Monitoring,System Interrogation and Data Logging

Model DMC 1 is provided as standard with an integral Mixed Outlet Water sensor and Remote Set Point Adjustment capability for "plug and play" system communication via PC, LAN or resident Building Automation System.

Model DMC1 offers an integral relay point for connection to a selected accessory component such as a pump on/off switch, to activate/deactivate a solenoid or to enable an audible alarm etc.

Model DMC1 is supplied as standard with integral Hot Water & Cold Water/System Return Water sensors and a serial connection data port which enables communication to third party system hardware via an accessory component called BrainScan®.

BrainScan®

BrainScan® is an optionally selected Digital Hot Water Management System from Armstrong complete with custom configured software. BrainScan® connects to the integral serial connection data port on DRV 80 and enables a direct onward connection to Building Automation Systems which utilize BacNet™, Lonworks™ and ModBus protocols, a communication capability with other Building Automation Systems which connect via an RS485 port and an Ethernet port for Web access.

Operational Specifications

The enhanced accuracy possible with DRV80 digital technology, combined with its data input/output communication capability equals:

- Accurate control of blended water drawn from the system at a point of use typically within +/-2°F at draw off points a minimum of 5m downstream of mixing valve during consistent system demand periods
- Operational water pressure of 10 -150 psig
- Minimum valve inlet to outlet temperature differential requirement (system recirculation temperature loss) of 2°F

- Automatic shutoff of hot water flow upon cold water inlet supply failure
- Automatic shutoff of hot water flow in the event of a power failure
- Maintain a consistent system "idling" temperature and control Temperature Creep without the use of a manual throttling device or balance valve.
- System shall not require a temperature activated pump shut-off device (aquastat).
- Programmable set point range of 100-160°F (37-71°C) plus full hot/full cold
- Ability to thermally disinfect at recommended temperatures
- Programmable 1st level hi/lo temp alarm display
- Programmable temperature error level for safety shutdown

Technical Specifications

- 100-240 V Power supply (12 V DC output)
- 2 x 4-20 mA current loop interfaces:
  Input: Setpoint Selection
  Output: Measured Blend Temperature
- Relay output: Contacts
  Error Relay: Activated in alarm or error mode
- Serial Connection Data Port
- Stainless Steel Construction

DMC 1

Supplied as a pre-plumbed, pressure-tested and mounted to an enameled steel frame comprising:

- 1 ea: DRV 80 Digital Recirculation System Controller
- 3" inlet/outlet piping with flanged connections
- System isolation valves,
- Inlet strainers
- Mixed return flow indicator
- Check valves
- Thermometers

DMC 12

As above with system circulating pump.

Hot Water System Monitoring

BrainScan™

BrainScan™ is a Digital Hot Water Management System optionally supplied with DRV80 Digital Recirculating Valves and DRV80 based Digital Mixing Centers.

BrainScan™ is factory configured to engage with either a Local Area Network (LAN), a third party Building Automation System (BAS) or an Internet Service Provider (ISP) to enable the DRV80's integral monitoring features.

Standard BrainScan™ configurations include hardware and software options which include on screen system graphics which are compatible with most standard Building Automation System open protocols.

All of the standard alarm conditions and error messages available through the DRV80 are also available through BrainScan™. BrainScan™ is available in three (3) different configuration packages as described below:

BrainScan™ 1

Includes remote hot water supply, cold/recirculation water supply and blended water outlet temperature readings. Also gives the ability to remotely change blended water outlet temperature setpoint. Included with all BrainScan™ options is the valve/system graphic.

BrainScan™ 2

Provided as BrainScan™ 1 with hot water supply, cold water supply and blended water outlet pressure transmitters.

BrainScan™ 3

Provided as BrainScan™ 2 with blended water outlet and recirculation return flow meters. These can be used to calculate water usage.

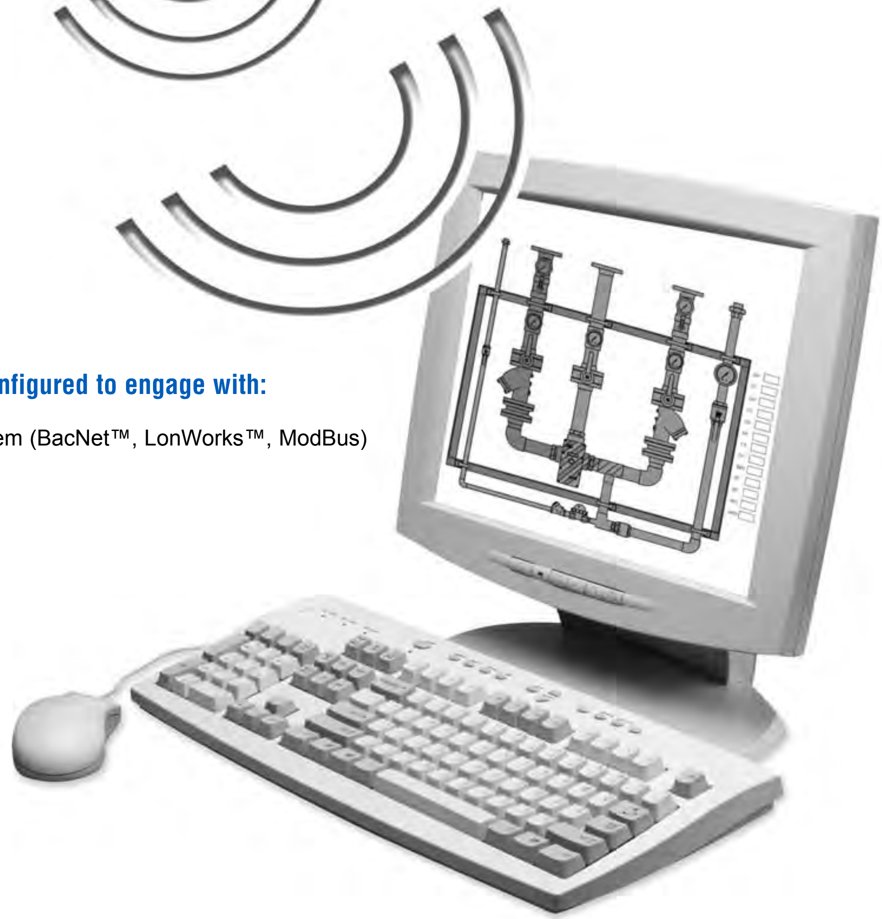
Technical Specifications

- BrainScan™ utilizes the SoM-5282 System Module as the processing engine and uClinux as the operating system
- BrainScan™ accommodates a socket for a protocol translator module that is capable of communicating with BacNet™, LonWorks™ and ModBus
- Standard ethernet port available to bring system on to the internet via a secured HTTP network server
- System displays "real time" values as well as stored data to be downloaded by the facility into their preferred program
- Data storage and exporting is done via XML formatted files, written every 15 minutes

Hot Water System Monitoring

BrainScan™

BrainScan™ is a Digital Hot Water Management System optionally supplied with DRV80 Digital Recirculating Valves and DRV80 based Digital Mixing Centers.



BrainScan™ is factory configured to engage with:

- Building Automation System (BacNet™, LonWorks™, ModBus)
- Local Area Network
- Web Browser

Flo-Direct®
Complete Thermal Exchange Gas Fired Water Heater

Ultra low Nox option available ≤ 9 ppm

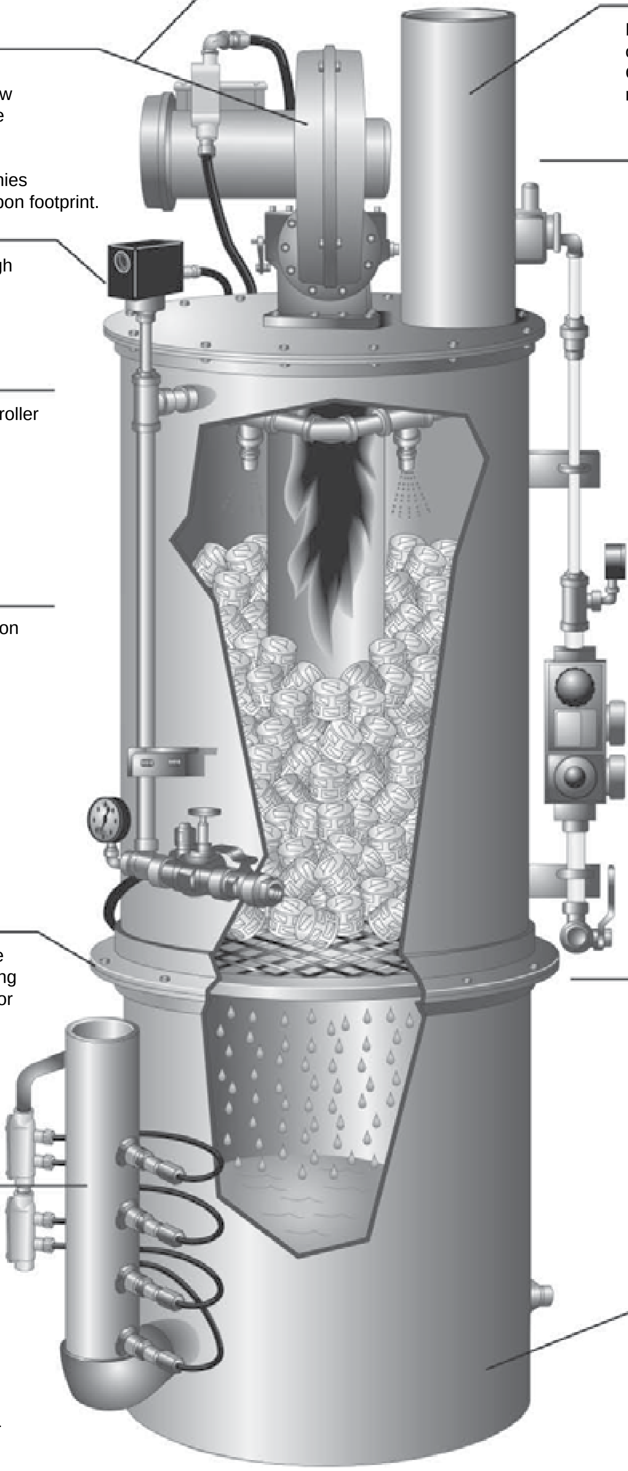
Standard Low Nox (30-50ppm) high-efficiency burner/blower for low carbon monoxide and nitrous oxide emissions. Complies with even the most stringent emission standards and is an ideal element for companies seeking to reduce their overall carbon footprint.

Exhaust temperatures within a few degrees of the incoming water allow for inexpensive CPVC or single-wall stainless for ducting materials.

Water pressure limit switch and high temperature switch shut down the unit for safety if water pressure fails or is accidentally shut off.

CTE compliant for enhanced water purity and safety.

Electrical programmable logic controller (PLC). NEMA 4 - IP 65 (watertight) enclosure; modular components for easy service or replacement. Status lights for easy troubleshooting.



10 gauge stainless steel construction with a 10-year warranty on the structure and its internals. 2-year warranty on external components.

Modular fuel train using slide out components for ease of maintenance or replacement. CSA, ETL, CTE and FM compliant. CE approved according to PED (97/23/EC)

Indexability of the top portion to the bottom allows for flexibility in rotating for easiest utility hookups. Allows for ease of internal inspection.

Flo Direct Complete Thermal Exchange Gas Fired Water Heaters are fully compliant and correctly identified as required by the relevant CE marking regulations.

This includes:
- Low Voltage Directive (2006/95/EC)
- EMC Directive (2004/108/EC)
- Machinery Directive (98/37/EC)
- Gas Directive (90/396/EC)

Level controls automatically control the transfer pump (included) which delivers heated water to application.

Small footprint because the burner is installed on top of the unit "out of the way" and not on the side. No side clearance required.

Flo-Direct is U.S. Patent 5,924,391

Flo-Direct®
Complete Thermal Exchange Gas Fired Water Heater

Armstrong Flo-Direct CTE gas fired water heaters offer a complete range of high efficiency, compact, all stainless steel water heaters which are remarkably dependable, simple in design and operation, and suitable for a wide variety of hot water applications.

The Flo-Direct CTE gas fired water heaters often deliver fuel savings as high as 30-60% when compared to steam/water heating systems. Standard operating capacities are between 1 million and 16 million BTU per hour.

With a small footprint, 99.7% or greater high heat value (110% low heat value) heat transfer efficiencies*, remarkable dependability, ease of maintenance, and the ability to operate well with poor water quality, Armstrong Flo-Direct CTE gas fired water heaters are the product of choice for companies seeking to achieve Energy Conservation Measure (ECM) and Reduced Carbon Footprint objectives.

Primary Markets include:

Food Process Industries
- Washdown
- Batch Production
- Vessel Filling
- Tank Cleaning
- Bottle Warming

Concrete Plants
- Pre-Heated Water for batch production

Space Heating
- Greenhouses
  Re-Circulated HW for general space heating

- Light Manufacturing/Warehouses
  Re-Circulated HW for general space heating

General Industry
- Boiler Make-Up Water

Customized Hot Water System Solutions are our specialty. Multiple orientations, configurations and options are available.

Hot Water System Solutions which include transfer pumps, storage tanks variable frequency drive (VFD) pump skid-packaged solutions, hose stations, circulating pumps, downstream digital water temperature controls/loops with BAS/DDC interface along with a multitude of performance matched components can be application engineered specifically to meet the projects requirements.

Additionally, where appropriate, Armstrong can integrate engineering services, turn key installation, project management, system assessment and optimization along with energy conservation measure (ECM) capability through Armstrong Service Incorporated.

Flo-Direct Complete Thermal Exchange Gas-Fired Water Heaters deliver unrivaled Performance and Efficiency.

Incoming water is introduced into the top of the water heater through a series of calibrated dispersion nozzles. Cold water travels down through a bed of multifaceted stainless steel packing rings (Pall Rings) which break the water into smaller and smaller droplets.

A burner is mounted on top of the unit, firing downward through a centrally located flame tube. The flame tube is cooled by incoming cold water, and all of the fuel gasses are consumed within this flame tube. The design allows all combustion to take place within a dry and cool environment, and produces very low levels of nitrous oxide (NO) and carbon monoxide (CO).

Heat from the flame enters the lower chamber from the bottom of the flame tube, and travels slowly upward through the packing rings. Efficient heat transfer occurs as the descending water comes in contact with the rising hot gasses as both pass through the bed of packing rings in opposite directions.

This “rain” of hot water then falls into the lower chamber and is pumped out to a storage tank. Water temperatures up to 185ºF are available within two minutes after the unit starts.

Outlet water temperature is set with a value controlling the incoming water flow. More incoming water results in cooler outlet water temperatures, and less incoming water produces hotter outlet water temperatures.

The products of combustion are vented out of the top of the unit, and this exhaust is typically within a few degrees of incoming water temperature.

Features
- CTE Compliant
- Meets multiple global water quality standards
- No internal moving parts
- Low-temperature exhaust
- 99.7% or greater high heat value efficiency
- Water treatment not required
- Stainless steel construction
- Takes up minimal floor space
- Ten year warranty on structure/two years on all other components

Engineered Solutions
Armstrong can provide integrated engineering, turnkey installation and project management services. Additionally, Armstrong can perform system assessments and optimizations and identify Energy Conservation Measures (ECMs).

Flo-Direct®
Complete Thermal Exchange Gas Fired Water Heater

CTE Technology

Developed from direct contact water heating science which was first introduced more than two decades ago, Complete Thermal Exchange (CTE) technology has revolutionized high efficiency water heating methods. Today CTE enjoys a proven record and has rapidly become the new standard in high efficiency water heating and energy savings.

While traditional direct contact water heating can offer significant energy savings when compared to a conventional steam boiler system, the Armstrong Flo-Direct CTE gas fired water heater offers an unparalled, 99.7% high heat value (110% approx. low heat value) efficiency rating* throughout each phase of its operation cycle.

The sustained operational efficiency of Flo-Direct CTE gas fired water heaters creates the most energy efficient method of hot water production currently available.

No Scale Build-Up

The Flo-Direct CTE gas fired water heater's unique design prevents scale build-up because there are no "hot spots" internally or externally, and because calcium is prevented from completely falling out of suspension during operation. As a result, the mineral content of the influent water and the effluent water will be equal.

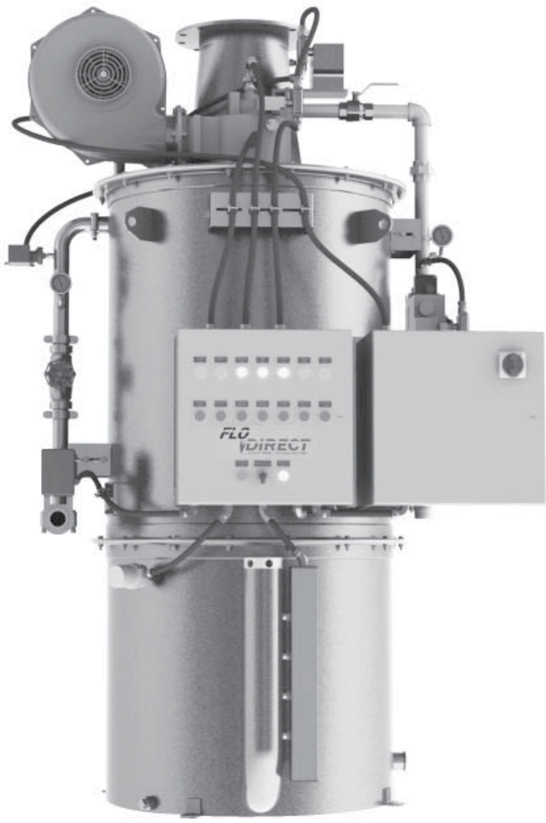
Armstrong Flo-Direct CTE gas fired water heaters achieve CTE Standards

The Flo-Direct CTE direct contact water heaters, meet five standards not available with the older designs and traditional methods of direct contact water heater technology:

1. CTE units maintain a minimum of 99.7% high heat value (110% approx. low heat value) efficiency in all modes of operation, not just under optimal conditions.
2. CTE units have multiple thermal passes. Water and the combustion gasses (or heat from the combustion) repeatedly come in contact. This ensures that the maximum amount of heat or energy from combustion is transferred to the water.
3. CTE units have a dry combustion chamber. This is vital to maintaining complete combustion at all times during operation.
4. CTE units maintain complete combustion at all times.
5. CTE units must have an integral water quality integrity system. Operational procedures must be in place to ensure that effluent water quality is equal to the influent water quality.

Complete Combustion = Complete Water Quality

While many traditional-method direct contact water heaters spray water directly on the flame – sometimes called "flame quenching" – Flo-Direct, using CTE technology, avoids this process altogether. According to the Industrial Heating Equipment Association's "Combustion Technology Manual," flame quenching promotes incomplete combustion, and produces alcohols, aldehyde, formic acid, higher order acids, carbon monoxide, as well as carbon dioxide and water vapor. With CTE technology, Flo-Direct maintains 99.7% high heat value* (110% approx. low heat value) combustion efficiency, while maintaining water quality at all times.
*See page 530 for high heat value (HHV) and low heat value (LHV) explanation.



Global Water Quality Standards

Flo-Direct Complete Thermal Exchange (CTE) Gas Fired Water Heating Technology significantly limits the effluent water chemical additives typically attributed to other process water heating systems.

Our unique CTE water heating process deaerates the water significantly. Independent third party testing has verified CTE technology can actually remove some chemical constituents from the influent water.

NSF test results show that the effluent water from a Flo-Direct CTE Gas Fired Water Heater meets US, European Union and PRC bottled drinking water standards* and has been tested and documented as fully compliant with:

• USFDA - The United States Food and Drug Administration, Code of Federal Regulations Bottled Water Standard: Chapter I, Title 21, Part 165, Subpart B, Section 165.110.

• EU-TRW - The European Union Directives(s) - Treated Waters: 98/83/EC.

* Peoples Republic of China Standards for Drinking Water: GB5749-2006

*Statement presumes influent water also meets listed standards.

Flo-Direct®
Complete Thermal Exchange Gas Fired Water Heater

Specifications	
Gas Supply Pressure	2 - 6 psig / .14 - .41 bar
Dynamic Water Supply Pressure	Constant water pressure (+/-5 psi variation maximum) within a minimum of 30 psig/2 bar and a maximum of 100 psig/6.8 bar range is required for optimum performance.
Maximum Inlet Water Temperature	120°F (49°C)
Minimum Inlet Water Temperature	32°F (0°C)
Maximum Effective Outlet Temperature	185°F (85°C)

Standard Sizing Formulas

$\frac{gpm}{2} \times \Delta T$ = AFD Model

$\frac{(\text{AFD Model}) \times 2}{\Delta T}$ = gpm

(AFD Model) x 2 = ΔT gpm

Standard Formula Key

gpm = Gallons per Minute

ΔT = Temperature rise (ºF)

AFD = Armstrong Flo-Direct (e.g., 1000, 5000)

Use the Flo-Direct sizing tool at **armstrong**international.com/flo-direct

Metric Sizing Formulas

$\frac{lpm}{4.2} \times \Delta T$ = AFD Model

$\frac{(\text{AFD Model}) \times 4.2}{\Delta T}$ = lpm

(AFD Model) x 4.2 = ΔT lpm

Metric Formula Key

lpm = Liters per Minute

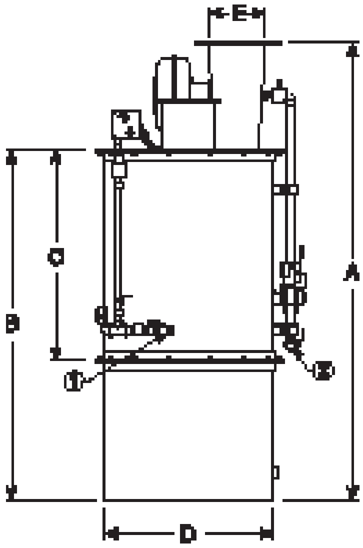
ΔT = Temperature rise (ºC)

AFD = Armstrong Flo-Direct (e.g., 1000, 5000)

Use the Flo-Direct sizing tool at **armstrong**international.eu/flo-direct

Materials	
Upper and Lower Canister	Type 304 Stainless Steel #10 Glass Finish
Inlet Gas Train Piping	Malleable Iron with Standard Yellow Finish
Inlet Water Train Piping	Copper with Brass/Bronze Fittings
Spray Ring	Type 304/316 Stainless Steel
Canister Gaskets	Warco White
Flame Tube	Type 304 Stainless Steel
Pall Rings	Type 304 Stainless Steel

Optional/Custom materials of construction available upon request.



For fully detailed certified drawing, refer to CDY #1088.

Flo-Direct Dimensions and Weights

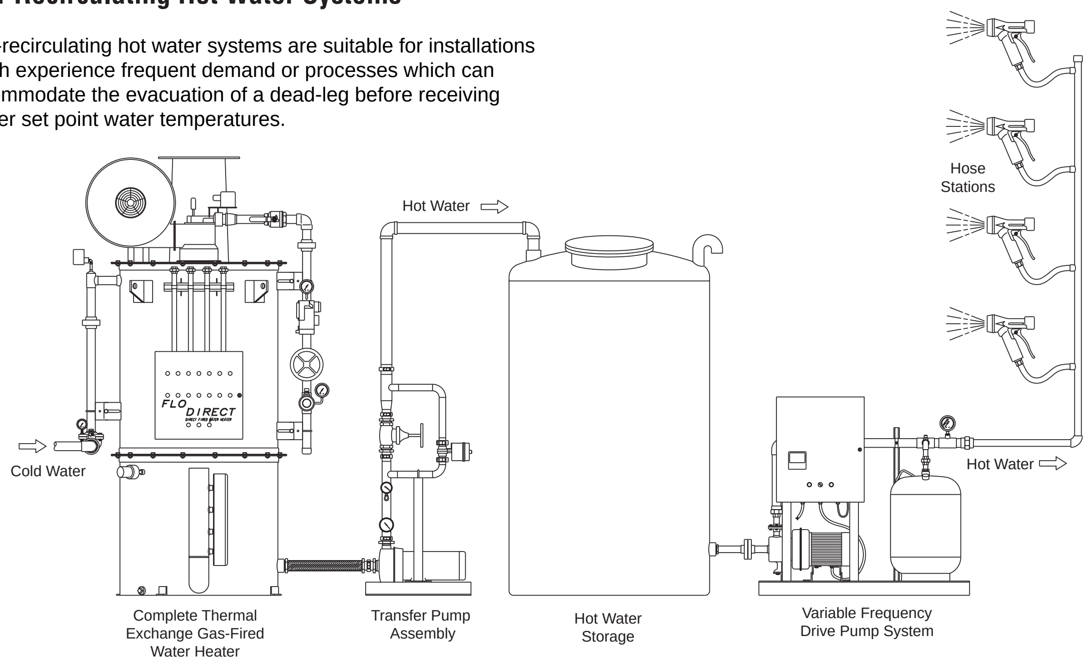
Model	Connections* 1		Connections* 2		Dimensions A		B		C		D		E		Weight*		btu/hr	kW
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	lb	kg		
1000	1	25	1	25	95	2413	71	1803	39	991	24	610	8	203	825	375	1,000,000	292
1500	1	25	1	25	97	2464	73	1854	41	1041	26	660	8	203	850	386	1,500,000	439
2000	1-1/2	40	1-1/2	40	100	2540	76	1930	44	1118	30	762	10-3/4	273	1500	680	2,000,000	585
3000	2	50	1-1/2	40	100	2540	76	1930	44	1118	36	914	12	305	1600	725	3,000,000	878
4000	2	50	2	50	104	2642	80	2032	48	1214	40	1016	14	356	2000	907	4,000,000	1171
5000	2-1/2	65	2	50	127	3226	97	2464	65	1651	44	1118	16	406	2500	1136	5,000,000	1464
6000	3	80	2	50	132	3353	100	2540	70	1778	47	1194	18	457	2900	1316	6,000,000	1757
7000	3	80	2	50	139	3531	107	2718	77	1956	50	1270	18	457	3200	1455	7,000,000	2050
8000	3	80	2	50	139	3531	107	2718	77	1956	50	1270	18	457	3200	1455	8,000,000	2342
9000	3	80	2	50	169	4293	139	3531	107	2718	60	1524	20	508	5000	2273	9,000,000	2635
10000	3	80	2	50	181	4597	151	3835	119	3023	61	1549	20	508	5200	2405	10,000,000	2928
11000	4	100	3	80	181	4597	151	3835	119	3023	61	1549	22	559	5500	2495	11,000,000	3221
12000	4	100	3	80	181	4597	151	3835	119	3023	61	1549	22	559	5500	2495	12,000,000	3514
13000	4	100	3	80	192	4877	161	4089	129	3277	70	1778	24	610	7000	3175	13,000,000	3807
14000	4	100	3	80	192	4877	161	4089	129	3277	70	1778	24	610	7000	3175	14,000,000	4099
15000	4	100	3	80	192	4877	161	4089	129	3277	70	1778	24	610	7000	3175	15,000,000	4392
16000	4	100	3	80	216	5486	185	4699	153	3886	70	1778	24	610	7500	3402	16,000,000	4685

Hot Water Systems

Flo-Direct Complete Thermal Exchange Gas Fired Water Heaters deliver a wide variety of hot water solutions.

Non-Recirculating Hot Water Systems

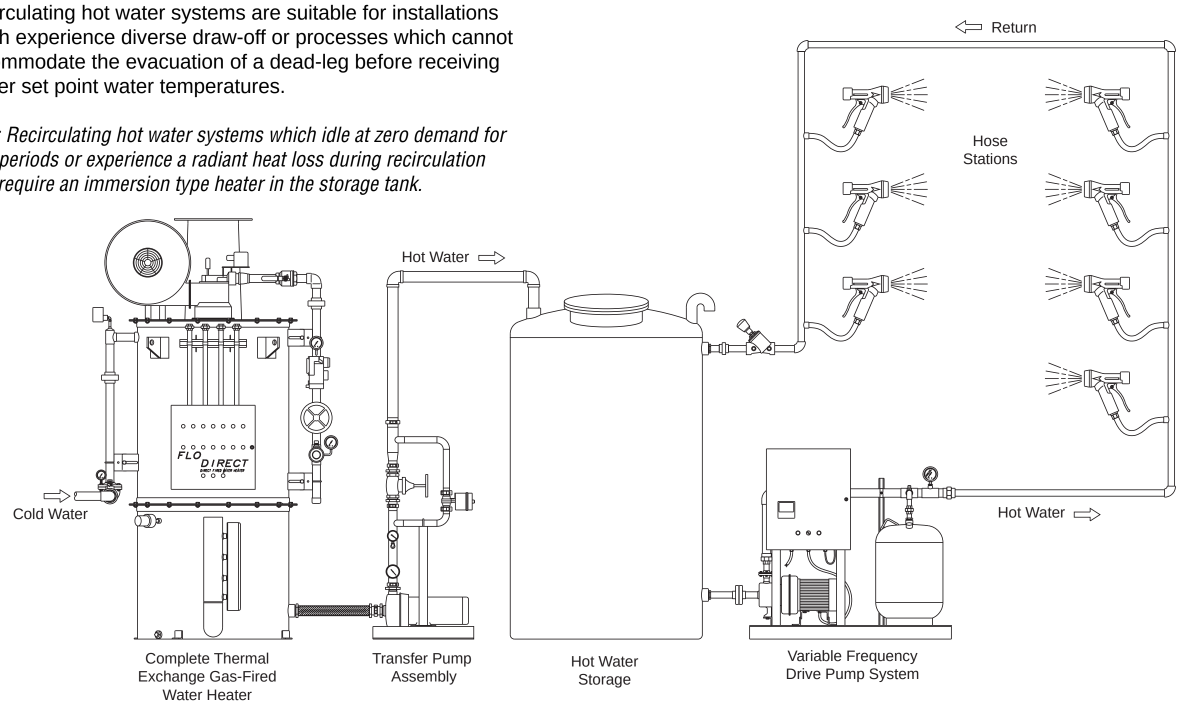
Non-recirculating hot water systems are suitable for installations which experience frequent demand or processes which can accommodate the evacuation of a dead-leg before receiving heater set point water temperatures.



Recirculating Hot Water Systems

Recirculating hot water systems are suitable for installations which experience diverse draw-off or processes which cannot accommodate the evacuation of a dead-leg before receiving heater set point water temperatures.

Note: Recirculating hot water systems which idle at zero demand for long periods or experience a radiant heat loss during recirculation may require an immersion type heater in the storage tank.

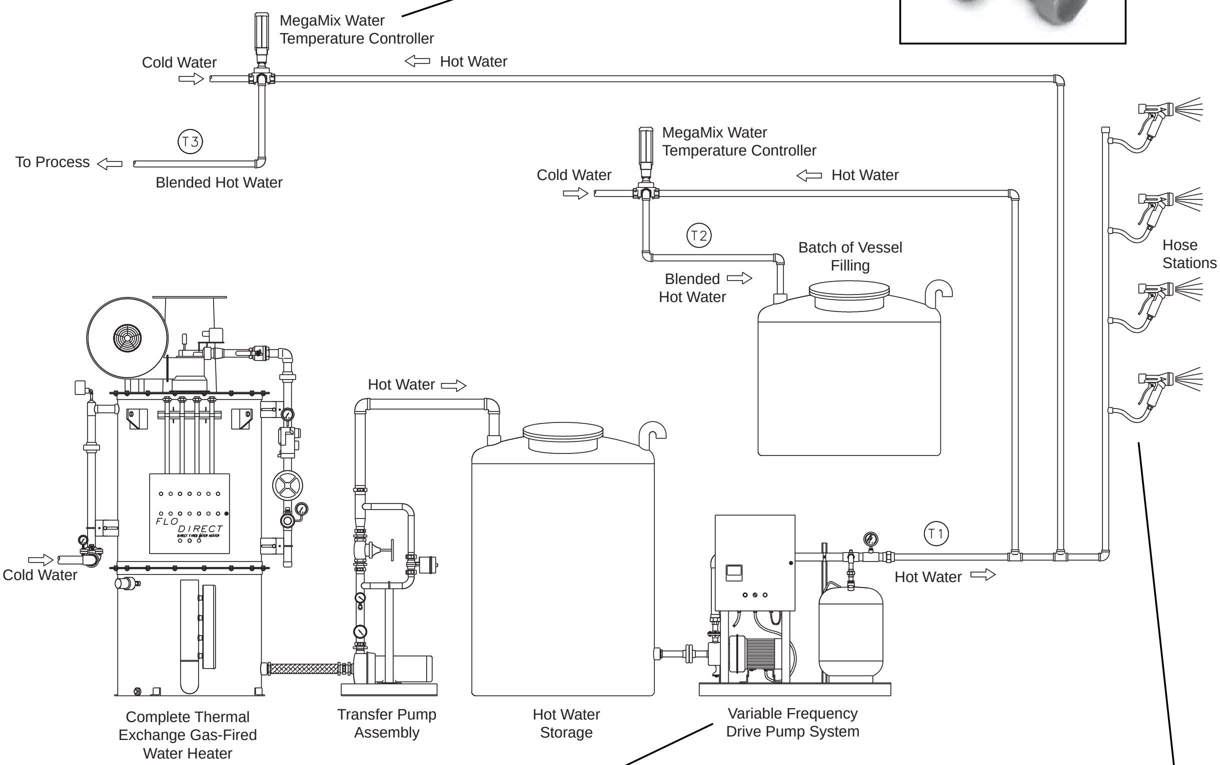


Hot Water Systems

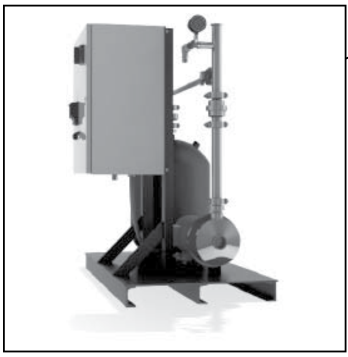
Multiple Temperature Hot Water Systems

Multiple temperature hot water systems can be designed as either recirculating, non-recirculating or a combination of both. To achieve multiple temperatures for the same hot water system, Armstrong recommends one or more MegaMix™ electronic water temperature controllers along with Armstrong thermostatic hot and cold water hose stations.

MegaMix™ Water Temperature Controller

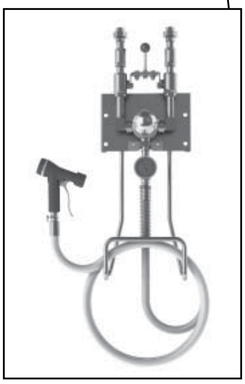


Armstrong Variable Frequency Drive Pump Assemblies



It is strongly recommended that the hot water storage temperatures are maintained at 140ºF (60ºC) or higher in accordance with US OSHA and CDC and corresponding global legionella guidelines. If water temperatures below 140ºF (60ºC) are required, Armstrong offers a variety of supplemental thermostatic, electronic and digital water temperature controllers.

Armstrong Hot/Cold Water Hose Station



Conformité Européane (CE)

Flo-Direct is U.S. Patent 5,924,301

Flo-Direct Complete Thermal Exchange Gas Fired Water Heaters are fully compliant and correctly identified as required by the relevant CE marking regulations.

This includes:
- Low Voltage Directive (2006/95/EC)
- EMC Directive (2004/108/EC)
- Machinery Directive (98/37/EC)
- Gas Directive (90/396/EC)

High Heat Value vs. Low Heat Value

High Heat Value = Total Energy Content of Fuel	Low Heat Value = Total Heat of Hot Water or Steam Generated by the boiler

High Heat Value (HHV) is the method for evaluating boiler efficiency typically used in the USA. The efficiency is calculated by comparing the total heat content (enthalpy) of the hot water or steam generated by a boiler with the total potential energy of the input fuel.

As a result efficiency measured using HHV will not exceed 100%.

Low Heat Value (LHV) is the method for evaluating boiler efficiency typically used in Europe. A LHV calculation includes recoverable heat.

Combustion exhaust contains hot water vapor which is created by both the evaporation of the water contained in the input fuel and the chemical reaction in the combustion process. Newer technologies such as “condensing” type water heaters and boilers can capture the “latent” heat.

As a result efficiency measured using LHV can, in some cases, exceed 100%.

When developing unit and system efficiency comparisons it is important to first determine whether the stated heat transfer efficiency is measured in HHV or LHV.

Plate Heat Exchanger Packages

Armstrong can provide a full range of either brazed plate or gasketted plate type heat exchangers for all hot water generation applications. These can be supplied either as stand alone units or assembled in our own fabrication workshop as skid mounted packages inclusive of all valves and control equipment. Please **CONTACT US** for further technical assistance.

Gasketed Plate Heat Exchangers are made up of a series of assembled corrugated plates. Between the plates there are two channels with a cold and warm medium (EG: water, steam etc).

These pass on each side of the plates and in opposite direction to each other. Our product portfolio includes various types of plate heat exchangers and freshwater distillers such as:

- **Gasketed**
- **Semi-welded and fully welded**
- **Brazed**
- **Free Flow**
- **Plate and Shell**
- **Shell and Tube**
- **Fresh Water Distillers (FWD)**

THERM-OMEGA-TECH
ISO 9001 CERTIFIED

MODEL HAT
IN-LINE TEMPERATURE CONTROL

FREEZE PROBLEMS?
CALL THE GURU 1-877-FRZ-VALVE

DESIGN FEATURES

- Stainless steel body, fittings, spring and plug
- Corrosion resistant - Long service life
- Most narrow temperature band available
- Compact, low mass - Fast response
- Ram-type plug for reliable tight shutoff
- Downstream actuator for greater sensitivity
- Sensitive to temperature only
- Unaffected by pressure variations
- Easy installation with pipe wrench

ADVANTAGES

These valves save space and are easy and inexpensive to install. The unique ram-type plug & seat provide reliable, tight shut off longer than any other design available. ***HAT*** valves are covered with our standard 36 month prorated warranty & service policy to further reduce maintenance cost. Since ***HAT*** valves discharge condensate well below steam temperature, live steam losses are eliminated. For heating of temperature sensitive instruments or process fluids, the reduced temperature available for tracing simplifies operations and eliminates overheating problems. For other heat transfer fluids, ***HAT*** valves maintain a constant discharge temperature, thus providing benefits of accurate process temperature control and improved efficiency.

OPERATION

The ***HAT*** valve responds only to temperature. After condensate forms and cools to near the setpoint, the ***HAT*** valve modulates the flow to maintain a constant condensate discharge temperature. ***HAT*** valves are wide open at start-up for rapid venting and initial heat-up. ***HAT*** valves are self-draining after shutdown, to eliminate freeze damage.

APPLICATIONS

Therm-Omega-Tech ***HAT*** (Heat Actuated Trap) valves are commonly used as sub-cooling steam traps. ***HAT*** valves are ideal for replacing conventional steam straps on winterization tracing, instrument tracing, condensate return system freeze protection, tracing for processes under 150°F (65°C), and other applications requiring in-line flow control based on temperature. ***HAT*** valves are also suitable for controlling discharge temperature in fluid tracing systems.

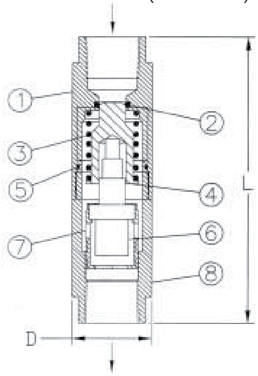
HAT (REV: 07/11/2007)

MODEL HAT

FIELD SERVICEABLE IN-LINE TEMPERATURE CONTROL VALVE

PARTS AND MATERIALS

INLET (see note #3)



OUTLET

ITEM	DESCRIPTION	MATERIAL
1	BODY - INLET HALF	300 SERIES STAINLESS
2	SEAT SEAL	PTFE
3	OPERATING SPRING	300 SERIES STAINLESS
4	RAM- TYPE PLUG	300 SERIES STAINLESS
5	BODY SEAL	EPDM / VITON
6	THERMAL ACTUATOR	BRASS or SS
7	ACTUATOR CARRIER	BRASS or SS
8	BODY - OUTLET HALF	300 SERIES STAINLESS

SPECIFICATIONS

Size (NPTF)	D		L		WEIGHT		Port Size	Cv	Maximum Pressure	Maximum Temperature
	in	mm	in	mm	Lb	Kg				
1/2"	1.25	32	4.5	114	0.9	0.41	C	1.3	200 PSIG (13.8 BAR)	300°F (149°C)
3/4"	1.5	38	5.5	140	1.4	0.64	D	2		

TO ORDER SPECIFY: (see note 1 for standard temperatures)

Part Number		Description
EPDM Seals	Viton Seals	
134 - 302100 - XXX	134 - 302200 - XXX	1/2" HAT C-Port
134 - 312100 - XXX	134 - 312200 - XXX	1/2" HAT C-Port, all SS
135 - 502100 - XXX	135 - 502200 - XXX	3/4" HAT D-Port
135 - 512100 - XXX	135 - 512200 - XXX	3/4" HAT D-Port, all SS

NOTES:

1. Standard open temperatures “XXX” available: 040F, 050F, 055F, 060F, 065F, 075F, 085F, 090F, 095F, 100F, 105F, 110F, 125F, 130F, 140F, 150F, 155F, 160F, 170F, 180F, 190F and 200F.
   Note: Closing temperature is typically 10F above opening temperature

2. Seal Material compatabiity:
   a. EPDM - air (to 300F), water, steam, ketones and synthetic hydraulic oils.
   b.Viton - air (to 450F), fuel, oil, gas, petroleum-based hydrulic oils.

3. Flow direction is reversed in valves that close over 200°F

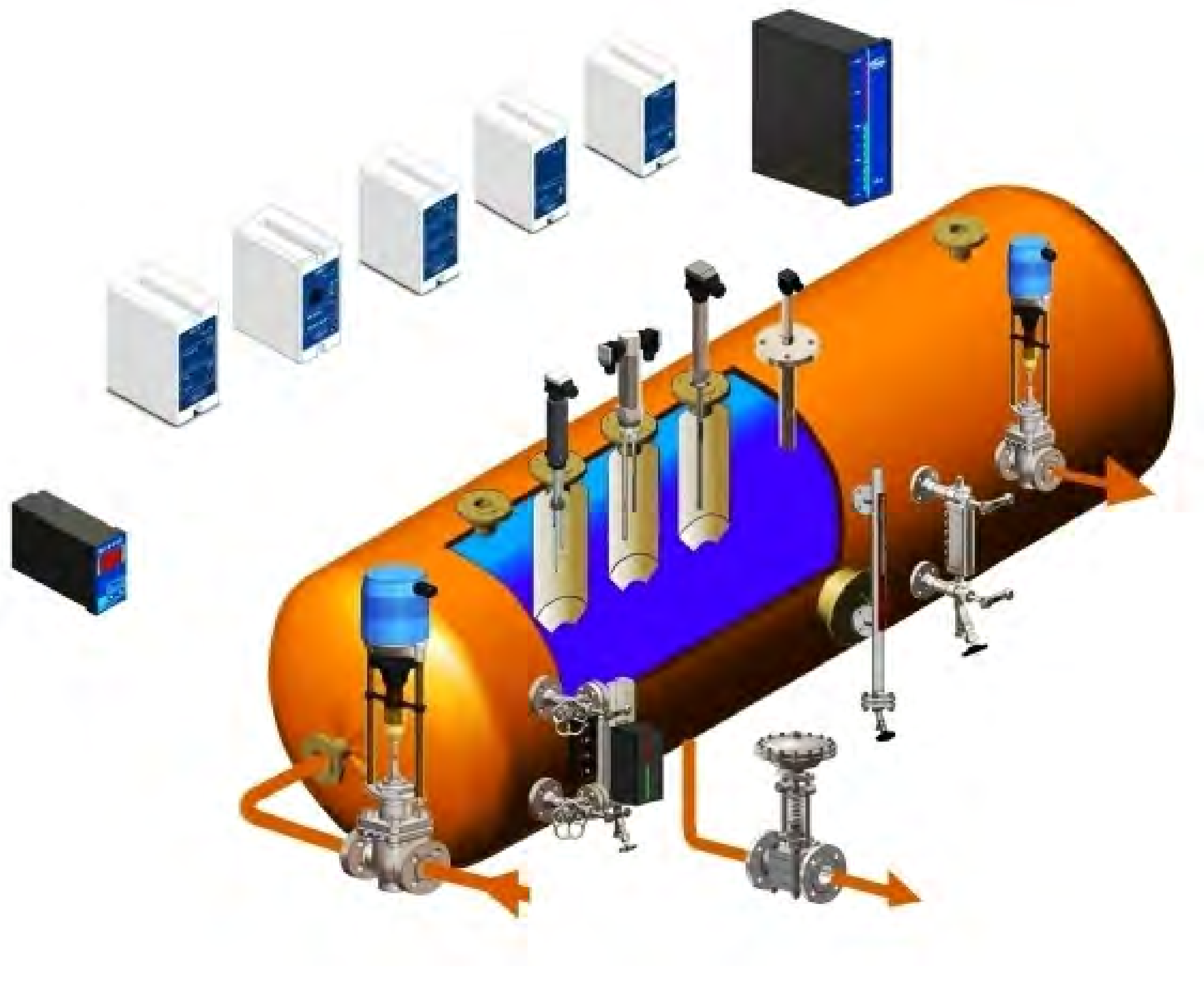
4. A#20 mesh stainer is recommended for use with all port sizes

Therm-Omega-Tech, Inc. reserves the right to change the design and specifications without notice

ARMSTRONG
FLOW CONTROL

Boiler Controls & Waste Heat Recovery

IGEMA BOILER LEVEL & TDS CONTROLS



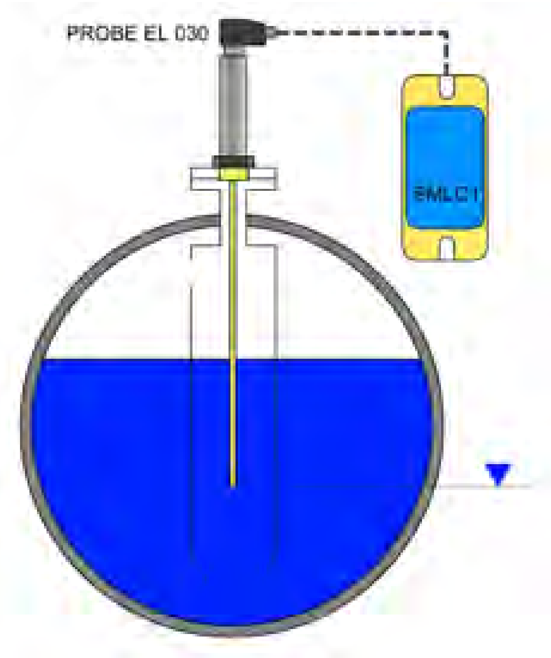
IGEMA offers boiler level and TDS control products of the highest quality standard, being certified to ISO 9001.

Made in Germany, *IGEMA* products are manufactured in compliance with the European Pressure Directive 97/23, and the current standards for steam boiler operation, such as TRD – German Technical Regulations for Steam Boilers, AD 2000 – Workgroup for Pressure Vessels, ASME boiler codes etc.

Type Approvals have been obtained from virtually all significant international classification societies, such as TUV Rheinland, German Lloyd, Det Norske Veritas, Lloyds Register to name a few.

PROBE-TYPE LEVEL CONTROLS & ALARMS

FOR ATTENDED AND UNATTENDED BOILERS



UNATTENDED BOILERS – Self-Checking Low Level Alarm

The combination of probe EL 30 and controller SMLC1 represents a High Integrity Water Level Limiter of Special Design.

Featuring an insulated compensating electrode in addition to the measuring tip, these probes are designed to respond to any conceivable failure condition, such as scaling due to boiler water impurities, open or short circuit of internal and external wiring or leakage of boiler water.

The SMLC1 controller checks system integrity continuously. It incorporates a cyclic self-test function. If it fails to react to a simulated fault, the burner safety circuit is activated.

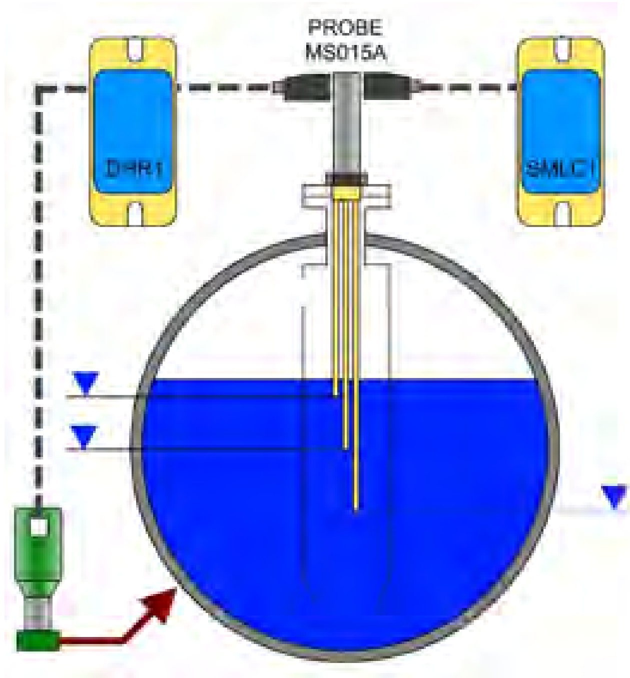
Similar models are available for High Level Alarm and for boiler pressure to 200 bar.

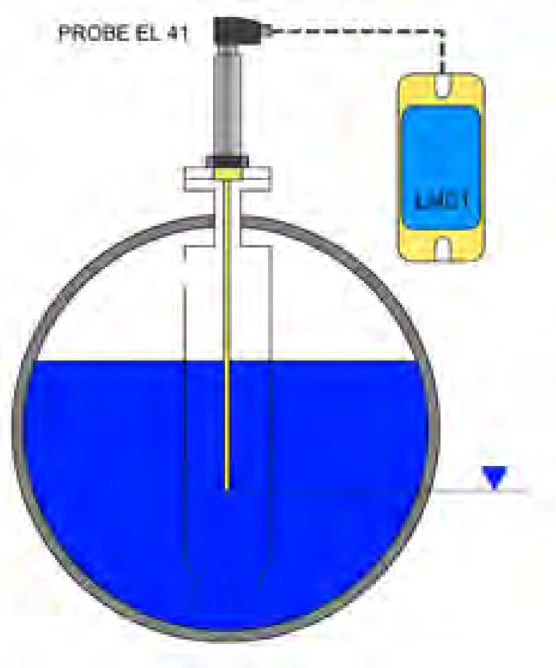
UNATTENDED BOILERS – Self-Checking Low Level Alarm and Feed Pump On-Off Control

The probe MS015A combines a High Integrity Water Level Limiter of Special Design with two additional standard design probes.

The self-checking SMLC1 controller serves as the Water Level Limiter, while the DHR1 controller switches the feed pump on and off as signalled by the additional standard probes.

This represents a compact and economical system, since only a single probe entry into the boiler shell is required for both self-checking low level alarm and feed pump on-off control.





ATTENDED BOILERS – Standard Low Level Alarm

The combination of EL 41 probe and controller LMC1 are used for applications where there is no requirement for Self-Checking.

This high quality equipment is designed to comply with the relevant European boiler codes such as TRD and Water Level 2000.

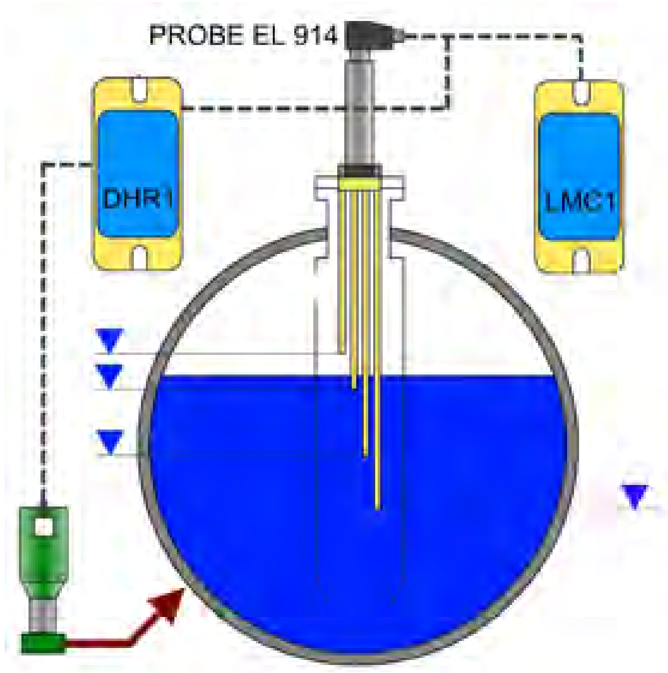
Alternative probes for high level alarm and for boiler pressures to 200 bar are available.

ATTENDED BOILERS – Standard Low Level Alarm with Feed Pump On-Off Control and High Level Alarm

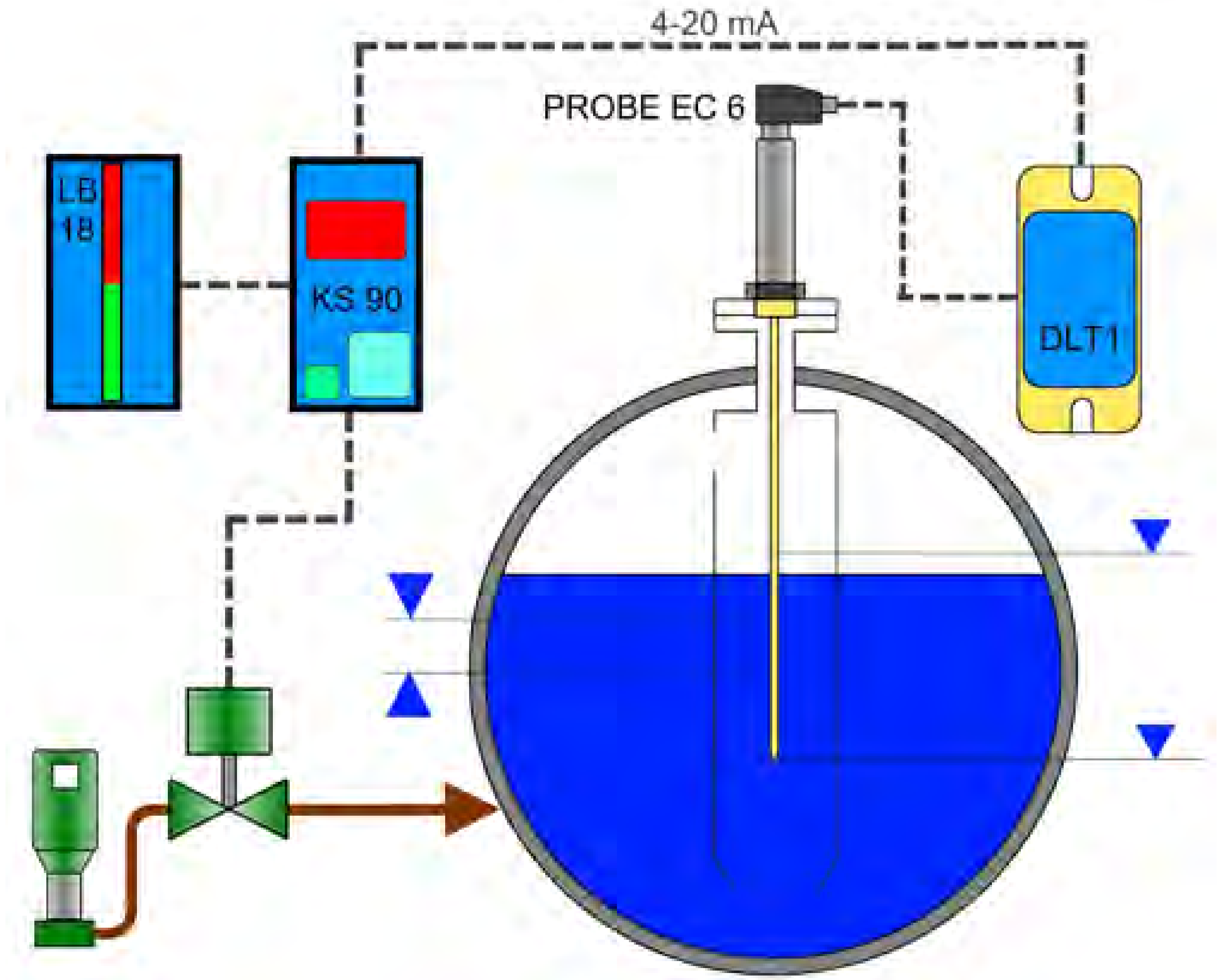
The multiple probe EL 914 is used for many applications requiring up to 4 individual switching or alarm points.

Combined with the DHR1 feed pump on/off controller with high level alarm, and an LMC1 controller for low level alarm, this gives an example of the versatility of the EL 914 multiple probe.

This probe is also available with 2 points (EL 912) or 3 points (EL 913).



MODULATING BOILER LEVEL CONTROLS



The basic **IGEMA** modulating control system comprises a capacitance probe EC 6, and a DLT 1 level transmitter.

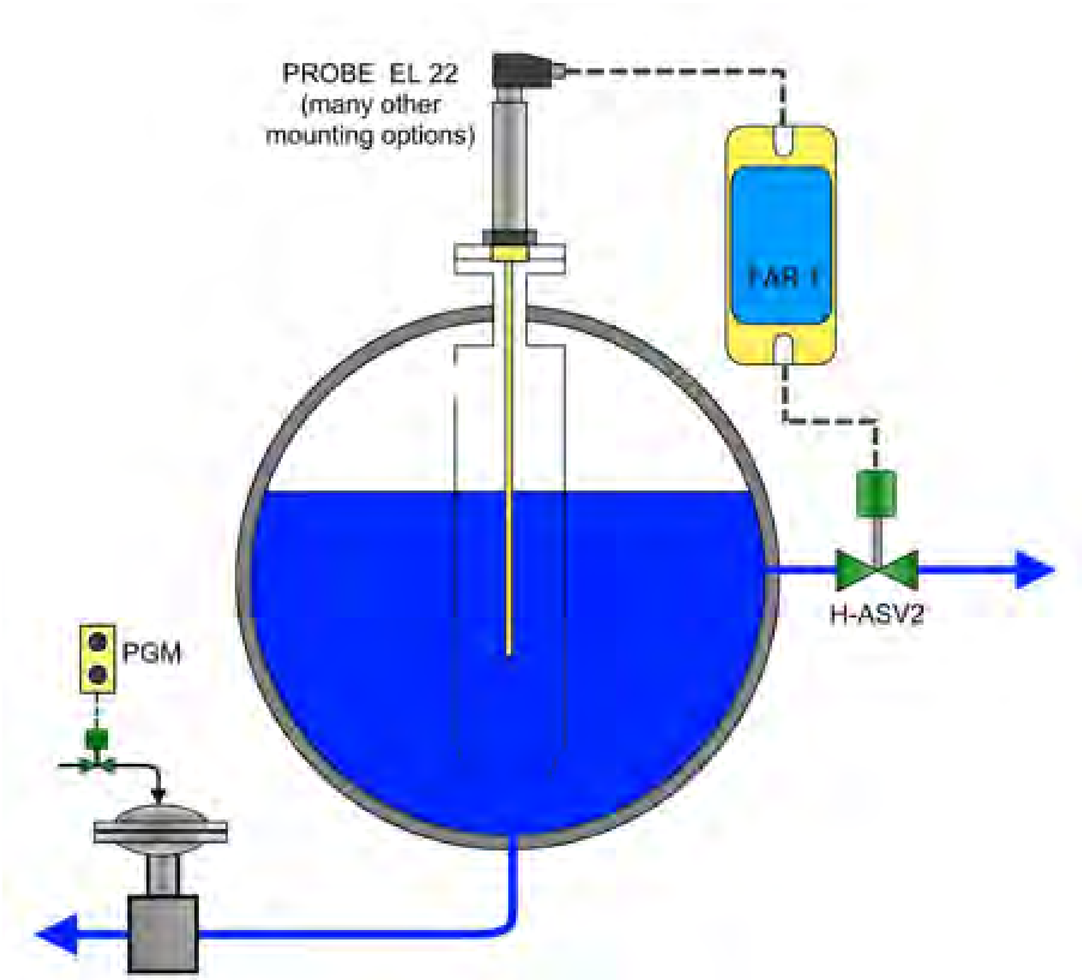
This combination provides for a 4-20mA output signal proportional to the desired level control range.

The PID controller KS 90 or KS 40 accepts the 4-20mA signal and provides an appropriate output to the electric actuator of the feedwater control valve.

This relatively simple system has been found to provide excellent control for the majority of boilers, usually with a bypass orifice to ensure feed pump minimum flow requirements.

For situations with extremely rapid load swings, it is possible to add a feed forward signal from a steam flow meter, and/or feed back from a feed water flow signal to compensate for the effects of boiler water level sag or swell.

BOILER BLOWDOWN CONTROLS



INTERMITTENT BLOWDOWN FOR SEDIMENT AND SLUDGE CONTROL

If continuous blowdown is employed for TDS control, the requirement for intermittent blowdown to remove settled sludge and other solids from the bottom of the boiler drum can be reduced to a few seconds per day.

IGEMA bottom blowdown valves are available for pressures to 50 bar.

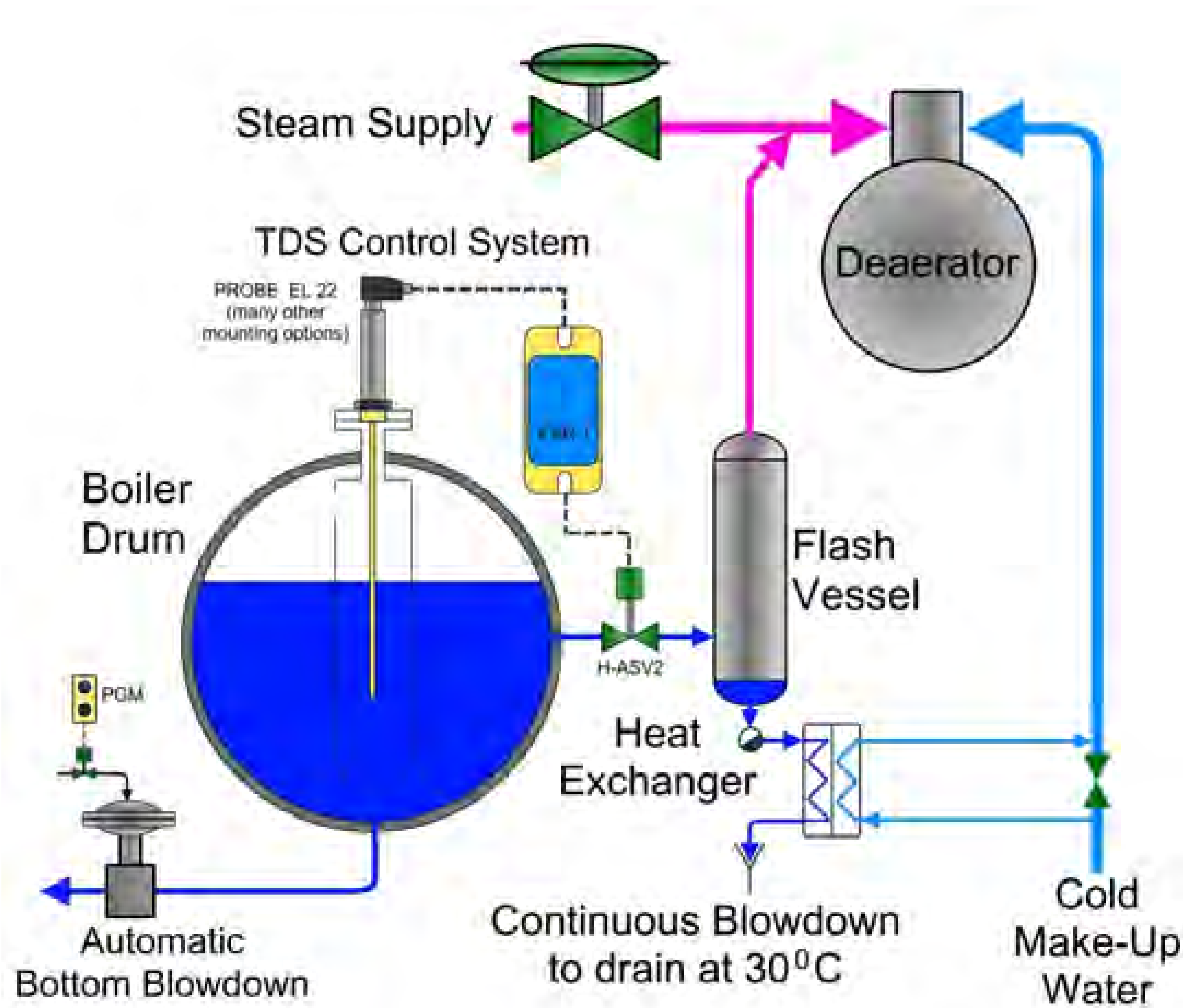
Control can be manual or via timer-controlled pneumatic actuator.

CONTINUOUS BLOWDOWN FOR TDS (Total Dissolved Solids) CONTROL

Boiler water conductivity is closely related to TDS. An appropriate IGEMA conductivity electrode measures conductivity, which is amplified by the FAR1 blowdown setpoint controller. The output signal from the FAR1 is applied to the electric actuator of the H-ASV2 continuous blowdown valve.

This system not only ensures that boiler water TDS stays within allowable limits. It also saves energy by limiting the amount of heat and treated water discharged from a boiler to the absolute minimum.

BOILER BLOWDOWN & HEAT RECOVERY



ENERGY-EFFICIENT BOILER BLOWDOWN HEAT RECOVERY

Boiler water discharging as continuous blowdown contains both the sensible heat at boiler pressure and the latent heat content due to let-down from boiler pressure to near-atmospheric pressure.

With a THERMGARD 2-stage blowdown heat recovery system, typically some 80% of this otherwise wasted heat content is saved.

In addition, a significant amount of treated boiler water is saved, due to condensation of flash steam in the deaerator or feed tank.

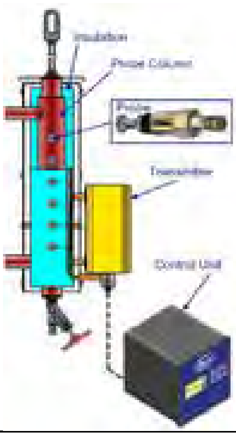
Payback periods of less than 2 years are the norm. In applications where there is a high amount of make-up causing high continuous blowdown, the payback is sometimes only a few months.

OTHER IGEMA EQUIPMENT

Illuminated boiler level gauges – any application to 200 bar

Float-Type level controls for boiler pressure to 200 bar.

Also for Self-Checking Applications



Remote Level Indication

Boiler Conductivity Probes

Bi-Colour Level Gauges

Aspects you should consider:

- *Requirements for efficient boiler blowdown.*
- *Manual or Automatic TDS control, intermittent or continuous.*
- *Benefits of continuous blowdown.*
- *Calculation of blowdown rate.*

- *Blowdown heat recovery.*
- *Flash steam recovery.*
- *Residual sensible heat recovery.*
- *Calculation of heat recovery potential and payback period.*
- *Integration with feed tank or deaerator.*

Boiler Blowdown has two distinct separate purposes:

*1. To ensure that the concentration of total **dissolved** solids (TDS) is kept below a certain maximum allowable level.*

*2. To prevent the accumulation of **suspended** solids that collect at the bottom of the boiler drum.*

The TDS concentration gradually increases due to evaporation. To ensure steady conditions, blowdown for TDS control should be continuous.

Suspended solids removal from the bottom of the boiler needs only a puff of blowdown for a few seconds once or twice per shift.

Feedwater = Condensate Return + Make-Up water.

Feedwater has to be treated to inhibit corrosion and scale formation.

Standard industrial boiler water treatment: *Base Exchange water softening + Chemical dosing + Blowdown to limit TDS to a safe level.* ***This is managed by a chemical specialist.***

Excessive TDS causes scaling, foaming and carry-over of boiler water.

Excessive blowdown causes higher energy and treated water costs.

Good blowdown control results in economical boiler operation.

Good blowdown control is essential for all aspects of boiler water treatment.

THEREFORE THE CHEMICAL SPECIALIST IS VITALLY INTERESTED IN PROPER BLOWDOWN PROCEDURES.

WHAT DO THE CHEMICAL COMPANIES SAY?

(extract from a boiler water treatment company info sheet)

The main purpose of blowdown is to maintain the solids content of the boiler water within prescribed limits. This would be under normal steaming conditions. However, in the event contamination is introduced in the boiler, high continuous and manual blowdown rates are used to reduce the contamination as quickly as possible.

Bottom Blowdown

By definition, bottom blowdown is intermittent and designed to remove sludge from the areas of the boiler where it settles. The frequency of bottom blowdown is a function of experience and plant operation. Bottom blowdown can be accomplished manually or electronically using automatic blowdown controllers.

Continuous Blowdown

Frequently used in conjunction with manual blowdown, continuous blowdown constantly removes concentrated water from the boiler. By design, it is in the area of highest boiler water concentration. This point is determined by the design of the boiler and is generally the area of greatest steam release. With modern boilers having high circulation, this point can be practically anywhere.

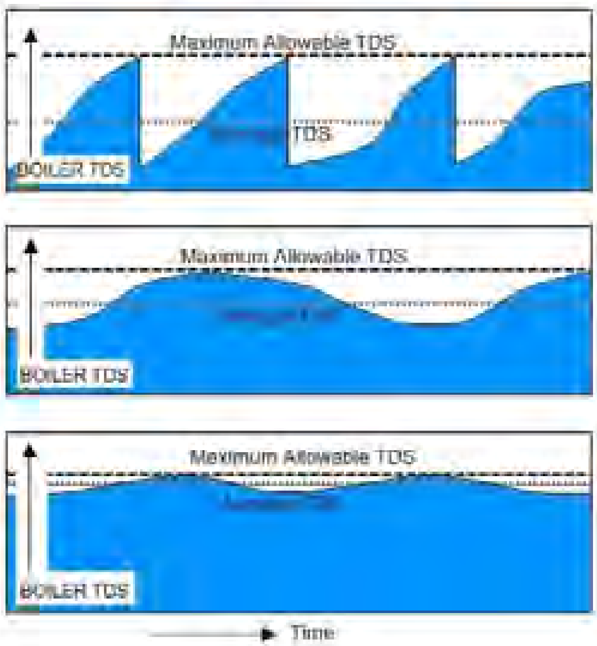
Continuous blowdown allows for excellent control over boiler water solids. In addition, it can remove significant levels of suspended solids. Another advantage is that the continuous blowdown can be passed through heat recovery equipment.

TDS CONTROL - THE CASE FOR AUTOMATIC CONTINUOUS BLOWDOWN

ONLY INTERMITTENT BLOWDOWN
The boiler water TDS falls after each blowdown, then gradually increases over time. The average TDS is therefore well below the maximum TDS allowable, consequently wasting heat and water.

MANUAL CONTINUOUS BLOWDOWN
The constant blowdown rate keeps the average TDS much closer to the maximum. However, TDS still varies in line with changing operating conditions and boiler load variations.

AUTOMATIC CONTINUOUS BLOWDOWN
Operating changes can be compensated for by continuously measuring boiler TDS and controlling the blowdown rate. The average TDS is now practically identical to the maximum allowable, and the amount of blowdown is reduced to the minimum.



CALCULATION OF CONTINUOUS BLOWDOWN RATE

Continuous blowdown and automatic TDS control ensures:

Least amount of heat loss.

Least amount of treated water loss.

Stable chemistry inside boiler.

No upsets due to foaming or carry-over.

Heat recovery can be considered.

$$\boxed{\text{Blowdown rate} = (F / B - F) \times \text{Steam Rate}}$$

F = TDS feedwater B = TDS boiler water

TDS feedwater is the sum of TDS make-up water, percentage of condensate return and TDS due to treatment chemicals.

TDS boiler water is the desired maximum TDS in the boiler.

SAVINGS DUE TO AUTOMATIC TDS CONTROL

Example for 5 t/h, 10 bar watertube boiler, 6000 hours/year, cost of fuel $ 10/GJ, cost of treated feedwater $ 2/kL:

Blowdown water heat content = 782 kJ/kg at 10 barg (sensible heat boiler water).

TDS of feedwater = 150 ppm

Max. allowable TDS = 2500 ppm

Actual average TDS with intermittent blowdown to ensure the max. allowed TDS is not exceeded = 1500 ppm

Blowdown rate = F/B-F x 5000 kg/h

For intermittent blowdown = 150/1500-150 x 5000 kg/h = 555 kg/h

Heat loss = 555 kg/h x 782 kJ/kg = 0.43 GJ/h x $ 10/GJ x 6000 h/y

Heat loss cost = $ 25,800/year

For continuous blowdown = 150/2500-150 x 5000 kg/h = 319 kg/h

Heat loss = 319 kg/h x 782 kJ/kg = 0.25 GJ/h x $ 10/GJ x 6000 h/y

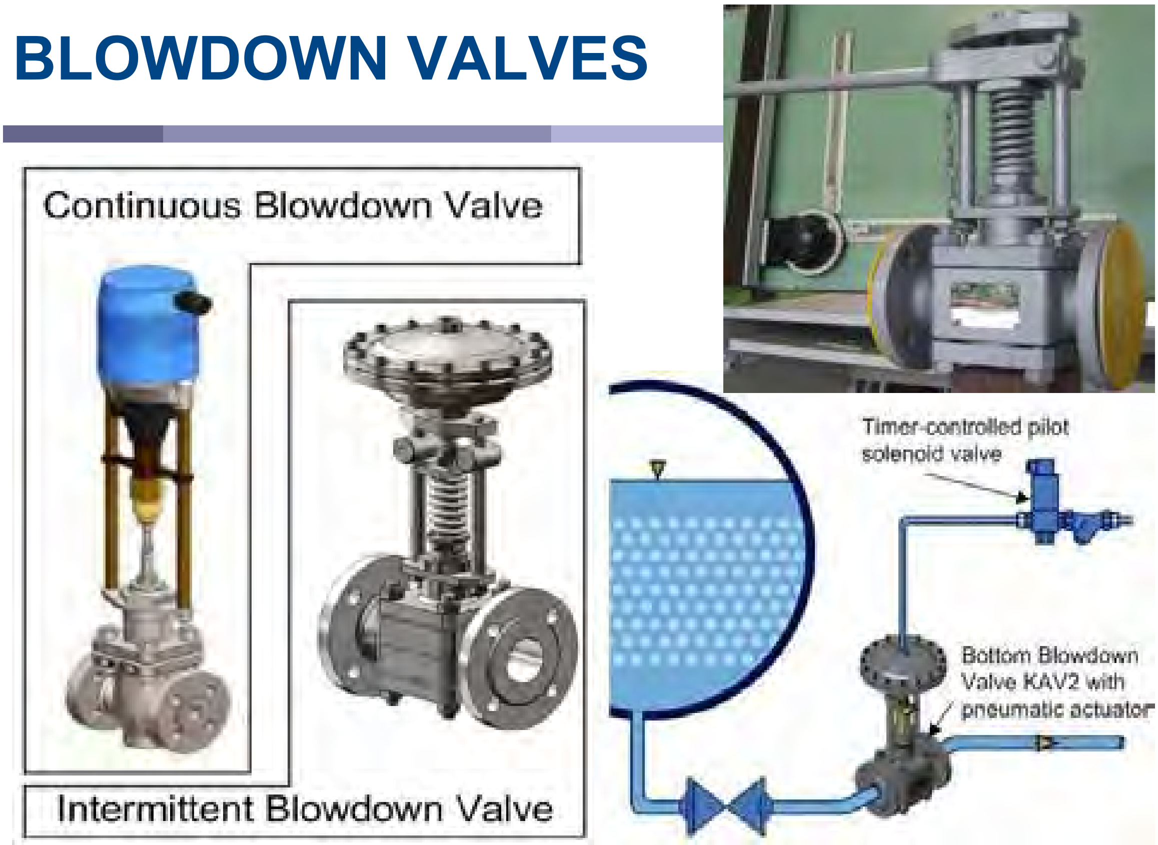
Heat loss cost = $ 15,000/year

SAVING DUE TO AUTO. BLOWDOWN = $ 10,800 /YEAR

There is also a saving of treated water cost of 1416 kL/y = $ 2,832/YEAR

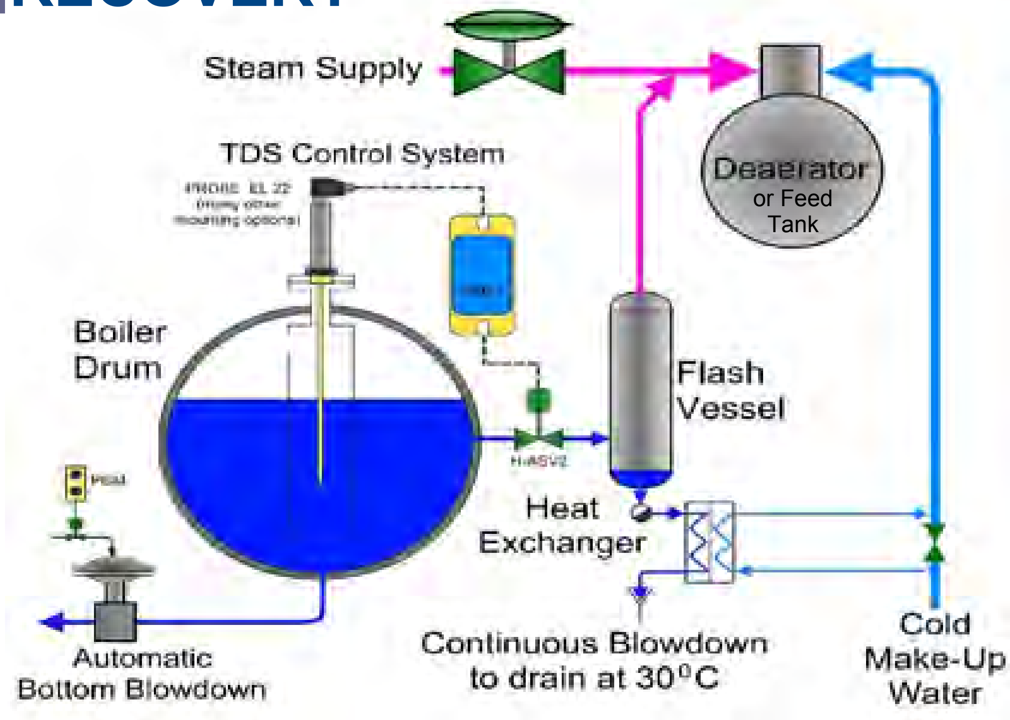
AUTOMATIC TDS CONTROL SYSTEM

BLOWDOWN VALVES



10

CONTINUOUS BLOWDOWN HEAT RECOVERY



SAVINGS DUE TO FLASH STEAM RECOVERY

Example for 5 t/h, 10 bar watertube boiler, 6000 hours/year,
cost of fuel$ 10/GJ:

Flash Steam = Blowdown flow 319 kg/h x (h_{f1} – h_{f2} / h_{fg2})

Sensible heat water before expansion h_{f1} = 782 kJ/kg at 10 barg.

Sensible heat water after expansion h_{f2} = 419 kJ/kg at 0 barg.

Latent heat steam after expansion h_{fg2} = 2257 kJ/kg at 0 barg.

Sensible heat make-up water h_{f3} = 104 kJ/kg at 25° C.

Flash steam= 319 kg/h x (782–419/2257) = 51.3 kg/h x 2257 kJ/kg= 0.116 GJ/h saved

Sensible heat recovery due to flash steam condensation in feed tank:

Flash steam x (h_{f2} – h_{f3}) = 51.3 kg/h x (419-104) = 0.016 GJ/h saved

SAVINGS DUE TO FLASH STEAM RECOVERY:

0.116 + 0.016 GJ/h x $ 10/GJ x 6000 h/y = $ 7920/year

In addition, 308 kL / year of treated water is saved due to flash steam condensing in feed tank or deaerator = $ 616/year.

SAVINGS DUE TO RESIDUAL BLOWDOWN RECOVERY

Example for 5 t/h, 10 bar watertube boiler, 6000 hours/year,
cost of fuel $ 10/GJ:

Residual Blowdown = Blowdown 319 kg/h – Flash Steam 51.3 kg/h = 267.7 kg/h

Residual Blowdown Recovery = 267.7 kg/h x Δt x spec. heat of water

Δt = 100 – 25 = 75° C, spec. heat of water = 4.19 kJ/kg°C

= 267.7 kg/h x 75°C x 4.19 kJ/kg°C = 0.084 GJ/h saved

Residual Blowdown Recovery through Plate Heat Exchanger
= 0.084 x $ 10/GJ x 6000 h/y = $ 5040/year

AUTOMATIC TDS CONTROL & HEAT RECOVERY SUMMARY

Example for 5 t/h, 10 bar watertube boiler, 6000 hours/year,
cost of fuel $ 10/GJ, cost of treated feedwater $ 2/kL:

FUEL COST SAVINGS

DUE TO AUTO. BLOWDOWN	= $ 10,800 /year
DUE TO FLASH STEAM	= $ 7,920/year
DUE TO RESIDUAL BLOWDOWN	= $ 5,040/year
	SUB-TOTAL = $ 23,760/YEAR

WATER COST SAVINGS

DUE TO LOWER BLOWDOWN RATE WITH AUTOMATIC TDS CONTROL	= $ 2,832/year
DUE TO FLASH STEAM CONDENSING IN FEED TANK	= $ 616/year
	SUB-TOTAL = $ 3,448/YEAR

TOTAL SAVINGS $ 27,208/YEAR

Equipment cost including installation ~ $ 20,000
Simple pay-back period ~ 7.5 months

BLOWDOWN HEAT RECOVERY EQUIPMENT

Flash Vessel

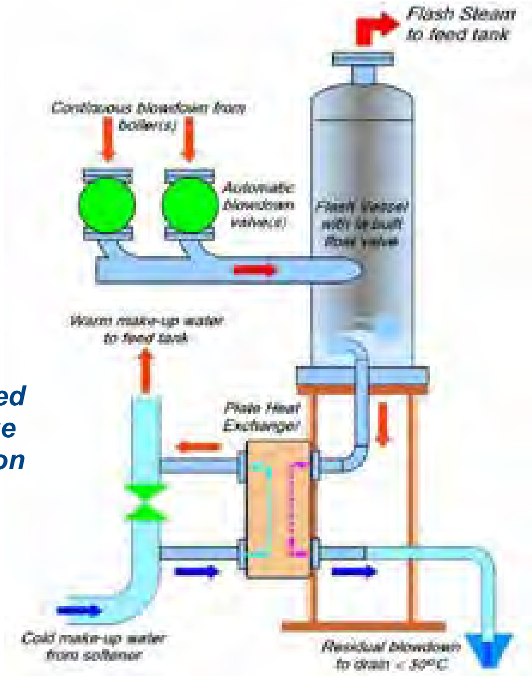
Plate Heat Exchanger

Float Trap

INTEGRATION into boiler house

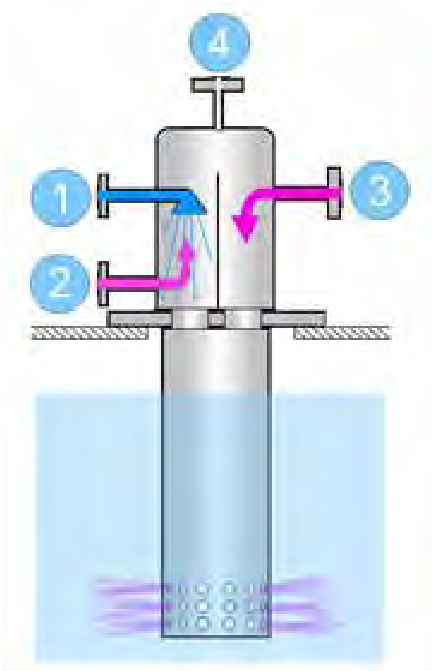
Any number of boilers can be connected to a single flash vessel

System can be supplied as a pre-piped package for easy site installation

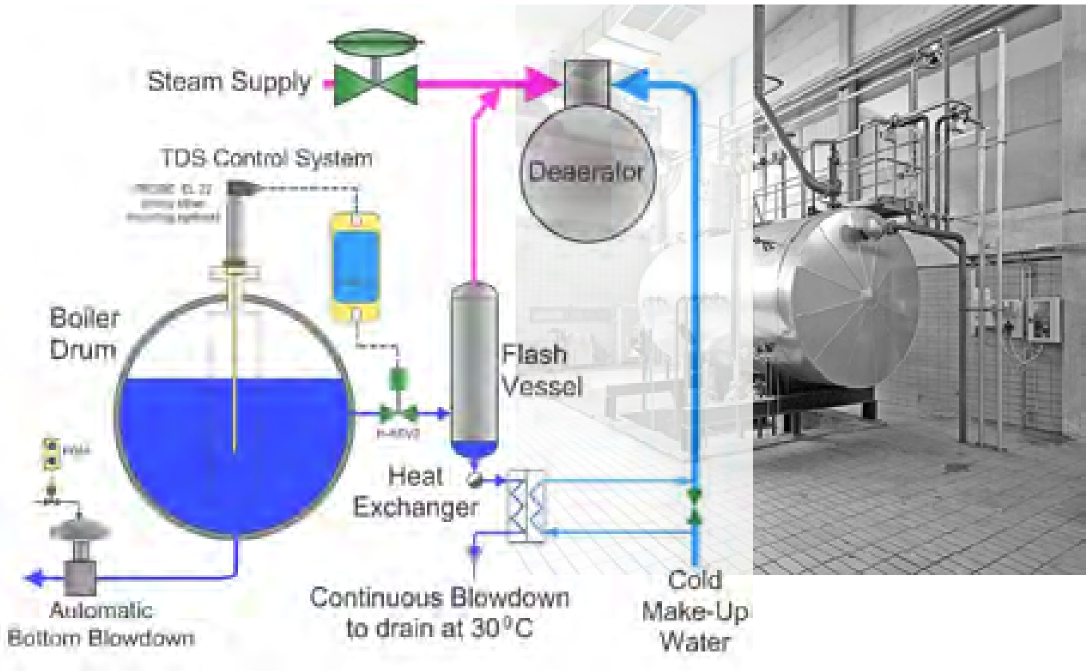


INTEGRATION WITH FEED TANK

Flash steam needs to be diffused into feed tank to prevent large steam bubbles from escaping via the atmospheric vent



INTEGRATION WITH DEAERATOR



ecoFLUE

MODULAR FLUE GAS HEAT RECOVERY

for Steam Boilers, Hot Water Heaters and Dryers

Without flue gas heat recovery, about 20% of the natural gas input to boilers, dryers etc. is wasted through the flue to atmosphere. This presents an excellent opportunity for significant fuel cost and energy savings, as well as reducing the carbon footprint of the facility.

The ***ecoFLUE*** creates hot water from otherwise wasted flue gas heat, up to about 85 ^{0}C.

Modular design of the ***ecoFLUE*** matches the available heat recovery to the available cool water heat sink.

A single module is suitable for a nominal boiler capacity of 100 kW. Additional modules are simply stacked together for larger boiler or dryer capacities.

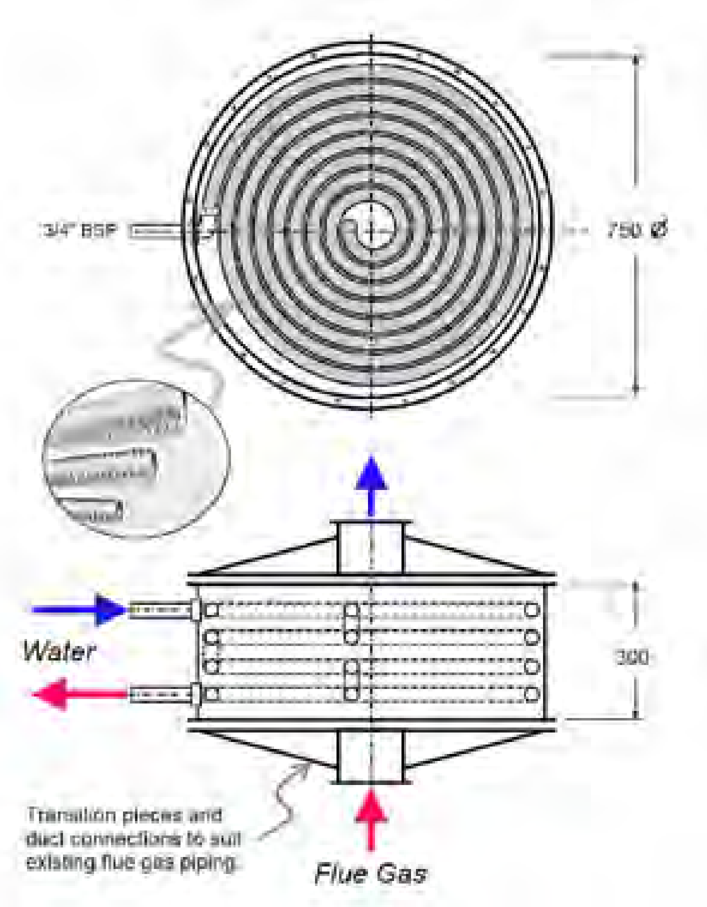
The heart of the ***ecoFLUE*** is a multi-tiered spiral coil of flexible stainless steel tubing, which is inherently suitable for absorbing thermal expansion and contraction.

Corrugated flexible tubing has approx. twice the surface area of plain pipe, which, together with the spiral geometry, translates into a very compact heat exchanger.

Conventional finned tube economiser coils use dissimilar metals for fins and tubes, which are subject to corrosion and mechanical issues. Flexible tubes for our spiral coils are 304 or 316 stainless steel.

The shell of the ***ecoFLUE*** is also 304 stainless steel, therefore the entire unit can withstand the corrosive nature of flue gas condensate.

If a sufficiently large heat sink is available in the form of cold water <30 ^{0}C, we strongly recommend using the ***ecoFLUE*** as a flue gas condenser, since a large proportion of energy in the flue gas is in the form of latent heat.



Test pressure for the flexible stainless steel tubing is 1500 kPag (215 psig).
Burst pressure is 20 000 kPag (2900 psig).
However, the recommended relief valve setting is 400 kPag (60 psig) to ensure long life under the most arduous conditions.
The flue gas temperature limit for the standard ***ecoFLUE*** is 300 ^{0}C.

For condensing applications, a 2-zone recovery system is usually most efficient, to generate hot water at say 50 and 85 ^{0}C.

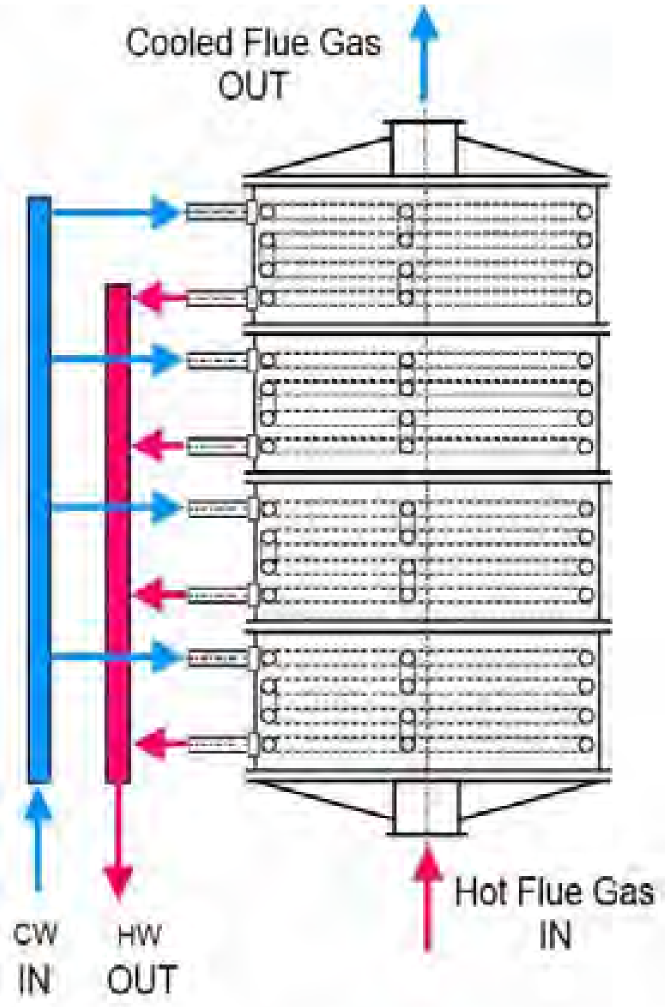
In many situations, the hot water outlet from the ***ecoFLUE*** is directed to an insulated buffer storage tank, especially when the boiler is on/off controlled.

To prevent a steam pressure from being generated inside the ***ecoFLUE*** coils, a pressure relief valve is required at the hot water outlet.

Many control options are possible to integrate the ***ecoFLUE*** into an existing boiler system.

The ***ecoFLUE*** is suitable for use with most forced draft burners which can tolerate an additional pressure drop of < 75 Pa (0.3" H_2O).

A draft inducer is available for installations with atmospheric burners.



Stacked heat exchanger sections shown connected in parallel. Connection in series is also possible.

The straightforward layout and compact size of the ***ecoFLUE*** makes installation an easy task.

Essentially, the ***ecoFLUE*** replaces a short length of flue duct.

Installation can be into either vertical, horizontal or inclined flue ducts.

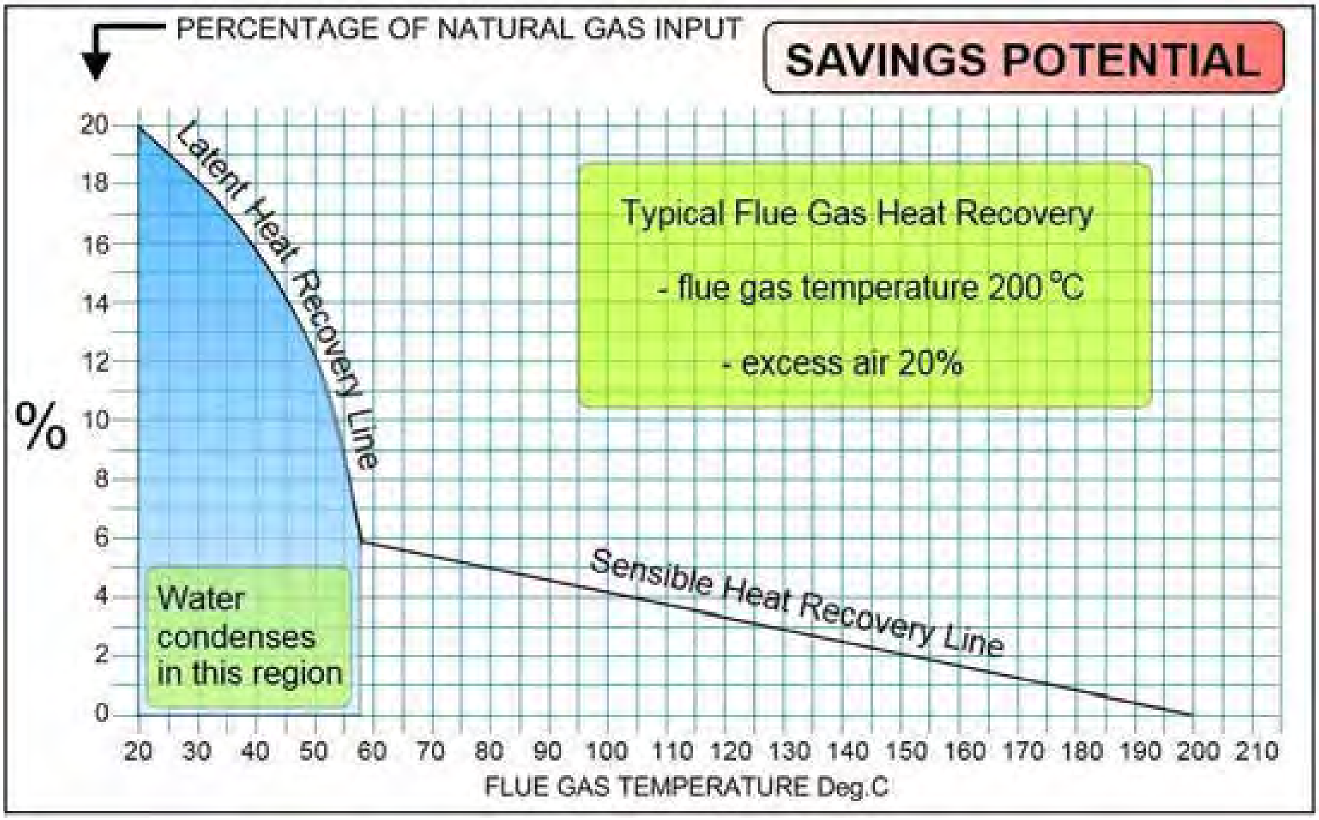
The actual flue connections are tailored to suit each individual plant.

Larger ***ecoFLUE*** units than the standard 100 kW modules can be provided to special order.

CONTACT US TO CHECK OUT THE FUEL COST SAVINGS FOR YOUR PLANT TODAY!

The following graph illustrates the savings potential for heat recovery from the ***ecoFLUE***.

Flue gas (at 200 ^{0}C for this example) flows through the ***ecoFLUE***, and cool water flows through the heat exchange coils, absorbing heat from flue gas. Until the flue gas temperature reaches about 57 ^{0}C, this heat reduction follows the straight inclined line of the graph. This represents Sensible Heat recovery.



At about 57 ^{0}C the water vapour dewpoint is reached, and water will now start to condense out of the flue gas. The heat of condensation (Latent Heat) which had to be added in the boiler is now released.

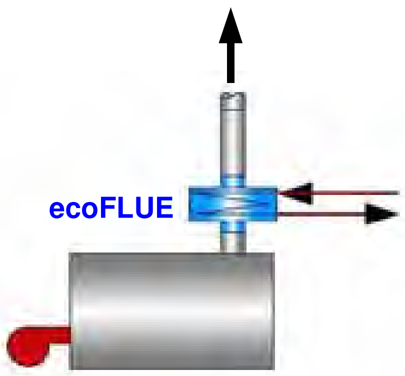
The start of condensation can be observed by the sharp rise in the Latent Heat Recovery Line. It can also be seen that just a small reduction of flue gas temperature in the condensing region results in a significant increase in heat recovery potential.

For this reason the coldest water available in your plant should be used as the heat sink for flue gas heat recovery.

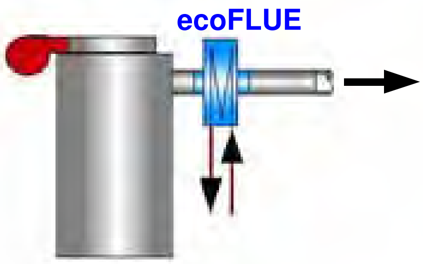
Effectively, the ecoFLUE converts any boiler into a modern condensing boiler.

Contact us for a heat recovery graph and energy savings calculation for your particular installation.

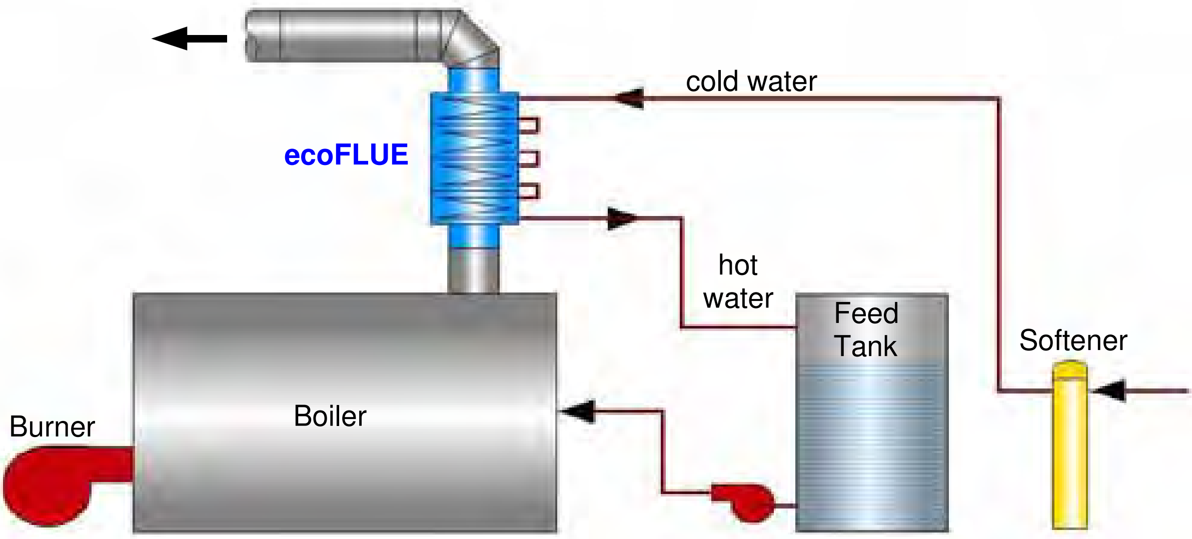
INSTALLATION OPTION



Installation in vertical flue



Installation in horizontal flue



Installation on 400 kW boiler for feedwater pre-heating

ARMSTRONG
FLOW CONTROL

Humidification

Humidification Selection Guide

Table 4-1. Armstrong Humidification Selection Guide

	Central Steam Available				Central Steam Not Available				
	No Chemical Concern with Plant Steam	Concern with Chemicals <800 lb/hr Capacity	Concern with Chemicals >800 lb/hr Capacity	Steam From DI Source	Hard Water Used. Minimal Maintenance.	Tap Water Used. Price More Critical Than Performance	DI Water Used (Electrical Units)	Gas Preferred. Tap Water or DI <475 pph capacity. Non-critical control.	Low Maintenance. Low Operating Costs. Evaporative cooling desired.
Air Handling System Application w/Critical Vapor Trail	C	D/L	E/C	C	F/L	G/L	F/L	H/L	—
Air Handling System Application w/Non-Critical Vapor Trail	A/J	D/K/O	E/A/J	B/J	F/K/O	G/K/O	F/K/O	H/K/O	I
Direct Area Discharge	A/M	D/M	E/A/M	B/M	F/M	G/M	F/M	H/M	I

Humidifier Type Key
A. Series 9000 Direct Steam Injection Humidifier
B. Series 1000 Direct Steam Injection Humidifier
C. HumidiPack/HumidiPack Plus/HumidiPack CF System w/Control Valve, Trap(s), Strainer
D. Series CS-10 Steam-to-Steam Humidifier
E. Armstrong Unfired Steam Generator
F. Series HC-6000 HumidiClean Electronic Humidifier
G. Series EHU-700 Electrode Type Electronic Humidifier
H. Gas Fired HumidiClean
I. Armstrong Cool-Fog

Dispersion Type
J. SS Jacketed Manifold or aluminum SteamStik™ jacketed manifolds
K. SS Non-Jacketed Dispersion Tube
L. HumidiPack Distribution Panel (Only)
M. Fan Type Dispersion
N. Venturi Nozzle Type Dispersion
O. Steam Jacketed Dispersion Tube (SJDT)

Critical Vapor Trail includes requirements <3 feet

Humidification Plays an Essential Role

Although humidity is invisible to our eyes, we can easily observe its effects. In human terms, we are more comfortable and more efficient with proper humidification. In business and industrial environments, the performance of equipment and materials is enhanced by effectively applying humidity control.

Maintaining indoor air quality through humidity management can lower energy costs, increase productivity, save labor and maintenance costs, and ensure product quality. In short, humidification can provide a better environment and improve the quality of life and work.

Armstrong has been sharing know-how in humidification application since 1938. Through the design, manufacturing, and application of humidification equipment Armstrong has led the way to countless savings in energy, time and money. Armstrong also provides humidification sizing and selection software, videotapes, and other educational materials to aid in humidification equipment selection, sizing, installation, and maintenance.

Armstrong offers this updated Humidification Engineering section as a problem-solving, educational aid for those involved with the design, installation, and maintenance of environmental control systems in all types of buildings. In addition, you may request a free copy of Armstrong's Humid-A-ware™ Humidification Sizing and Selection Software for step-by-step sizing of your own installation. It can also be downloaded by accessing www.armstrong-intl.com.

Your specific humidification questions can be answered by your Armstrong Representative. Additional support from Armstrong International humidification specialists is available to assist with difficult or unusual applications.

Controlled humidification helps protect humidity-sensitive materials, personnel, delicate machinery, and equipment. Beyond the important issues of comfort and process control, humidity control can help safeguard against explosive atmospheres. You can't afford NOT to humidify. And the best way to protect your investment is through proven humidification strategies and solutions pioneered by Armstrong.

Inside the Humidification Engineering Section...

References

ASHRAE Handbook, 2000 Systems and Equipment.

ASHRAE Handbook, 2002 Fundamentals.

ASHRAE Handbook, 1999 HVAC Applications.

IBM Installation Planning Manual, April, 1973.

Obert, Edward F. Thermodynamics, 1948.

Static Electricity, National Fire Protection Association. 1941.
U.S. National Bureau of Standards.

IMPORTANT: This section is intended to summarize general principles of installation and operation. Actual installation and operation should be performed only by experienced personnel. Selection or installation should always be accompanied by competent technical assistance or advice. This data should never be used as a substitute for such technical advice or assistance. We encourage you to contact Armstrong or its local representative for further details.

Why Humidification is Important

Glossary

Relative Humidity(RH):
The ratio of the vapor pressure (or mole fraction) of water vapor in the air to the vapor pressure (or mole fraction) of saturated air at the same dry-bulb temperature and pressure.

Sensible Heat:
Heat that when added to or taken away from a substance causes a change in temperature or, in other words, is “sensed” by a thermometer. Measured in Btu.

Latent Heat:
Heat that when added to or taken away from a substance causes or accompanies a phase change for that substance. This heat does not register on a thermometer, hence its name “latent” or hidden. Measured in Btu.

Dew Point:
The temperature at which condensation occurs (100%RH) when air is cooled at a constant pressure without adding or taking away water vapor.

Evaporative Cooling:
A process in which liquid water is evaporated into air. The liquid absorbs the heat necessary for the evaporation process from the air, thus, there is a reduction in air temperature and an increase in the actual water vapor content of the air.

Enthalpy:
Also called heat content, this is the sum of the internal energy and the product of the volume times the pressure. Measured in Btu/lb.

Hygroscopic Materials:
Materials capable of absorbing or giving up moisture.

Phase:
The states of existence for a substance, solid, liquid, or gas (vapor).

Humidification is simply the addition of water to air. However, humidity exerts a powerful influence on environmental and physiological factors. Improper humidity levels (either too high or too low) can cause discomfort for people, and can damage many kinds of equipment and materials. Conversely, the proper type of humidification equipment and controls can help you achieve effective, economical, and trouble-free control of humidity.

As we consider the importance of humidity among other environmental factors—temperature, cleanliness, air movement, and thermal radiation—it is important to remember that humidity is perhaps the least evident to human perception. Most of us will recognize and react more quickly to temperature changes, odors or heavy dust in the air, drafts, or radiant heat. Since relative humidity interrelates with these variables, it becomes a vital ingredient in total environmental control.

Humidity and Temperature

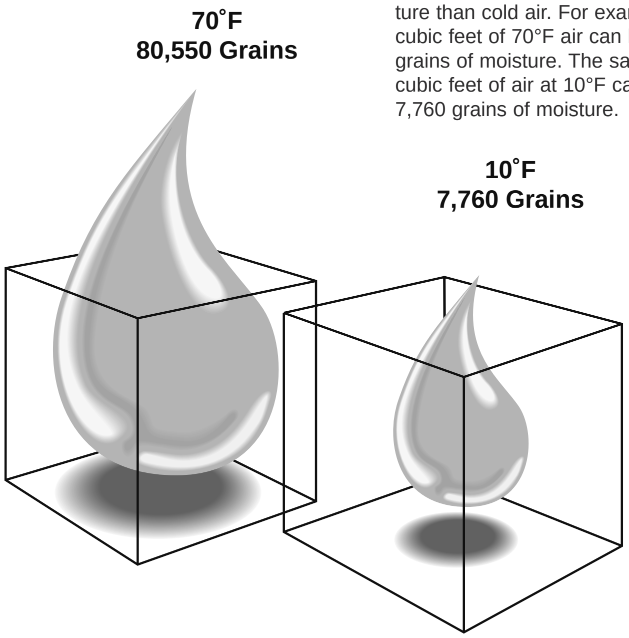
Humidity is water vapor or moisture content always present in the air. Humidity is definable as an absolute measure: the amount of water vapor in a unit of air. But this measure of humidity does not indicate how dry or damp the air is. This can only be done by computing the ratio of the actual partial vapor pressure to the saturated partial vapor pressure at the same temperature. This is relative humidity, expressed by the formula:

$$RH = \frac{vp_a}{vp_s}\Bigg|_t$$

vp_a = actual vapor pressure
vp_s = vapor pressure at saturation
t = dry-bulb temperature

For practical purposes, at temperatures and pressures normally encountered in building systems, relative humidity is considered as the amount of water vapor in the air compared to the amount the air can hold at a given temperature.

“At a given temperature” is the key to understanding relative humidity. Warm air has the capacity to hold more moisture than cold air. For example, 10,000 cubic feet of 70°F air can hold 80,550 grains of moisture. The same 10,000 cubic feet of air at 10°F can hold only 7,760 grains of moisture.



If the 10,000 cubic feet of 10°F air held 5,820 grains of moisture, its relative humidity would be 75%. If your heating system raises the temperature of this air to 70°F with no moisture added, it will still contain 5,820 grains of moisture. However, at 70°F, 10,000 cubic feet of air can hold 80,550 grains of moisture. So the 5,820 grains it actually holds give it a relative humidity of slightly more than 7%. That’s very dry...drier than the Sahara Desert.

Air Movement and Humidity

Another variable, air movement in the form of infiltration and exfiltration from the building, influences the relationship between temperature and relative humidity. Typically, one to three times every hour (and many more times with forced air make-up or exhaust) cold outdoor air replaces your indoor air. Your heating system heats this cold, moist outdoor air, producing warm, dry indoor air.

Evaporative Cooling

We've discussed the effects of changing temperature on relative humidity. Altering RH can also cause temperature to change. For every pound of moisture evaporated by the air, the heat of vaporization reduces the sensible heat in the air by about 1,000 Btu. This can be moisture absorbed from people or from wood, paper, textiles, and other hygroscopic material in the building. Conversely, if hygroscopic materials absorb moisture from humid air, the heat of vaporization can be released to the air, raising the sensible heat.

Dew Point

Condensation will form on windows whenever the temperature of the glass surface is below the dew point of the air. Table 7-2, from data presented in the ASHRAE Systems and Equipment Handbook, indicates combinations of indoor relative humidity and outside temperature at which condensation will form. Induction units, commonly used below windows in modern buildings to blow heated air across the glass, permit carrying higher relative humidities without visible condensation.

Table 7-2. Relative Humidities at Which Condensation Will Appear on Windows at 74°F When Glass Surface Is Unheated

Outdoor Temperature	Single Glazing	Double Glazing
40	39%	59%
30	29%	50%
20	21%	43%
10	15%	36%
0	10%	30%
-10	7%	26%
-20	5%	21%
-30	3%	17%

Table 7-1. Grains of Water per Cubic Foot of Saturated Air and per Pound of Dry Air at Various Temperatures.
(Abstracted from ASHRAE Handbook)

°F	Per cu ft	Per lb Dry Air	°F	Per cu ft	Per lb Dry Air	°F	Per cu ft	Per lb Dry Air	°F	Per cu ft	Per lb Dry Air
-10	0.28466	3.2186	50	4.106	53.38	78	10.38	145.3	106	23.60	364.0
-5	0.36917	4.2210	51	4.255	55.45	79	10.71	150.3	107	24.26	375.8
0	0.47500	5.5000	52	4.407	57.58	80	11.04	155.5	108	24.93	387.9
5	0.609	7.12	53	4.561	59.74	81	11.39	160.9	109	25.62	400.3
10	0.776	9.18	54	4.722	61.99	82	11.75	166.4	110	26.34	413.3
15	0.984	11.77	55	4.889	64.34	83	12.11	172.1	111	27.07	426.4
20	1.242	15.01	56	5.060	66.75	84	12.49	178.0	112	27.81	440.4
25	1.558	19.05	57	5.234	69.23	85	12.87	184.0	113	28.57	454.5
30	1.946	24.07	58	5.415	71.82	86	13.27	190.3	114	29.34	469.0
31	2.033	25.21	59	5.602	74.48	87	13.67	196.7	115	30.13	483.9
32	2.124	26.40	60	5.795	77.21	88	14.08	203.3	120	34.38	566.5
33	2.203	27.52	61	5.993	80.08	89	14.51	210.1	125	39.13	662.6
34	2.288	28.66	62	6.196	83.02	90	14.94	217.1	130	44.41	774.9
35	2.376	29.83	63	6.407	86.03	91	15.39	224.4	135	50.30	907.9
36	2.469	31.07	64	6.622	89.18	92	15.84	231.8	140	56.81	1064.7
37	2.563	32.33	65	6.845	92.40	93	16.31	239.5	145	64.04	1250.9
38	2.660	33.62	66	7.074	95.76	94	16.79	247.5	150	71.99	1473.5
39	2.760	34.97	67	7.308	99.19	95	17.28	255.6	155	80.77	1743.0
40	2.863	36.36	68	7.571	102.8	96	17.80	264.0	160	90.43	2072.7
41	2.970	37.80	69	7.798	106.4	97	18.31	272.7	165	101.0	2480.8
42	3.081	39.31	70	8.055	110.2	98	18.85	281.7	170	112.6	2996.0
43	3.196	40.88	71	8.319	114.2	99	19.39	290.9	175	125.4	3664.5
44	3.315	42.48	72	8.588	118.2	100	19.95	300.5	180	139.2	4550.7
45	3.436	44.14	73	8.867	122.4	101	20.52	310.3	185	154.3	5780.6
46	3.562	45.87	74	9.153	126.6	102	21.11	320.4	190	170.7	7581.0
47	3.692	47.66	75	9.448	131.1	103	21.71	330.8	195	188.6	10493.0
48	3.826	49.50	76	9.749	135.7	104	22.32	341.5	200	207.9	15827.0
49	3.964	51.42	77	10.06	140.4	105	22.95	352.6			

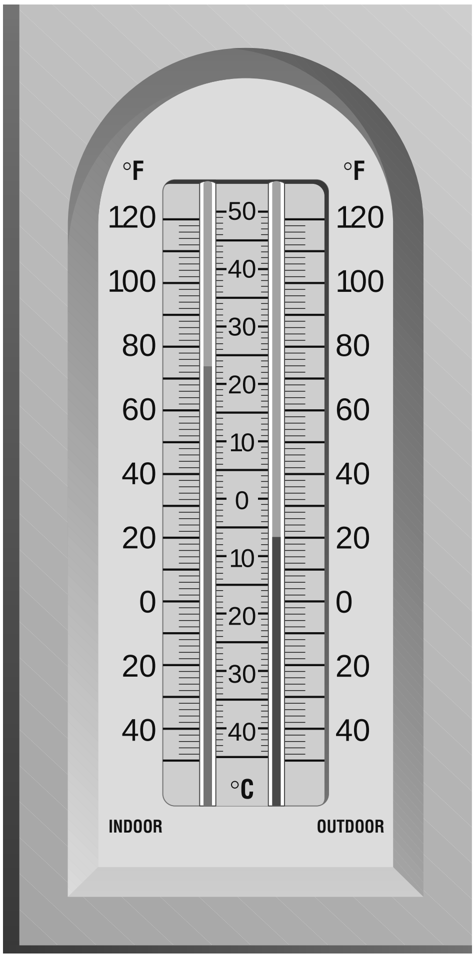
Why Humidification is Important, continued…

Energy Conservation With Controlled RH

Indoor relative humidity as we have computed it is called Theoretical Indoor Relative Humidity (TIRH). It virtually never exists. RH observed on a measuring device known as a hygrometer will almost always exceed the TIRH. Why? Dry air is thirsty air. It seeks to draw moisture from any source it can. Thus it will soak up moisture from any hygroscopic materials (such as wood, paper, foodstuffs, leather, etc.) and dry out the nasal passages and skin of human beings in the building.

But is this free "humidification"? No, it is the most expensive kind there is when translated into terms of human comfort, material deterioration, and production difficulties. Moreover, it requires the same amount of energy whether the moisture is absorbed from people and materials or added to the air by an efficient humidification system.

The true energy required for a humidification system is calculated from what the actual humidity level will be in the building, NOT from the theoretical level. In virtually all cases, the cost of controlling RH at the desired level will be nominal in terms of additional energy load, and in some cases may result in reduced energy consumption.



A major convention center in the Central United States reported that it experienced a decrease in overall steam consumption when it added steam humidification. From one heating season with no humidification to the next with humidifiers operating, the steam consumption for humidification was 1,803,000 lbs, while the steam for heating decreased by 2,486,000 lbs in the same period. The decreased (metered) consumption occurred despite 7.2% colder weather from the previous year. The records from this installation indicate that it is possible to reduce the total amount of steam required for environmental control by maintaining a higher, controlled relative humidity.

Let's examine a theoretical system using enthalpy (heat content) as our base.

- Assume a winter day with outside temperature of 0°F at 75% RH.
- The enthalpy of the air is .6 Btu/lb dry air (DA).
- If the air is heated to 72°F without adding moisture, the enthalpy becomes 18 Btu/lb DA.
- Theoretical relative humidity becomes 3.75%, but actual RH will be about 25%.
- At 72°F and 25% RH the enthalpy is 22 Btu/lb DA.
- The additional moisture is derived from hygroscopic materials and people in the area.

But what about the additional energy — the difference between the 18 Btu/lb DA and 22 Btu/lb DA? This 22% increase must come from the heating system to compensate for the evaporative cooling effect. If a humidification system is used and moisture added to achieve a comfortable 35% RH, the enthalpy is 23.6 Btu/lb DA.

This is only a 7% increase over the "inevitable" energy load of 22 Btu/lb DA—substantially less than the theoretical increase of 31% from 3.75% RH (18 Btu/lb DA) to 35% RH (23.6 Btu/lb DA) at 72°F. If the temperature was only 68°F at 35% RH (because people can be comfortable at a lower temperature with higher humidity levels), the enthalpy is 21.8 Btu/lb DA, or a slight decrease in energy.

Problems With Dry Air

Dry air can cause a variety of costly, troublesome, and sometimes dangerous problems. If you are not familiar with the effects of dry air, the cause of these problems may not be obvious. You should be concerned if you are processing or handling hygroscopic materials such as wood, paper, textile fibers, leather, or chemicals. Dry air and/or fluctuating humidity can cause serious production problems and/or material deterioration.

Static electricity can accumulate in dry atmospheric conditions and interfere with efficient operation of production machinery or electronic office machines. Where static-prone materials such as paper, films, computer disks, and other plastics are handled, dry air intensely aggravates the static problem. In potentially explosive atmospheres, dry air and its resultant static electricity accumulations can be extremely dangerous.

Humidity and Human Comfort

Studies indicate people are generally most comfortable when relative humidity is maintained between 35% and 55%. When air is dry, moisture evaporates more readily from the skin, producing a feeling of chilliness even with temperatures of 75°F or more. Because human perception of RH is often sensed as temperature differential, it's possible to achieve comfortable conditions with proper humidity control at lower temperatures. The savings in heating costs are typically very significant over the course of just a single heating season.

The Need for Humidity Control in Today's Electronic Workplace

Electronics are revolutionizing the way your office and plant floor operates, communicates, collects data, and maintains equipment. In the office, xerographic copies, phone systems, computers, and fax machines, even wall thermostats are electronically controlled. What's more, office decor has far more work stations incorporating wall panels and furniture with natural and synthetic fabric than ever before.

In manufacturing areas, more machines are electronically controlled. In fact, you see more control rooms (just to house electronic control systems) than in previous years.

All this means that the nature of today's business makes proper humidification a virtual necessity.

Why Improper Humidification Threatens Sensitive Electronic Equipment

Central to all electronic circuits today is the IC (integrated circuit) or "chip." The heart of the IC is a wafer-thin miniature circuit engraved in semiconductor material. Electronic components—and chips in particular—can be overstressed by electrical transients (voltage spikes). This may cause cratering and melting of minute areas of the semiconductor, leading to operational upsets, loss of memory, or permanent failure. The damage may be immediate or the component may fail sooner than an identical part not exposed to an electrical transient.

A major cause of voltage spikes is electrostatic discharge (ESD). Although of extremely short duration, transients can be lethal to the wafer-thin surfaces of semiconductors. ESD may deliver voltage as high as lightning and it strikes faster.

ESD is a particularly dangerous phenomenon because you are the source of these transients. It is the static electricity that builds up on your body. The jolt you get from touching a doorknob or shaking someone's hand is ESD. Table 9-1 below shows voltages which can be generated by everyday activities.

Voltage accumulates on surfaces (in this case, the human body), and when the surface approaches another at a lower voltage a discharge of electrical voltage occurs. Note the humidity levels at which these voltages may be generated. As the level of humidity rises, voltages are reduced because a film of moisture forms on surfaces, conducting the charges to the ground. Although the 65%-90% RH cited in Table 9-1 is impractical for office areas, any increase in humidity will yield a significant reduction in ESD events.

ESD Damage is Not Only Possible but Probable

A study of personnel ESD events in a poorly controlled room with a wool carpet was conducted for 16 months. The strength of the ESD event was measured in current (amps). Results indicate, for example, that a current discharge of 0.3 amps is 100 times more likely to occur at 10%-20% RH than at 45%-50% RH. In other words, the higher the relative humidity, the lower the occurrence and severity of ESD.

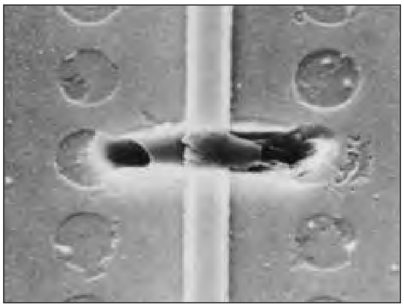
In addition to the risk of damage to electronic devices from static electricity charges, there are grave risks associated with sparks from static charges in many process applications. Static electricity is extremely dangerous in the presence of gases, volatile liquids, or explosive dusts such as is found in munitions plants, paint spray booths, printing plants, pharmaceutical plants, and other places.

While many static control products (special mats, carpeting, sprays, straps, etc.) are available, bear in mind that humidification is a passive static-control means. It is working to control static all the time—not just when someone remembers.

Table 9-1. Effect of Humidity on Electrostatic Voltages

Means of Static Generation	Electrostatic Voltages 10%-20% Relative Humidity	Electrostatic Voltages 65%-90% Relative Humidity
Walking across carpet	35,000	1,500
Walking over vinyl floor	12,000	250
Worker at bench	6,000	100
Vinyl envelopes for work instructions	7,000	600
Common poly bag picked up from bench	20,000	1,200
Work chair padded with polyurethane foam	18,000	1,500

Figure 9-1.
Effect of humidity on electrostatic voltages.



Integrated circuit damaged by ESD.
(Photo courtesy of Motorola Semiconductor, Inc.)

How Humidity Affects Materials

Paper and Paper Products

Every production superintendent in the paper industry is, by experience, familiar with the excessive scrap losses and customer complaints that can result from the following wintertime headaches:

1. Curling of stock.
2. Cracking or breaking at creases of folding boxes, cartons, corrugated and solid fiber containers.
3. Loss of package and container strength.
4. Production delays when sheets fail to go through machines smoothly due to static electricity.
5. Gluing failures.

All of the above wintertime problems have a common cause—dry or curling paper caused by low indoor relative humidities.

Whenever you heat air, without adding moisture, its RH drops. Table 10-1 shows that 0°F outside air at 75% RH will have a relative humidity of only 4.4% when heated to 70°F indoors. Even though the theoretical RH should be 4.4% in your plant, the actual observed humidity will be much higher because of the moisture given off by the paper. This type of humidification is very expensive in terms of stock and production.

Figure 10-1.
Effects of moisture content in folding paper. Sheet on left has proper moisture. Sheet on right lacks enough moisture—is dry and brittle—breaks on fold.

The RH of surrounding air governs the moisture content of paper, as shown in Table 11-1. The fibrils in paper take on moisture when the paper is drier than the surrounding air and give up moisture when the conditions are reversed.

A paper moisture content range of 5%-7% is essential to maintain satisfactory strength and workability of paper. This requires an indoor RH of about 40%-50%, depending upon the composition of the paper.

Moisture contents of different types of papers will vary slightly from those shown in the table but will follow an identical pattern.

Changes in moisture content thus cause paper to become thicker or thinner, flatter or curlier, harder or softer, larger or smaller, limp or brittle.

Table 10-1. How Indoor Heating Reduces Indoor RH and Dries Out Paper

Outdoor Temperature Degrees	Indoor Temperature 70°F	
	Indoor Relative Humidity %	Approx. Moisture Content of Paper
-20	1.5	0.5
-10	2.5	0.8
0	4.4	1.2
10	7.2	2.2
20	11.6	3.3
30	18.1	4.3
40	26.8	5.3
50	38.3	6.4
60	54.0	8.0
70	75.0	11.6

Effect of Indoor Heating Upon RH and Moisture Content of Kraft Wrapping Paper. NOTE: This table assumes an outdoor relative humidity of 75%. When outdoor RH is less, as is common, indoor RH will also be less. Indoor temperatures higher than 70° F will also cause lower relative humidities.

Printing

The dry air problems found in paper manufacturing are equally common to the printing industry.

Paper curling, generally caused by the expansion and contraction of an unprotected sheet of paper, takes place when too dry an atmosphere draws moisture from the exposed surface which shrinks and curls. The curl will be with the grain of the sheet. This trouble is most pronounced with very lightweight stocks or with cover stocks and coated-one-side papers.

Wood Products, Woodworking, and Furniture Manufacture

Like all hygroscopic materials, wood takes on or gives off moisture as the RH of the surrounding air varies. When, at any given temperature and relative humidity, the wood finally stops absorbing or liberating moisture, it is said to have reached its equilibrium moisture content (EMC). The moisture in the wood is then "in balance" with the moisture in the air.

It is generally not practical to hold indoor RH as high during the cold months as it is during the warm months. However, when the cold season sets in, humidifiers permit a gradual reduction of RH and EMC to a practical minimum working level. Under this controlled condition, warping and cracking will not occur.

Leather Processing

RH maintained uniformly in the 40%-60% range (higher in muller rooms) reduces cracking, minimizes loss of pliability, helps maintain quality and appearance, and reduces the dust problem in the plant.

Offices

RH maintained at 30%-40% stops splitting, checking, shrinkage, and glue joint failure in paneling and furnishings, adds life to carpeting and draperies. Electronic office equipment such as computers, xerographic copiers, and phone systems require a constant RH of 40%-50% to guard against harmful electrical transients (see Page 9).

Libraries and Museums

Relative humidity maintained uniformly at 40%-55% in storage rooms, vaults, and galleries prolongs the life of valuable collections by stabilizing the pliability of glue, starch and casein. The embrittlement of fibers in paper, canvas, papyrus, leather bindings, etc., is minimized.

Table 11-1. Moisture Content of Paper at Various Relative Humidities

Material	Description	Relative Humidity %								
		10	20	30	40	50	60	70	80	90
M.F. Newsprint	Wood Pulp 24% Ash	2.1	3.2	4.0	4.7	5.3	6.1	7.2	8.7	10.6
HMF Writing	Wood Pulp 3% Ash	3.0	4.2	5.2	6.2	7.2	8.3	9.9	11.9	14.2
White Bond	Rag 1% Ash	2.4	3.7	4.7	5.5	6.5	7.5	8.8	10.8	13.2
Com. Ledger	75% Rag 1% Ash	3.2	4.2	5.0	5.6	6.2	6.9	8.1	10.3	13.9
Kraft Wrapping	Coniferous	3.2	4.6	5.7	6.6	7.6	8.9	10.5	12.6	14.9

Determining Humidity Requirements of Materials

No single level of relative humidity provides adequate moisture content in all hygroscopic materials. Moisture content requirements vary greatly from one material to the next. We will discuss typical hygroscopic materials which require specific RH levels to avoid moisture loss and materials deterioration and/or production problems that result.

Table 12-1. Recommended Relative Humidities

Process or Product	Temp. °F	%RH
Residences	70-72	30
Libraries & Museums		
Archival	55-65	35
Art storage	60-72	50
Stuffed fur animals	40-50	50
Communication Centers		
Telephone terminals	72-78	40-50
Radio & TV studios	74-78	30-40
General Commercial & Public Buildings	70-74	20-30
(including cafeterias, restaurants, airport terminals, office buildings, & bowling centers)		
Hospitals & Health Facilities		
General clinical areas	72	30-60
Surgical area		
Operating rooms	68-76	50-60
Recovery rooms	75	50-60
Obstetrical		
Full-term nursery	75	30-60
Special care nursery	75-80	30-60
Industrial Hygroscopic Materials		
Abrasive		
Manufacture	79	50
Ceramics		
Refractory	110-150	50-90
Molding Room	80	60-70
Clay Storage	60-80	35-65
Decalcomania production	75-80	48
Decorating Room	75-80	48
Cereal		
Packaging	75-80	45-50
Distilling		
Storage		
Grain	6	35-40
Liquid Yeast	32-33	
General manufacturing	60-75	45-60
Aging	65-72	50-60
Electrical Products		
Electronics & X-ray:		
Coil & transformer winding	72	15
Semi conductor assembly	68	40-50
Electrical instruments:		
Manufacture & laboratory	70	50-55
Thermostat assembly & calibration	75	50-55
Humidistat assembly & calibration	75	50-55
Small mechanisms:		
Close tolerance assembly	72	40-45
Meter assembly & test	75	60-63
Switchgear:		
Fuse & cutout assembly	73	50
Capacitor winding	73	50
Paper Storage	73	50
Conductor wrapping with yarn	75	65-70
Lightning arrester assembly	68	20-40
Thermal circuit breakers assembly & test	75	30-60
High-voltage transformer repair	79	55
Water wheel generators:		
Thrust runner lapping	70	30-50
Rectifiers:		
Processing selenium & copper oxide plates	73	30-40
Fur		
Storage	40-50	55-65
Gum		
Manufacturing	77	33
Rolling	68	63
Stripping	72	53
Breaking	73	47
Wrapping	73	58
Leather		
Drying	68-125	75
Storage, winter room temp.	50-60	40-60
Lenses (Optical)		
Fusing	75	45
Grinding	80	80
Matches		
Manufacture	72-73	50
Drying	70-75	60
Storage	60-63	50
Mushrooms		
Spawn added	60-72	nearly sat.
Growing period	50-60	80
Storage	32-35	80-85
Paint Application		
Oils, paints: Paint spraying	60-90	80
Plastics		
Manufacturing areas:		
Thermosetting molding compounds	80	25-30
Cellophane wrapping	75-80	45-65
Plywood		
Hot pressing (resin)	90	60
Cold pressing	90	15-25
Rubber-Dipped Goods		
Cementing	80	25-30*
Dipping surgical articles	75-80	25-30*
Storage prior to manufacture	60-75	40-50*
Laboratory (ASTM Standard)	73.4	50*
*Dew point of air must be below evaporation temperature of solvent		
Tea		
Packaging	65	65
Tobacco		
Cigar & cigarette making	70-75	55-65
Softening	90	85-88
Stemming & stripping	75-85	70-75
Packing & shipping	73-75	65
Filler tobacco casing & conditioning	75	75
Filler tobacco storage & preparation	77	70
Wrapper tobacco storage & conditioning	75	75
Pharmaceuticals		
Powder storage (prior to mfg)*		*
Manufactured powder storage & packing areas	75	35
Milling room	75	35
Tablet compressing	75	35
Tablet coating room	75	35
Effervescent tablets and powders	75	20
Hypodermic tablets	75	30
Colloids	75	30-50
Cough drops	75	40
Glandular products	75	5-10
Ampoule manufacturing	75	35-50
Gelatin capsules	75	35
Capsule storage	75	35
Microanalysis	75	50
Biological manufacturing	75	35
Liver extracts	75	35
Serums	75	50
Animal rooms	75-80	50
Small animal rooms	75-78	50
*Store in sealed plastic containers in sealed drums.		
Photographic Processing		
Photo studio		
Dressing room	72-74	40-50
Studio (camera room)	72-74	40-50
Film darkroom	70-72	45-55
Print darkroom	70-72	45-55
Drying room	90-100	35-45
Finishing room	72-75	40-55
Storage room		
b/w film & paper	72-75	40-60
color film & paper	40-50	40-50
Motion picture studio	72	40-55
Static Electricity Control		
Textiles, paper, explosive control		>55
Clean Rooms & Spaces		45
Data Processing	72	45-50
Paper Processing		
Finishing area	70-75	40-45
Test laboratory	73	50

Abstracted from ASHRAE Systems and Applications Handbook.

How Psychometrics Help in Humidification

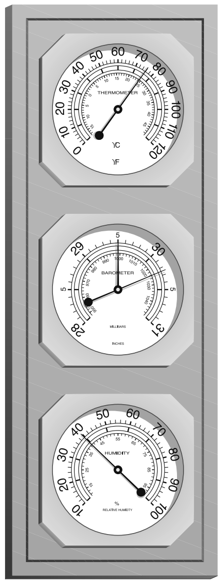
Psychometrics is the measurement of thermo-dynamic properties in moist air. As a problem-solving tool Psychometrics excel in clearly showing how changes in heating, cooling, humidification, and dehumidification can affect the properties of moist air. Psychrometric data is needed to solve various problems and processes relating to air distribution.

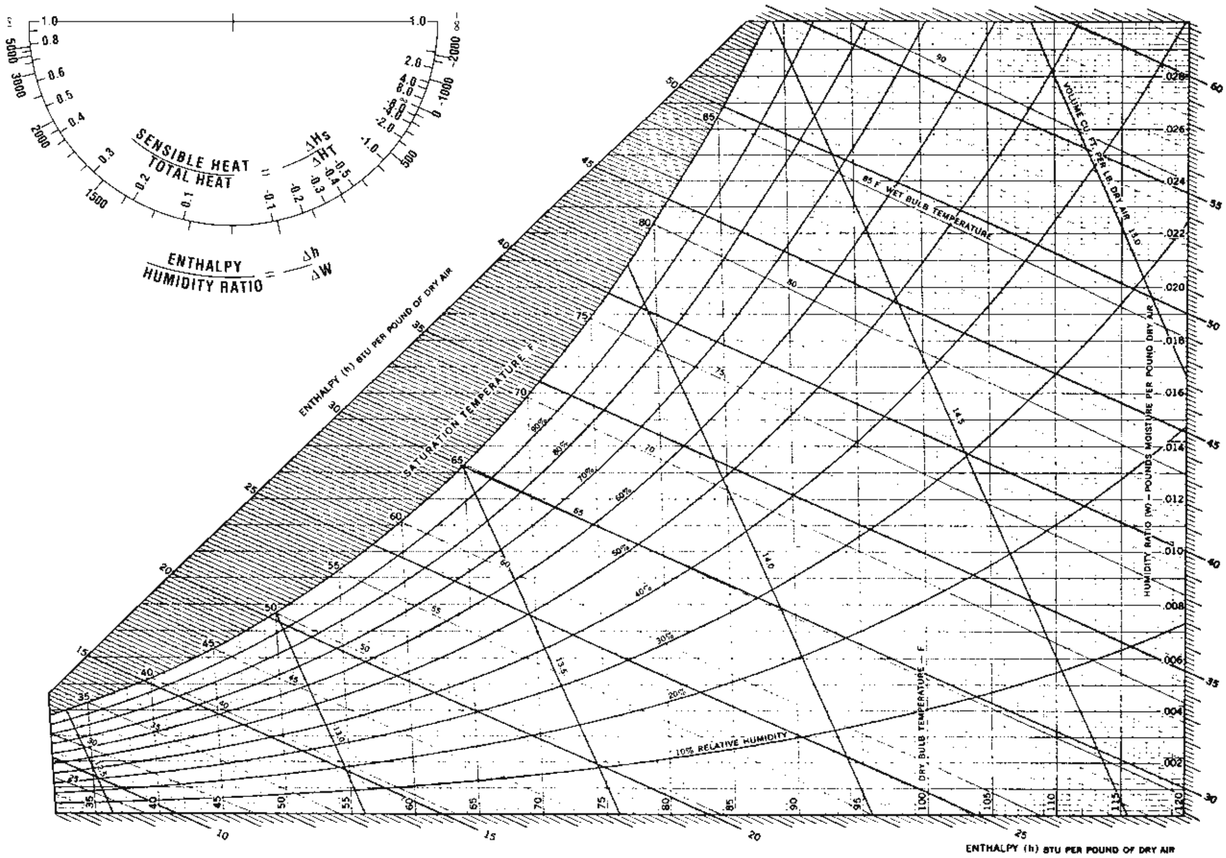
Most complex problems relating to heating, cooling and humidification are combinations of relatively simple problems. The psychrometric chart illustrates these processes in graphic form, clearly showing how changes affect the properties of moist air.

One of the reasons psychrometric data is particularly important today is traceable to the way most new buildings (and many older ones) are heated. The lower duct temperatures (55°F and below) used in new buildings make accurate humidity control more difficult to achieve. (This is because low duct temperatures have a limited ability to absorb moisture. Adding moisture via the central air handling system must compensate for reheating of air before it leaves the duct.)

For such applications, booster humidification must sometimes be accomplished in the duct of the zone after it has reached its final temperature (reheated).

To maintain typical conditions of 70°F and 50% RH, duct humidities will be very high (75% RH and above). To keep the duct from becoming saturated, a duct high limit humidistat is used, and becomes in these cases the main controller of the humidifier. Since this humidistat is in close proximity to the humidifier, and air is constantly moving, and must be controlled close to saturation, the humidifier output control must be fast, accurate and repeat-able.

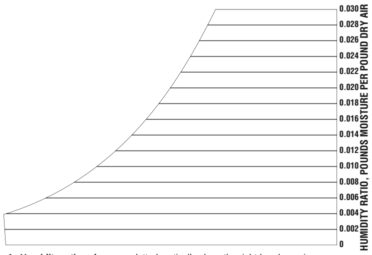




Using the Psychrometric Chart

The psychrometric chart is a graphical representation of the thermodynamic properties which impact moist air.

It consists of eight major components:



1. **Humidity ratio values** are plotted vertically along the right-hand margin, beginning with 0 at the bottom and extending to .03 at the top.

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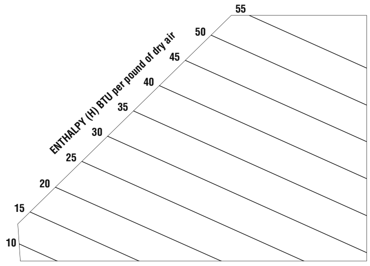

2. **Enthalpy**, or total heat, is plotted with oblique lines, at intervals of 5 Btu/lb of dry air, extending from upper left to lower right.

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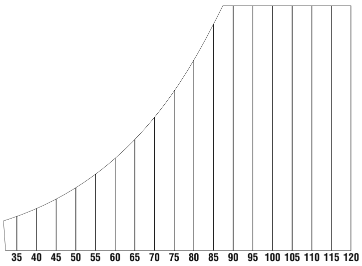

3. **Dry-bulb** temperature lines are plotted vertically at 1°F intervals.

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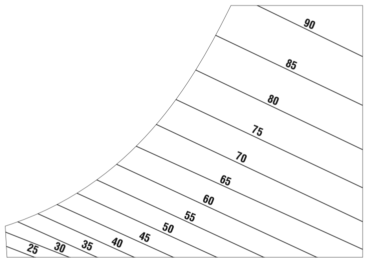

4. **Wet-bulb** temperature lines are indicated obliquely and fall almost parallel to enthalpy lines. They are shown at 1°F intervals.

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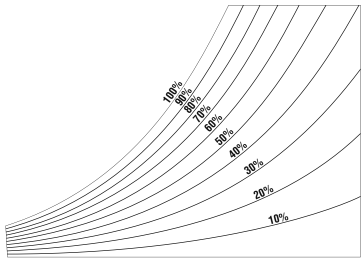

5. **Relative humidity** lines curve across the chart from left to right at intervals of 10%. They begin at the bottom at 10% and end at the top with the saturation curve (100%).

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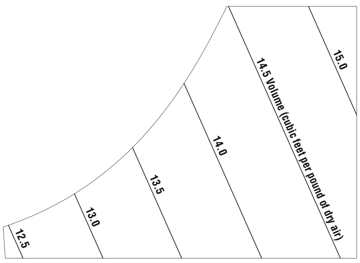

6. **Volume** lines indicating cubic feet per pound of dry air are plotted at intervals of .5 cubic feet.

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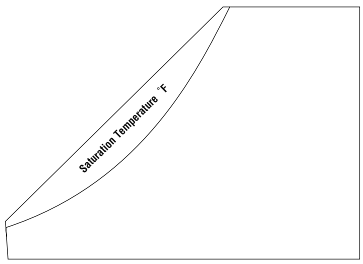

7. **Two-phase region** includes a narrow, cross-hatched area to the left of the saturation region indicating a mixture of condensed water in equilibrium.

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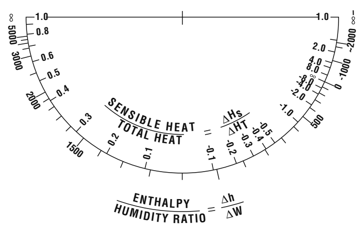
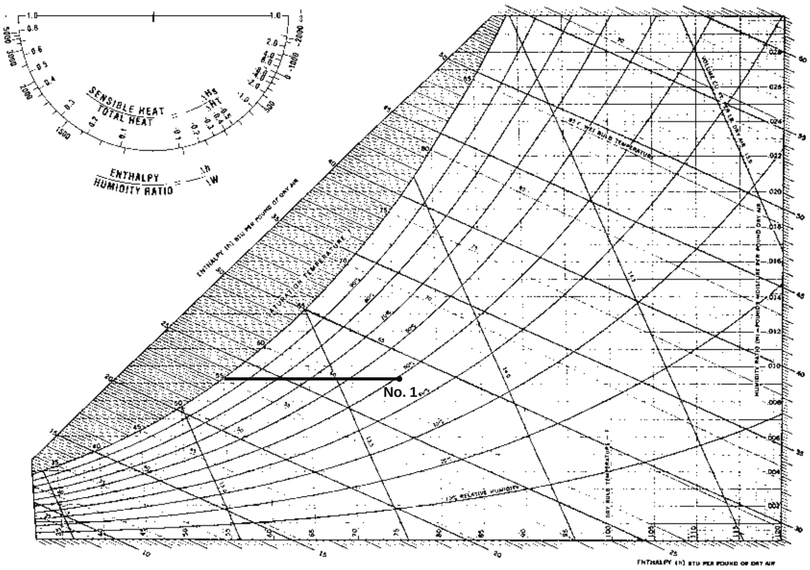


8. The protractor at the upper left of the chart contains two scales. One is for the ration of enthalpy difference. The other is for a ratio of sensible heat to the total heat. The protractor establishes the angle of a line on the chart along which a process will follow.



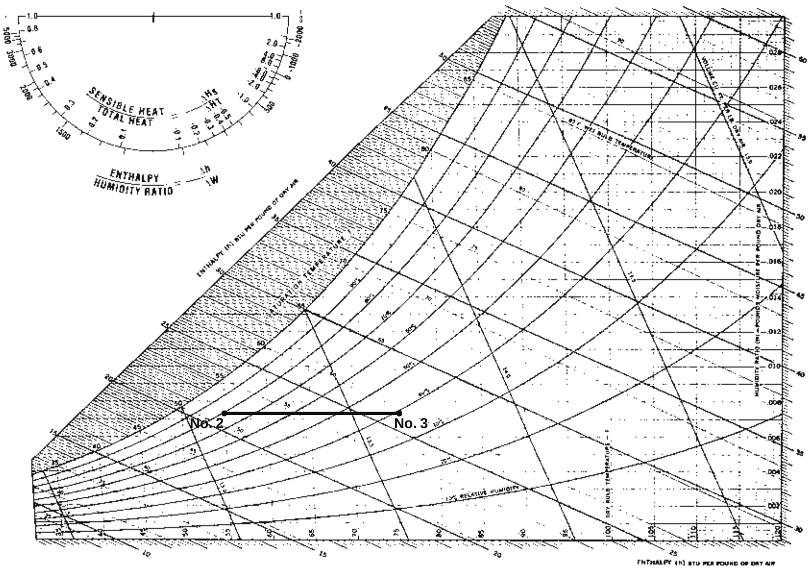
Example 1

Given the conditions of 75°F dry bulb and 50% RH, determine the dew point, volume and humidity content in grains per cubic foot of dry air.

Solution:

1. Locate the state point, where the 75°F dry-bulb line intersects the 50% RH line. Call this state point number 1.
2. Project horizontally to the left to the saturation curve and read 55°F (dew point).
3. Project horizontally to the right and read .0092 pounds of moisture per pound of dry air.
4. Draw a line through the state point parallel to 13.5 volume line and estimate a volume of 13.68 cubic feet per pound of dry air.
5. Solve for grains per cubic foot by converting:
   $\frac{0.0092 \times 7{,}000}{13.68} = 4.71$ grains/cu ft

See also Table 29-5, Page 29 for quick values.



Example 2

Determine resultant RH when 55°F air at 80% RH is heated to a temperature of 75°F.

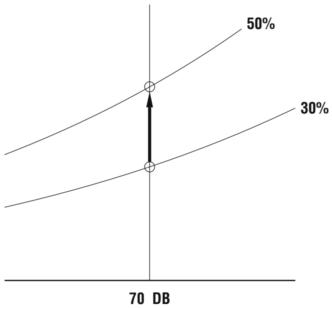
Solution:

1. Locate the state point where 55°F dry-bulb line intersects 80% RH line. Call this state point number 2.
2. Project horizontally to the right to intersect the 75°F dry-bulb line at 40% RH. Call this state point 3.
3. Observe that if air is delivered to a system at state point 2, that a reheat operation can deliver it to an area at state point 3.
4. If state point 1 (example 1) is desired in the area, then booster humidification is needed.

How Humidifiers Work

Steam Humidification (Isothermal)

Unlike other humidification methods, steam humidifiers have a minimal effect on dry-bulb (DB) temperatures. The steam humidifier discharges ready-made water vapor. This water vapor does not require any additional heat as it mixes with the air and increases relative humidity. Steam is pure water vapor existing at 212°F (100°C). This high temperature creates a perception that steam, when discharged into the air, will actually increase air temperature. This is a common misconception. In truth, as the humidifier discharges steam into the air, a steam/air mixture is established. In this mixture steam temperature will rapidly decrease to essentially the air temperature.



The psychrometric chart helps illustrate that steam humidification is a constant DB process. Starting from a point on any DB temperature line, steam humidification will cause movement straight up along the constant DB line. The example illustrates that 70°F DB is constant as we increase RH from 30%-50%. This is true because steam contains the necessary heat (enthalpy) to add moisture without increasing or decreasing DB temperature. Actual results utilizing high pressure steam or large RH increases (more than 50%) increase DB by 1° to 2°F. As a result, no additional heating or air conditioning load occurs.

Direct Steam Injection Humidifiers

The most common form of steam humidifier is the direct steam injection type. From a maintenance point of view, direct steam humidification systems require very little upkeep. The steam supply itself acts as a cleaning agent to keep system components free of mineral deposits that can clog many forms of water spray and evaporative pan systems.

Response to control and pinpoint control of output are two other advantages of the direct steam humidification method. Since steam is ready-made water vapor, it needs only to be mixed with air to satisfy the demands of the system. In addition, direct steam humidifiers can meter output by means of a modulating control valve. As the system responds to control, it can position the valve anywhere from closed to fully open. As a result, direct steam humidifiers can respond more quickly and precisely to fluctuating demand.

The high temperatures inherent in steam humidification make it virtually a sterile medium. Assuming boiler makeup water is of satisfactory quality and there is no condensation, dripping or spitting in the ducts, no bacteria or odors will be disseminated with steam humidification.

Corrosion is rarely a concern with a properly installed steam system. Scale and sediment—whether formed in the unit or entrained in the supply steam—are drained from the humidifier through the steam trap.

Steam-to-Steam Humidifiers

Steam-to-steam humidifiers use a heat exchanger and the heat of treated steam to create a secondary steam for humidification from untreated water. The secondary steam is typically at atmospheric pressure, placing increased importance on equipment location.

Maintenance of steam-to-steam humidifiers is dependent on water quality. Impurities such as calcium, magnesium and iron can deposit as scale, requiring frequent cleaning. Response to control is slower than with direct steam because of the time required to boil the water.

Direct Steam Humidification

Figure 16-1. Separator Type

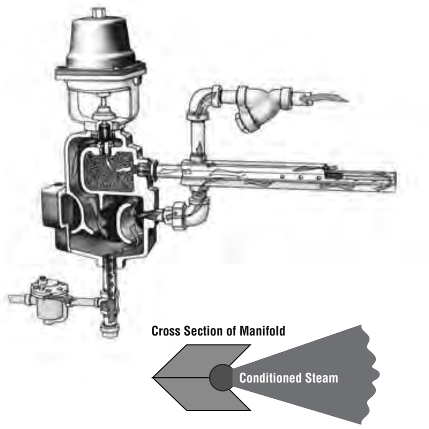
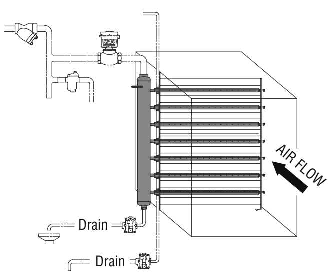
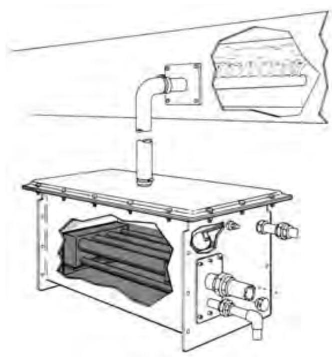


Figure 16-2. Panel Type



Steam-to-Steam Humidification

Figure 16-3.



Electric Steam Humidifiers (Electrode)

Electric steam humidifiers are used when a source of steam is not available. Electricity and water create steam at atmospheric pressure. Electrode-type units pass electrical current through water to provide proportional output. Use with pure demineralized, deionized or distilled water alone will generally not provide sufficient conductivity for electrode units.

Water quality affects the operation and maintenance of electrode-type humidifiers. Use with hard water requires more frequent cleaning, and pure softened water can shorten electrode life. Microprocessor-based diagnostics assist with troubleshooting.

Electrode units are easily adaptable to different control signals and offer full modulated output. However, the need to boil the water means control will not compare with direct-injection units.

Electric Steam Humidifiers (Ionic Bed)

Ionic bed electric humidifiers typically use immersed resistance heating elements to boil water. Since current does not pass through water, conductivity is not a concern. Ionic bed technology makes the humidifier versatile enough to accommodate various water qualities. These units work by using ionic bed inserts containing fibrous media to attract solids from water as its temperature rises, minimizing the buildup of solids inside the humidifier. Water quality does not affect operation, and maintenance typically consists of simply replacing the inserts.

Ionic bed humidifiers are adaptable to different control signals and offer full modulated output. Control is affected by the need to boil the water.

Gas-Fired Steam Humidifiers (Ionic Bed)

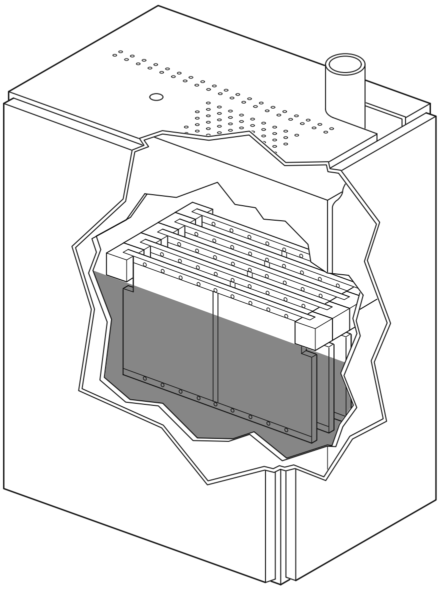
In gas-fired steam humidifiers, natural gas or propane are combined with combustion air and supplied to a gas burner. The heat of combustion is transferred to water through a heat exchanger, creating atmospheric steam for humidification. Combustion gasses must be vented per applicable codes. Fuel gas composition, combustion air quality and proper venting can affect operation.

Water quality also can impact the operation and maintenance of gas-fired humidifiers. Ionic bed-type gas-fired humidifiers use ionic bed inserts containing fibrous media to attract solids from water as its temperature rises, minimizing the buildup of solids inside the humidifier. Therefore, water quality does not affect operation, and maintenance typically consists of simply replacing the ionic bed inserts.

Ionic bed gas-fired humidifiers are adaptable to various control signals and offer modulated output. However, control of room RH is affected by the need to boil water and limitations inherent in gas valve and blower technology.

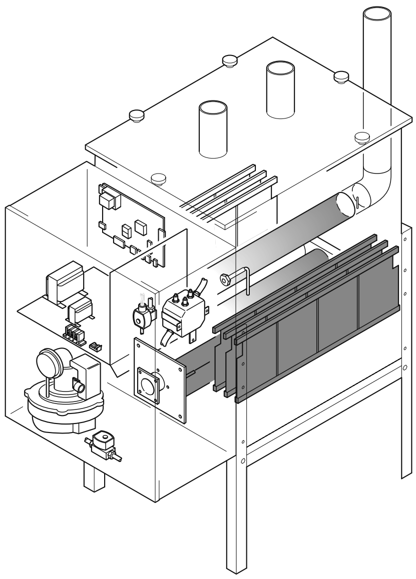
Electric Steam Humidification with Ionic Beds

Figure 17-1.



Gas-Fired with Ionic Beds

Figure 17-2.



How Humidifiers Work, continued...

Fogging Systems (Adiabatic)

Fogging systems use compressed air to atomize water and create a stream of microscopic water particles, which appears as fog. In order to become vapor, water requires approximately 1,000 Btu per pound. The water particles quickly change from liquid to gas as they absorb heat from the surrounding air, or air stream. Properly designed fogging systems include sufficient heat in the air to allow the water to vaporize, avoiding “plating out” of water on surfaces, which might lead to control or sanitation problems.

Fogging systems contain virtually none of the heat of vaporization required to increase RH to desired conditions. For this reason, fogging systems humidification is a virtually constant enthalpy process. As the psychrometric example illustrates, DB temperature changes as RH increases from 30% to 50%. This evaporative cooling can provide energy benefits for systems with high internal heat loads.

Unlike many adiabatic humidifiers, properly designed fogging systems are able to modulate both compressed air and water pressures to provide modulated output. Although time and distance (in an air handling system) are required for evaporation, response to control is immediate. High evaporation efficiency guarantees maximum system performance.

A water analysis is suggested prior to applying fogging systems when reverse osmosis (RO) or deionized (DI) water is not available.

Cost Comparisons

To fairly evaluate the costs of selecting a humidification system, you should include installation, operating and maintenance costs as well as initial costs. Total humidification costs are typically far less than heating or cooling system costs.

Initial costs, of course, vary with the size of the units. Priced on a capacity basis, larger capacity units are the most economical, regardless of the type of humidifier, i.e.: one humidifier capable of delivering 1,000 pounds of humidification per hour costs less than two 500 lbs/hr units of the same type.

Direct steam humidifiers will provide the highest capacity per first cost dollar; fogging systems and gas-fired humidifiers are the least economical (first cost), assuming capacity needs of 100 lbs/hr or more.

Installation costs for the various types cannot be accurately formulated because the proximity of water, steam and electricity to humidifiers varies greatly among installations. Operating costs are low for direct steam and slightly higher for steam-to-

Figure 18-1.

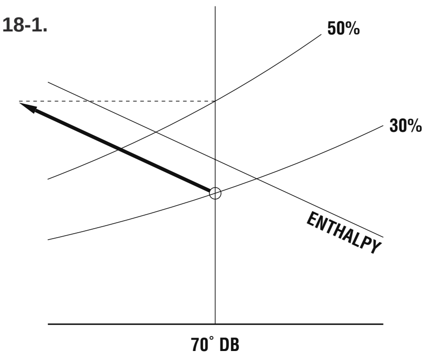


Figure 18-2. Fogger Head

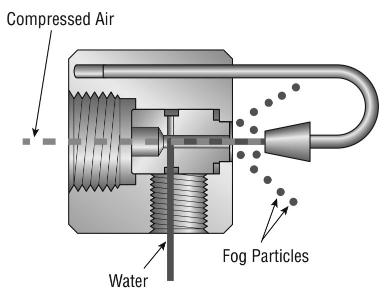


Table 18-1. Comparison of Humidification Methods

		Direct Steam	Steam-to-Steam	Electric Steam	Ionic Bed Electric Steam	Ionic Bed Gas-Fired Steam	Fogging Systems
Effect on temperature		Virtually no change					Substantial temperature drop
Unit capacity per unit size		Small to very large	Small	Small to medium	Small to medium	Small to medium	Small to very large
Vapor quality		Excellent	Good	Good	Good	Good	Average
Response to control		Immediate	Slow	Fair	Fair	Fair	Immediate
Control of output		Good to excellent	Below average	Average	Average	Below average	Good to excellent
Sanitation/corrosion		Sterile medium; corrosion free	Bacteria can be present	Programmed to not promote bacteria	Programmed to not promote bacteria	Programmed to not promote bacteria	Designed to not promote bacteria
Maintenance frequency		Annual	Monthly	Monthly to quarterly	Quarterly to semi-annually	Quarterly	Annual
Maintenance difficulty		Low	High	Medium	Low	Medium	Low
Costs:	Price (per unit of capacity)	Low	High	Medium	Medium	High	Medium
	Installation	Varies with availability of steam, water, gas, electricity, etc.					
	Operating	Low	Low	Medium	Medium	Low	Low
	Maintenance	Low	High	High	Low to medium	Low to medium	Low

steam. Fogging system and gas-fired (ionic bed) operating costs are also low. Energy costs are higher for electric humidifiers.

Direct steam humidifiers have the lowest maintenance costs, followed by fogging systems. Ionic bed electric and gas-fired humidifiers are designed specifically to minimize maintenance while adapting to various water qualities. Maintenance costs for other types can vary widely, depending on water quality and applications.

These are the principal considerations in selecting a humidification system. Table 18-1, Page 18 summarizes the capabilities of each humidifier type.

Recommended Applications

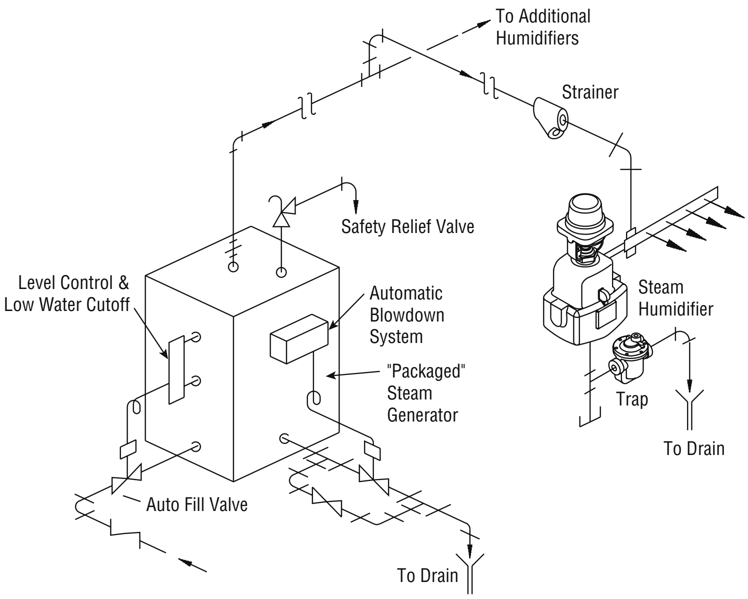
Steam: Recommended for virtually all commercial, institutional and industrial applications. Where steam is not available, small capacity needs up to 200 lbs/hr can be met best using ionic bed type, self-contained steam generating units. Above this capacity range, central system steam humidifiers are most effective and economical. Steam should be specified with caution where humidification is used in small, confined areas to add large amounts of moisture to hygroscopic materials. We recommend that you consult your Armstrong Representative regarding applications where these conditions exist.

Fogging Systems: Properly designed compressed air/water fogging systems used with a reverse osmosis (RO) or deionized (DI) water source will avoid problems associated with sanitation, growth of algae or bacteria, odor, or scale. The potential energy benefit associated with fogging systems should be examined for any application requiring over 500 lb/hr where steam is not available, or where evaporative cooling is beneficial, such as air side economizers or facilities with high internal heat loads.

Summary: The evidence supports the conclusion that steam is the best natural medium for humidification. It provides ready-made vapor produced in the most efficient evaporator possible, the boiler. There is no mineral dust deposited, and because there is no liquid moisture present, steam creates no sanitation problems, will not support the growth of algae or bacteria, has no odor and creates no corrosion or residual mineral scale.

With these advantages in mind, engineers specify steam boilers and generators solely for humidification when the building to be humidified does not have a steam supply. The minimum humidification load where this becomes economically feasible falls in the range of 200 lbs/hr. Steam generator capacity is generally specified 50% greater than maximum humidification load, depending on the amount of piping and number of humidifiers and distribution manifolds that must be heated. Typical piping for boiler-humidifier installations is shown in Figure 19-1.

Figure 19-1. Typical Piping for Boiler-Humidifier Installation



Design Guidelines— Boiler-Humidifier Combinations

1. Boiler gross output capacity should be at least 1.5 times the total humidification load.
2. Water softeners should be used on boiler feedwater.
3. Condensate return system is not necessary (unless required by circumstances).
4. Boiler pressure should be at 15 psig or less.
5. An automatic blowdown system is desirable.
6. All steam supply piping should be insulated.
7. No limit to size or number of humidifiers from one boiler.

Considerations in Selecting Steam Humidifiers

Electric Or Gas-Fired Steam Humidifiers

When steam is not available, self-contained electric or gas-fired humidifiers can meet low-capacity requirements. The primary consideration in selecting this type of humidifier is its ability to work with wide ranges in water quality. Ionic bed electric or gas-fired humidifiers are frequently selected for this capability.

Direct Injection Steam Humidifiers

An evaluation of three performance characteristics is essential to understand the advantages steam holds over other humidification media:

- Conditioning
- Control
- Distribution

The humidifier must condition the steam so that it's completely dry and free of significant particulate matter. Response to control signals must be immediate, and modulation of output must be precise. Distribution of steam into the air must be as uniform as possible. Inadequate performance in any of these areas means the humidifier will not meet the basic humidification requirements.

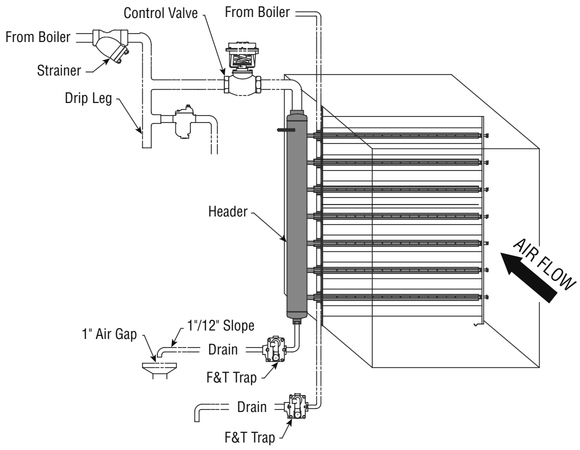
Direct injection steam humidifiers are available in three basic types: specially designed steam panels, steam cups and the steam separator.

Specially designed steam panel systems incorporate advanced engineering in addressing unique applications where vapor trail is of prime concern.

Steam cup humidifiers receive steam from the side of the cup, which theoretically permits the condensate to fall by gravity to the steam trap. However, in practice a great deal of the liquid moisture in the steam goes into the air flow, and the steam itself is poorly distributed.

The steam separator is a more sophisticated device which, when properly designed, meets essential performance criteria.

Figure 20-1. Steam Panel Humidifier



NOTE: Condensate cannot be lifted or discharged into pressurized return.

Figure 20-2. Cup Type Steam Humidifier

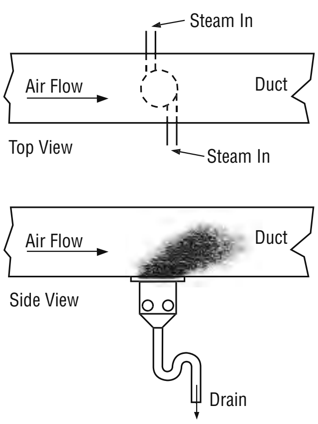
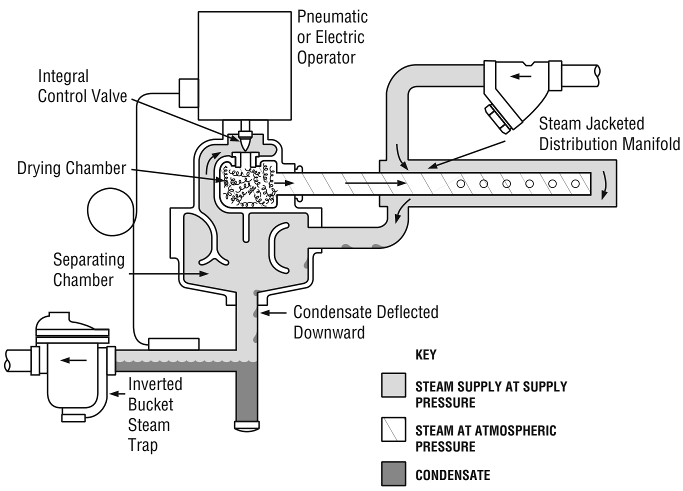


Figure 20-3. Steam Separator Type Humidifier



Steam Conditioning

As steam moves through supply lines, scale and sediment may be entrained in the flow—a Y-type strainer is required to remove larger solid particles. Similarly, the condensation that occurs in the supply lines permits water droplets or even slugs of condensate to be carried into the humidifier.

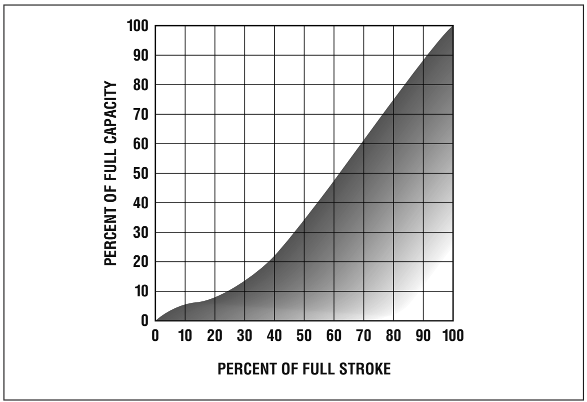
Several steps within the humidifier are required to positively prevent the discharge of liquid moisture and finer particulate matter along with the humidifying steam.

The separating chamber in the humidifier body should provide the volume required for optimum velocity reduction and maximum separation of steam from condensate. Properly separated, the condensate carries a substantial portion of the significant micronic particulates with it to be discharged through the drain trap.

Steam from the separating chamber can still carry liquid mist which must be removed. Humidifiers equipped with an inner drying chamber that is jacketed by the steam in the separating chamber can effectively re-evaporate any remaining water droplets before steam is discharged. Similarly, the control valve should be integral with the humidifier. Both the humidifier and the distribution pipe should be jacketed by steam at supply pressure and temperature to prevent condensation as steam is discharged.

Only proper design of the humidifier for conditioning of steam can assure the essential levels of sanitation and a clean atmosphere. These guidelines contribute to better comfort conditions and ensure that the humidifier meets the vital physical requirements of the system.

Chart 21-1. Desirable modified linear characteristic curve for valves used under modulating control. The modification of true linear characteristics provides more precise control when capacity requirements are very low and the valve is just cracked off the seat.



Control of Output

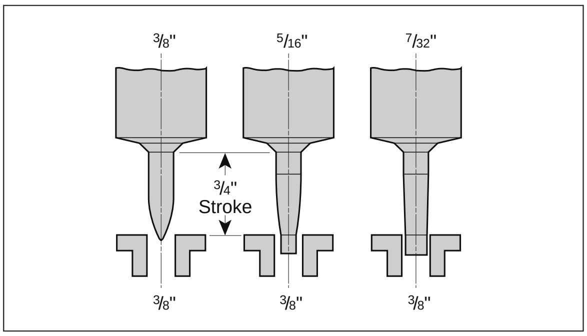
In most applications, humidifiers consistently operate at a fraction of maximum output.

Humidifier control must provide immediate response and precise modulation in order to accurately maintain the required relative humidity. Faulty control can make it difficult to provide the desired humidity level, and can lead to overloading the ducts with moisture and the creation of wet spots.

Two design factors affect the accuracy of humidifier control that can be achieved—the metering valve and the actuator that positions the valve.

Precise flow control can be achieved with a valve designed expressly for the purpose of adding steam to air. Parabolic plug type valves have been established as best for this service. They permit a longer stroke than comparable industrial valves, and the plug normally extends into the orifice even with the valve in "full open" position. This facilitates full and accurate modulation of flow over the complete stroke of the valve.

Figure 21-1. Parabolic Plug Metering Valve



Considerations in Selecting Steam Humidifiers, continued

The Control Valve

The parabolic plug design also provides exceptionally high rangeability. Rangeability is the ratio between the maximum controllable flow and the minimum controllable flow of steam through the valve. The higher the rangeability of a valve, the more accurately it can control steam flow. Rangeabilities of the parabolic plug valves used in Armstrong Series 9000 Humidifiers shown in Table 22-1 are typical of the ratios that can be achieved with this type of valve.

The actuator is another important component in humidity control. Several types are available to provide compatibility with various system types. The actuator must be able to position the valve in very nearly identical relationship to the seat on both opening and closing strokes. This is essential to provide consistent, accurate metering of steam discharged by the humidifier.

By their design, electric motor modulating actuators provide true linear positioning characteristics on both opening and closing cycles. Pneumatic actuators may or may not be able to provide the precise positioning and holding characteristics essential to accurate control. Rolling diaphragm type pneumatic actuators are recommended, providing they meet the following criteria:

1. Large diaphragm area—12 sq in or more—to provide ample lifting force. This permits the use of a spring heavy enough to stabilize both the hysteresis effect and the flow velocity effect on the positioning of the valve stem versus air pressure to the actuator.
2. Diaphragm material highly resistant to wear or weakening from continuous cycling.
3. Actuator stroke long enough (in conjunction with valve plug and seat design) to provide high rangeability ratios.

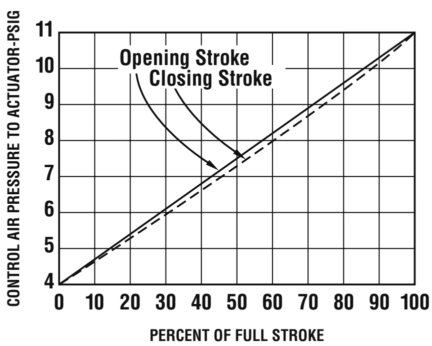
All modulating actuators, whether electric or pneumatic, should incorporate a spring return. This is necessary to ensure closing the valve if there is an interruption of power or control air to the unit.

For industrial in-plant operation and for very limited duct applications, a solenoid actuator may be used to provide simple on-off operation. This type of actuator should not be specified for duct applications without a detailed analysis of the system.

Table 22-1. Steam Humidifier Valve Rangeabilities

Valve Size	Rangeability	
Equivalent Diameter	Ratio of Flow Max:Min	Minimum Flow as % of Maximum
1-1/2"	63:1	1.6
1-1/4"	69:1	1.4
1-1/8"	61:1	1.6
1"	53:1	1.9
7/8"	44:1	2.3
3/4"	33:1	3.0
5/8"	123:1	0.8
9/16"	105:1	0.9
1/2"	97:1	1.0
15/32"	85:1	1.2
7/16"	75:1	1.3
13/32"	64:1	1.6
3/8"	70:1	1.4
11/32"	59:1	1.7
5/16"	49:1	2.0
9/32"	40:1	2.5
1/4"	31:1	3.2
7/32"	24:1	4.2
3/16"	18:1	5.6
5/32"	59:1	1.7
1/8"	37:1	2.7
7/64"	28:1	3.5
3/32"	21:1	4.8
5/64"	15:1	6.9
1/16"	10:1	10.0

Chart 22-1. Desirable Operating Characteristic for Pneumatic Actuators
Position of valve is very nearly identical on both opening and closing strokes at any given air pressure to the actuator.



Distribution of Steam

The third essential factor in proper humidifier design is distribution. Steam must be discharged as uniformly as possible into the air to permit the fastest possible absorption without creating damp spots or saturated zones.

In normal ducts, a single distribution manifold installed across the long dimension will provide good distribution of steam. In large ducts or plenum chambers, it may be necessary to broaden the pattern of vapor discharge to achieve the required distribution, thus requiring multiple manifolds from single or multiple humidifiers.

Humidification for industrial areas without central air handling systems is customarily achieved with unit humidifiers discharging steam directly into the atmosphere. Proper mixing of steam and air can be accomplished in two ways. A dispersing fan may be mounted on the humidifier or a unit heater can be positioned to absorb and distribute the water vapor.

Figure 23-1. Unit Humidifier for Direct Discharge into Area Humidified

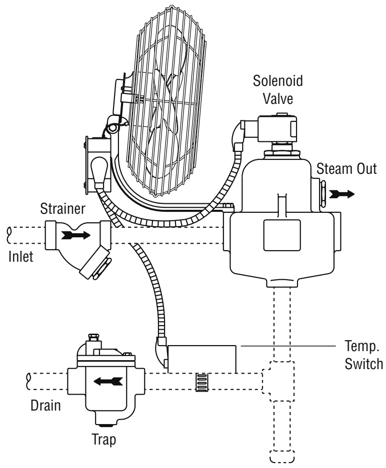


Figure 23-2. Single Distribution Manifold in a Normal Duct

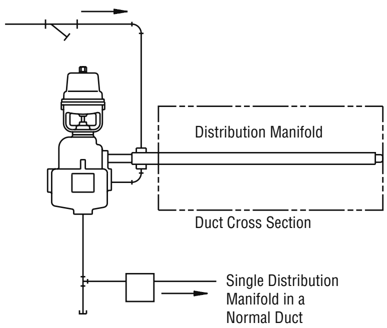
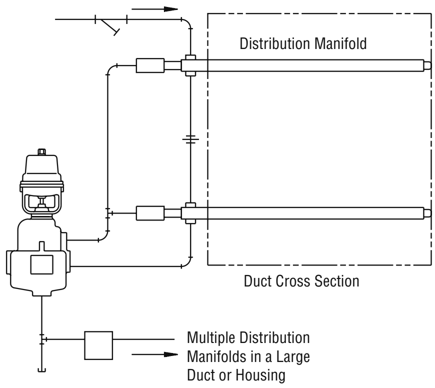


Figure 23-3. Multiple Distribution Manifolds in a Large Duct or Housing



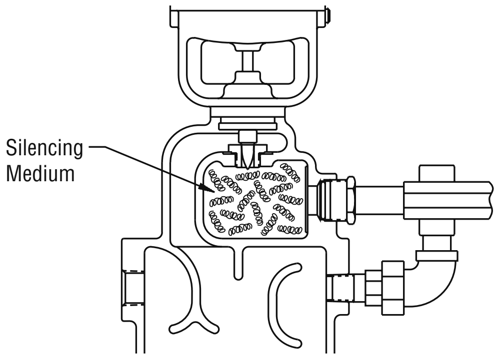
Note: See Page 26 for multiple manifold hook-ups.

Operating Noise

In addition to these crucial performance characteristics, operating noise is a consideration in selecting steam humidifiers for areas where quiet operation is essential or desirable, i.e., hospitals, office buildings, schools, etc.

Figure 23-4.

The noise of escaping steam is generated at the control valve. Muffling materials around the valve are necessary to minimize this noise.



Basic Application Principles

Several basic principles must be considered in the application of steam humidification equipment to insure proper system operation.

Vapor dissipation in air ducts is one of these considerations. In the steam humidification process, pure water vapor at 212°F is mixed with air at a lower temperature. The mixing of hot steam with cooler air results in heat transfer. Any time heat is transferred from steam condensation takes place. This condensation is referred to as visible vapor. When steam is discharged from a manifold in an air duct, it quickly changes from an invisible gas into visible water particles, and then dissipates to become invisible again.

Visible vapor indicates an area of super-saturation, where the invisible steam gas is condensing into water particles. When condensation occurs, the steam gas releases its latent heat of vaporization (about 1,000 Btu/lb of vapor) to duct air. Then, as the vapor completely mixes with the duct air, the latent heat previously given off is reabsorbed, converting the visible vapor back into invisible gas with essentially no change in DB temperature. (See Figure 24-1).

Clearly, the vapor dissipation in air ducts is very important to proper location of temperature or humidity controllers. Any controller located in or near the visible vapor pattern will produce inaccurate results because of pockets of saturated air. Under typical duct conditions, all controllers should be located at least 10 to 12 feet downstream of a manifold. However, the following system characteristics will affect the visible vapor pattern, and therefore should be considered in controller location:

1. **Aspect Ratio of Duct.** The ratio of duct height to width is a factor that influences the visible vapor pattern. Figure 24-2 shows two ducts with equal cross section areas, but with different aspect ratios. Air velocities, temperatures, RH and vapor output from the manifolds are all identical. However, in the taller duct the manifold is shorter and its vapor output comes in contact with a much smaller percentage of duct air, causing a longer visible vapor pattern.

2. **Duct Air Temperature.** The temperature of the air flow in the duct also affects the length of the visible vapor pattern. Warmer air produces shorter vapor pattern, as shown in Figure 25-2, Page 25. All other conditions are the same.

Figure 24-1.
Typical dry-bulb (sensible) temperature variations within a duct near the humidifier manifold. As the latent heat of vaporization is released, the temperature increases (in or near the visible vapor the temperature may rise as much as 20° to 30° F). However, as the visible vapor mixes and re-evaporates in the air flow, the heat of vaporization is reabsorbed and the duct air temperature returns to its former level.

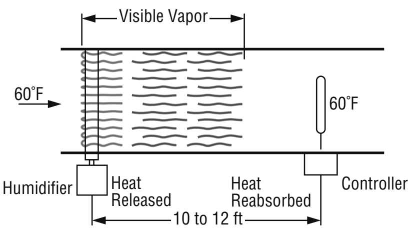
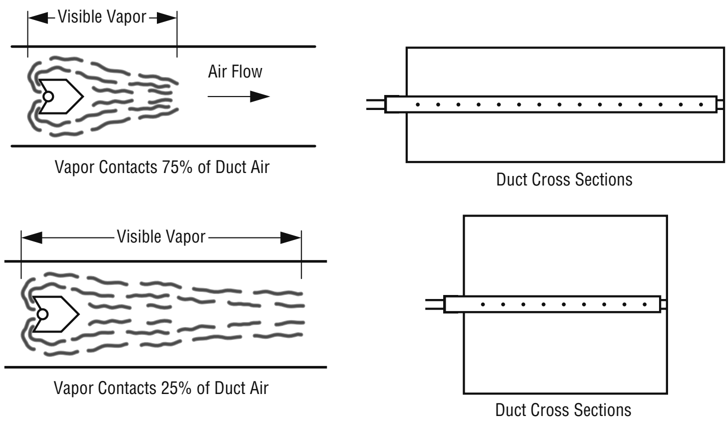


Figure 24-2.



3. **Insulated Manifolds.** While it is true that steam humidification is an isothermal process, several Btu's of energy will be transferred into the air stream when using steam jacketed manifolds. Typically, this will result in less than a 3°F temperature gain. The use of insulated steam jacketed manifolds will reduce this heat transfer for air temperature critical applications.

   When insulated manifolds cannot be avoided, considerations need to be taken during the installation of these manifolds. A typical installation of a steam jacketed manifold requires the steam to be injected into the air stream. **When insulated manifolds are used, they need to be installed with the steam being injected with the air stream.** This is done to ensure moisture will not accumulate on the cool insulation jacket surfaces. However, when the manifolds are installed in this fashion, the added turbulence caused by the air flow travelling around the standard steam jacketed manifold is lost, resulting in a longer visible vapor trail. Figure 25-1 shows the proper installation, and effects on the visible vapor trail.

4. **Duct Air Velocity.** As the duct air velocity increases, the length of the visible vapor pattern increases. Figure 25-4 shows two sections of air ducts with air velocities of 500 fpm and 2,000 fpm respectively. Other conditions are the same: temperature, duct air humidity, duct dimensions and the amount of steam released from the identical manifolds. The length of the visible vapor pattern is approximately proportional to the velocity of the air in the duct.

5. **Number of Manifolds in Duct.**
   In a large duct section requiring the discharge capacity of two humidifiers, better vapor distribution is achieved by using two manifolds full across the duct and vertically spaced to divide the duct section into thirds. The same effect is achieved by using multiple distribution manifolds from a single humidifier that has adequate capacity to meet the requirements. When a quantity of vapor is distributed among multiple manifolds, the amount released through each manifold is smaller, and more of the duct air comes into contact with the vapor. This effect is shown in Figure 25-5.

6. **Duct Air RH.** Relative humidity in the duct also affects the visible vapor. The higher the relative humidity downstream of the humidifier discharge, the longer the visible vapor trail. The closer duct conditions are to saturation, the longer the vapor trails are likely to be. Fortunately, duct air RH may be controlled with a duct high-limit humidistat, as shown in Figure 27-2, Page 27.

Figure 25-1. Standard Jacketed Manifold

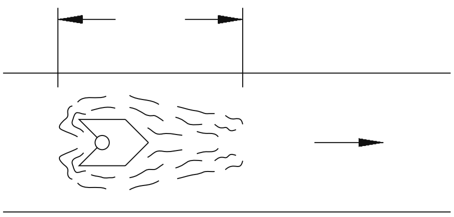


Figure 25-2. Insulated Jacketed Manifold

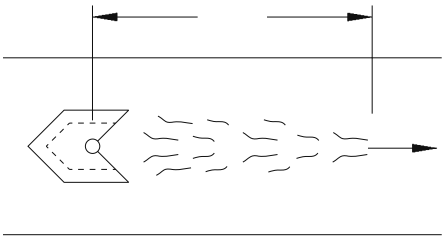


Figure 25-3.

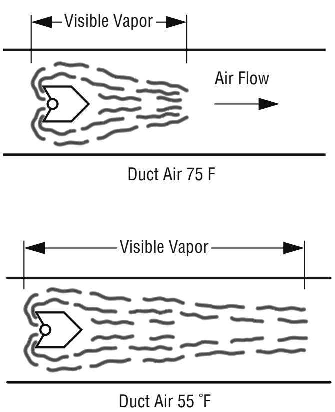


Figure 25-4.

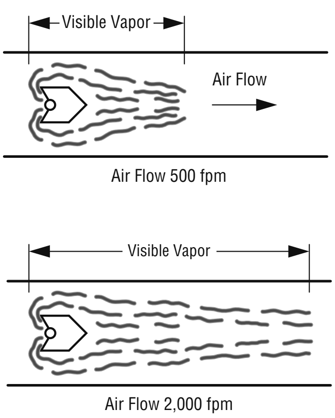
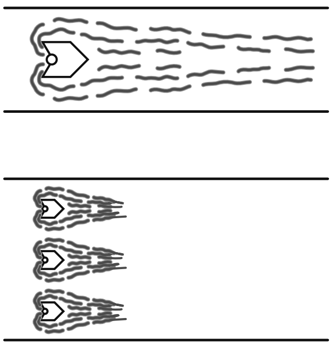


Figure 25-5.



Basic Application Principles, continued...

Since the use of multiple manifolds reduces the length of visible vapor, their use should be considered whenever any of the following conditions exist at the humidifier location:

A. Duct air temperature is below 55°F or relative humidity is above 80%.
B. Duct air velocity exceeds 800 fpm.
C. “Final” or “high efficiency” filters are located within 10 feet downstream from humidifier.
D. Height of duct section exceeds 36.”
E. Visible vapor impinges upon coils, fans, dampers, filters (not final), turning vanes, etc. located downstream from humidifier.

Table 26-1 and Figure 26-1 show a typical number of manifolds and typical spacing between them when duct height exceeds 36”.

Consult your Armstrong Representative or download Armstrong Humid-A-ware Humidification Sizing and Selection software at www.armstrong-intl.com for specific recommendations regarding your needs.

The piping arrangement for humidifiers with multiple manifolds varies with the location of the manifolds.

When all manifolds are located above the humidifier inlet, manifold piping should be as shown in Figure 26-2.

When one or more manifolds are located below the humidifier inlet, the manifolds should be trapped separately, as shown in Figure 26-3.

Smaller manifolds, when possible to use, reduce the cost of multiple manifold installations. Care must be taken that the humidifier capacity does not exceed the combined capacity of the multiple manifolds. Piping arrangement is shown in Figure 27-3, Page 27.

7. **Humidifier Manifold too Close to High Efficiency Filter.** Many air handling systems require the use of high efficiency filters (also called “absolute” or “final” filters). These filters remove up to 99.97% of all particles 0.3 micron in diameter, and up to 100% of larger particles. The significance of these filtering qualities is shown in Table 26-2, where particle sizes of common substances are compared.

Table 26-1. Typical Number of Manifolds for Various Duct Heights

Duct height at humidifier location	No. of manifolds to be installed from one or more humidifiers
37" to 58"	2
59" to 80"	3
81" to 100"	4
101" & Over	5

Table 26-2. Typical Particle Sizes of Common Substances

Material	Particle Size in Microns
Particles visible to human eye	10 or more
Human hair	100
Dust	1 to 100
Pollen	20 to 50
Fog (visible steam vapor)	2 to 40
Mist (water spray)	40 to 500
Industrial fumes	0.1 to 1
Bacteria	0.3 to 10
Gas molecules (steam gas)	0.0006

Figure 26-1.

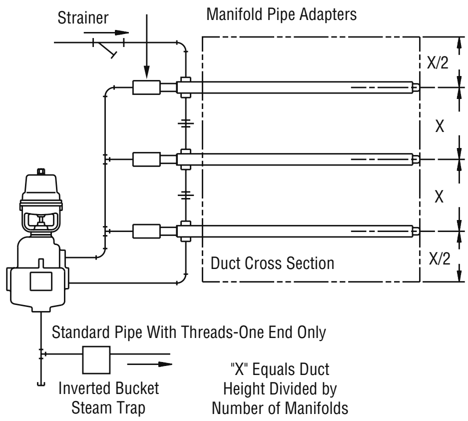


Figure 26-2.

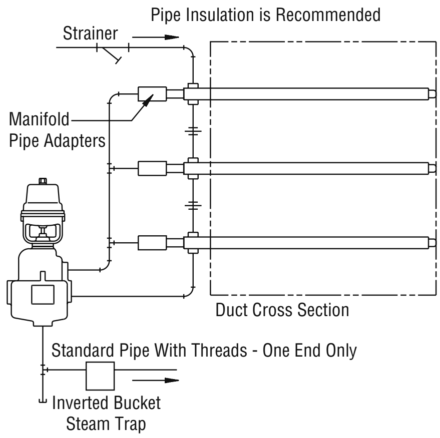
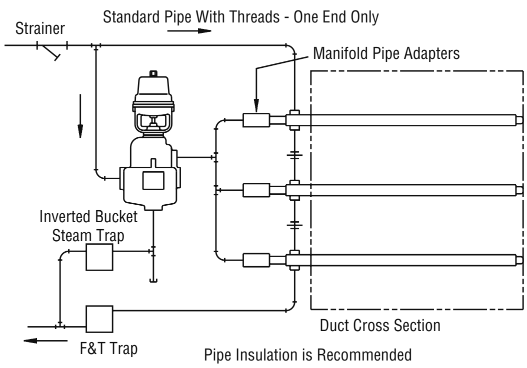


Figure 26-3.



Since water particles present in visible vapor range from 2 to 40 microns, these particles are trapped by high efficiency filters. Some types of filters absorb moisture and expand, reducing air flow through the filter material. As a result, the static pressure in the duct rises from normal (about 1" water gauge) to as high as 40" wg. When the filter absorbs moisture, it also releases the latent heat of condensed steam into the duct air.

When a humidifier manifold is located too close to an absolute filter, the filter collects water vapor, preventing the moisture from reaching the space to be humidified. Placing the humidifier manifold farther upstream allows the water vapor to change into steam gas, which will pass unhindered through an absolute filter.

Under most circumstances, the water vapor will dissipate properly if the humidifier manifold is located at least 10 feet ahead of the final filter. However, if the duct air temperature is low, air velocity is high or the duct is tall, multiple manifolds may be installed to speed the mixing of steam with the duct air. For additional protection, install a duct high-limit controller just ahead of the final filter to limit the maximum humidity to approximately 90%. (See Figure 27-2)

Specially Designed Steam Panel Systems
For applications with particularly limited downstream absorption distances, custom engineered systems may be considered. The system includes a separator/header and multiple dispersion tube assembly packaged with a control valve, strainer, steam supply drip trap and one or two header drain traps. Each system is customized to provide uniform distribution and shortened non-wetting distance downstream. (See Figure 27-4.)

How Steam Panel Systems Shorten Non-wetting Distance
Conditioned steam enters each of the dispersion tubes and flows through steam nozzles that extend from the center of each tube, before discharging through orifices into the airstream.

Airflow first encounters baffle tubes (See Figure 27-1) which influence its flow pattern and increase its velocity. Air traveling around each set of baffle tubes encounters opposing flow of high velocity steam exiting the orifices. The result is more uniform distribution and faster absorption of moisture into the air, resulting in a shorter non-wetting distance requirement than experienced with traditional manifolds or dispersion tubes.

Figure 27-1.

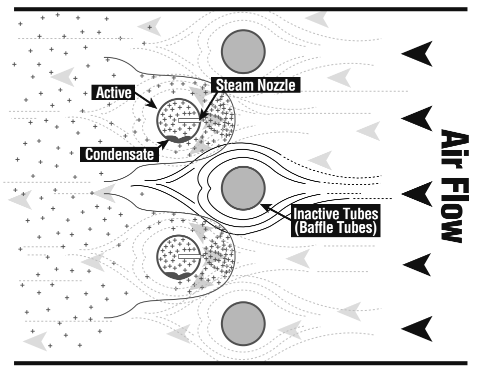


Figure 27-2.

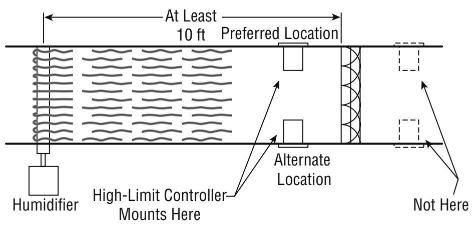


Figure 27-3.

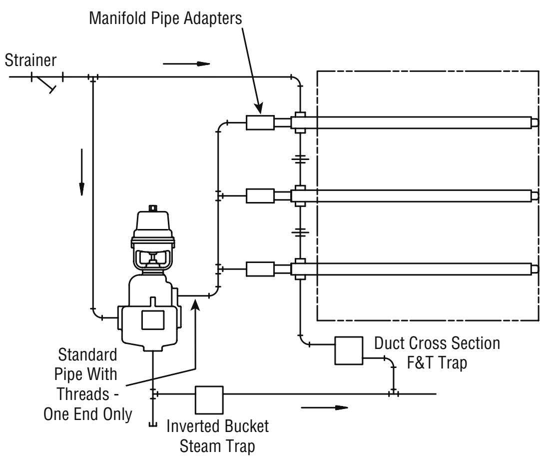
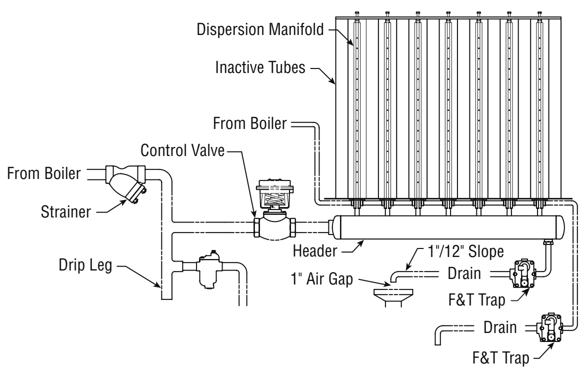


Figure 27-4. Steam Panel System



NOTE: Condensate cannot be lifted or discharged into pressurized return when using a steam panel system.

Sizing Considerations for Steam Humidifiers

Psychrometric Considerations in Ducted Systems

In practice you may find that areas need humidification but cannot be satisfactorily humidified through the central air handling system. These are often areas having high sensible heat loads that must be balanced with low duct air temperatures to maintain design temperature conditions in the area. Typical examples are data processing rooms or hospital operating rooms where duct air temperatures may be held as low as 50°F to maintain a design condition of 75°F in the room. These low duct air temperatures prevent adding enough moisture to the air to meet design RH requirements in the room—say, 55% RH.

Using these conditions as an example, duct air at 50°F and 90% RH holds slightly less than 3.7 grains of moisture per cubic foot. At 75°F the same 3.7 grains of moisture yield a relative humidity of 39%. To achieve design conditions of 55% RH at 75°F, the air must contain 5.2 grains of moisture per cubic foot—1.5 grains more than it psychrometrically can hold at duct air temperature.

For such applications, booster humidification must be accomplished in the air of the area after it has reached its final temperature. Self-contained electric humidifiers may be used for this purpose, although we would recommend using combined steam humidifier-fan units which can be installed either within the humidified space or remote ducted to the space. For hospital applications, steam humidifier-fan units should include an integral high efficiency (95%) filter to satisfy code requirements.

Determining Humidification Loads for Air Handling Systems

Most engineers prefer to determine humidification requirements psychrometrically on the basis of design conditions and humidification requirements. However, short-cut methods for making these calculations or for checking psychrometric calculations are described below.

Sizing for Primary Humidification

In sizing duct humidifiers for air handling systems, you should know:
CFM of air.
Design outdoor air temperature and relative humidity.
Required indoor temperature and relative humidity.
Humidifier steam supply pressure.

The formula for load calculation is:

$$\text{Humidification Load in lbs/hr} = \frac{\text{CFM (R2-R1) 60}}{7{,}000}$$

Where:

CFM	=	air flow of unhumidified air at moisture condition R1
R2	=	moisture content of required indoor condition air in gr/ft3
R1	=	moisture content of air to be humidified (from outdoor condition) in gr/ft3
7,000	=	gr/lb conversion
60	=	min/hr conversion

EXAMPLE, assume:
10,000 CFM of outdoor air.
Design outdoor air temperature 0°F.
Steam pressure 10 psig.
Required 40% RH at 70°F.
Air controls used.

From Table 29-1,Page 29, for 70°F final temperature, read 2.456 under 40% and opposite 0°F. This is pounds of vapor per hour for 100 CFM. Then 100 x 2.456 = 245.6 or, call it 246 lbs per hour required for design conditions.

A single humidifier can provide this capacity although sequence control for two humidifiers might be needed to avoid duct condensation on very light loads. Length of distribution manifold is governed by width of duct where the humidifier is to be located.

Sizing for Booster Humidifier

Assume that a primary humidifier provides air that will have 40% RH at 70°F, but you want to maintain 60% RH in a laboratory supplied with 900 CFM of the air at 40% at 70°F. Refer to Table 29-3, Page 29, and read 1.38 under 60% and opposite 70°F — 40%. 9 x 1.38 = 12.42 lbs. The humidifier must be able to provide this capacity at steam supply pressure.

Special Conditions

When relative humidities must be figured for temperature conditions other than those given in Tables 29-1 through 29-3, Table 29-5, Page 29, will prove helpful.

New Condition—55% RH at 77°F.
Makeup Air—35% RH at 70°F.
From Table 29-5, Page 29:
Grains per cu ft
New Condition..5.54
Less Grains per cu ft,
Makeup Air...2.82
Grains to be added 2.72
Assume 800 CFM

$$\frac{800 \times 2.72 \times 60}{7{,}000} = 18.65 \text{ lbs/hr}$$

NOTE: .857 lb of steam per hour will add 1 grain to 100 CFM. Use of this factor simplifies the above equation to:

$$8 \times 2.72 \times .857 = 18.65.$$

Where Table 29-5, page 29, is used for outdoor air makeup, assume 75% RH for the outdoor air at 0° to -20°F.

Room to Duct Comparisons

When high humidity is needed in a room (70°F-60% RH) and the duct temperature is lower than the room temperature (50°F), the duct high-limit humidistat often acts as the controlling stat. Duct high-limit humidistats should be set between 70% and 90% RH. We do not recommend setting the high-limit stat any higher than 90% RH. Table 29-4, Page 29, shows the maximum room humidity that can be achieved for the given duct conditions.

Humid-A-ware™ Can Simplify Humidifier Selection

Armstrong offers a free software program that can eliminate the need for time-consuming pencil-and-paper calculations. The Armstrong Humidi-A-ware™ Humidification Sizing and Selection Software runs on Microsoft® Windows® 9x and Windows® 200x. Once the user-friendly software is loaded into your computer, the program displays on your monitor a series of easy-to-understand questions about your humidification application. You respond to the questions—often with a single keystroke—and Humid-A-ware™ can:

- Calculate humidification load.
- Determine correct humidifier model number.
- Create and customize equipment and data schedule.
- Indicate psychrometric properties of air.
- Calculate non-wetting distance.
- Print the complete humidification application specification.

You may request a free copy of the Humid-A-ware™ Humidification Sizing and Selection software with catalog and drawings available as PDF files by contacting your local Armstrong Representative. Or visit www.**armstrong**international.com for complete humidification information.

Table 29-1. 70°F Primary Humidification Pounds of vapor required per hour per 100 CFM to secure desired RH at 70°F (outside air 75% saturated)

Outdoor	Relative Humidity Desired							
Temp.	35%	40%	45%	50%	55%	60%	65%	70%
*30	1.165	1.510	1.855	2.200	2.545	2.891	3.236	3.581
20	1.618	1.963	2.308	2.653	2.998	3.344	3.689	4.034
10	1.918	2.263	2.608	2.953	3.298	3.644	3.989	4.334
0	2.111	2.456	2.801	3.146	3.591	3.837	4.182	4.527
-10	2.233	2.578	2.923	3.268	3.613	3.959	4.304	4.649
-20	2.309	2.654	2.999	3.344	3.689	4.035	4.380	4.725

Table 29-2. 75°F Primary Humidification Pounds of vapor required per hour per 100 CFM to secure desired RH at 75°F (outside air 75% saturated)

Outdoor	Relative Humidity Desired							
Temp.	35%	40%	45%	50%	55%	60%	65%	70%
*30	1.584	1.989	2.394	2.799	3.204	3.609	4.014	4.419
20	2.034	2.439	2.844	3.249	3.654	4.059	4.464	4.869
10	2.334	2.739	3.144	3.549	3.954	4.359	4.764	5.169
0	2.529	2.934	3.339	3.744	4.149	4.554	4.959	5.364
-10	2.652	3.057	3.462	3.867	4.272	4.677	5.082	5.487
-20	2.727	3.132	3.537	3.942	4.347	4.752	5.157	5.562

*When outdoor design temperatures exceed 30°F, use Table 30-5, entering the table with both outdoor design temperature and outdoor design RH.

Table 29-3. Booster Humidification Pounds of vapor required per hour per 100 CFM to secure desired relative humidity with no change in air temperature

Initial Condition		Relative Humidity Desired						
Temp.	RH	40%	45%	50%	55%	60%	65%	70%
70	35%	.345	.690	1.03	1.38	1.72	2.07	2.42
70	40%	—	.345	.69	1.03	1.38	1.72	2.07
72	35%	.368	.728	1.10	1.46	1.83	2.20	2.57
72	40%	—	.368	.73	1.10	1.46	1.83	2.20
75	35%	.405	.810	1.22	1.62	2.03	2.43	2.84
75	40%	—	.405	.81	1.22	1.62	2.03	2.43

Table 29-4. Maximum Room RH for Given Duct Conditions

Duct Temperature °F	Duct Relative Humidity (RH)	Room RH @ Temperature °F			
		68°	70°	72°	75°
50	90%	47%	44%	41%	37%
	85%	44%	41%	39%	35%
	80%	42%	39%	36%	33%
55	90%	57%	53%	49%	44%
	85%	53%	50%	46%	42%
	80%	50%	47%	44%	39%
60	90%	68%	63%	59%	53%
	85%	64%	60%	56%	50%
	80%	60%	56%	52%	47%

Table 29-5. Grains of Water Vapor per cu ft of Air at Various Temperatures and Relative Humidities

Air Temp.	Grains cu ft Saturated	Grains per cu ft at Relative Humidity Specified							
		35%	40%	45%	50%	55%	60%	65%	75%
80	11.04	3.86	4.42	4.97	5.52	6.07	6.62	7.18	8.28
79	10.71	3.75	4.28	4.82	5.36	5.89	6.43	6.96	8.03
78	**10.38**	**3.63**	**4.15**	**4.67**	**5.19**	**5.71**	**6.23**	**6.75**	**7.79**
77	10.06	3.52	4.03	4.53	5.03	5.54	6.04	6.55	7.55
76	9.749	3.41	3.90	4.39	4.87	5.36	5.85	6.34	7.31
75	**9.448**	**3.31**	**3.78**	**4.25**	**4.72**	**5.20**	**5.67**	**6.14**	**7.09**
74	9.153	3.20	3.66	4.12	4.58	5.03	5.49	5.95	6.86
73	8.867	3.10	3.55	3.99	4.43	4.88	5.32	5.76	6.65
72	**8.568**	**3.01**	**3.44**	**3.86**	**4.29**	**4.72**	**5.15**	**5.58**	**6.44**
71	8.319	2.91	3.33	3.74	4.16	4.58	4.99	5.41	6.24
70	8.055	2.82	3.22	3.62	4.03	4.43	4.83	5.24	6.04
65	**6.845**	**2.40**	**2.74**	**3.08**	**3.42**	**3.76**	**4.11**	**4.45**	**5.13**
60	5.795	2.03	2.32	2.61	2.90	3.19	3.48	3.77	4.35
55	4.889	1.71	1.96	2.20	2.44	2.69	2.93	3.18	3.67
50	**4.106**	**1.44**	**1.64**	**1.85**	**2.05**	**2.26**	**2.46**	**2.67**	**3.08**
40	2.863	1.00	1.15	1.29	1.43	1.57	1.72	1.86	2.15
30	1.946	.58	.68	.78	.97	1.07	1.17	1.26	1.46
20	**1.242**	**.43**	**.50**	**.56**	**.62**	**.68**	**.75**	**.81**	**.93**
10	.776	.27	.31	.35	.39	.43	.47	.50	.58
0	.475	.17	.19	.21	.24	.26	.29	.31	.36
-10	**.285**	**.10**	**.11**	**.13**	**.14**	**.16**	**.17**	**.19**	**.21**
-20	.166	.06	.07	.07	.08	.09	.10	.11	.12

Steam required to add 1 gr per cu ft to 100 CFM: 100 x 60 = 6,000 cu ft per hour or 6,000 grains per hour. $\frac{6{,}000}{7{,}000}$ = .857 lb/hr

Sizing Considerations for Steam Humidifiers, continued...

Economizer Cycles

Fan coil air systems which mix return air and outside air in varying amounts to obtain a given final mixed air temperature require special consideration in determining maximum humidification loads.

Systems of this type usually use a fixed minimum amount of outside air (approximately 10%-30%) when outside air temperature is at a maximum design (-10°F). As the outside air temperature increases, more outside air is mixed with return air to achieve a final mixed air temperature (55°F). Since humidification load is a function of the amount of outside air introduced (plus its moisture content) the maximum humidification requirement will occur at some outside air temperature other than maximum design.

Conditions

Tables 30-1 and 30-3 below give the percent of outside air required to maintain desired mixed air temperature when outside air temperature is as shown. Table 30-1 is used when return air (room air) temperature is at 70°F. Table 30-3 is for 75°F return air systems.

Tables 30-2 and 30-4 can be used to determine maximum humidification load at the given conditions of mixed air temperature and required RH, assuming 40% RH OSA and 10% minimum OSA.

NOTE: Consideration must be given to over-saturating conditions in lower temperature systems.

EXAMPLE

Given conditions that 70°F return air temperature is mixed with outside air to produce 55°F constant mixed air temperature in duct. The design of the space being conditioned is 70°F at 40% RH. Total volume of air through the fan system is 40,000 CFM. Determine maximum humidification load.

From Table 30-2 with 55°F mixed air temperature and 40% RH space design, the maximum humidification load is 11.4 pounds per 1,000 CFM of total air volume. This maximum load occurs when the outside air temperature is at 55°F. Multiplying 11.4 x 40 results in total pounds per hour required in the 40,000 CFM system. Therefore maximum humidification load becomes 456 pounds of vapor per hour.

Table 30-1. With 70°F Return Air

Desired Mixed Air Temp. °F	% Outside Air Required at Temperature Shown														
	-10°	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°
50	25	29	31	33	36	40	45	50	57	67	80	100	—	—	—
55	19	21	23	25	27	30	33	36	43	50	60	75	100	—	—
60	12	14	15	17	18	20	22	25	29	33	40	50	67	100	—
65	6	7	7	8	9	10	11	13	14	16	20	25	33	50	100

Table 30-2. With 70°F Return Air

Max. Humidification Load (given in lbs. of vapor/hr/1,000 CFM of total air) Occurs at Outside Air Temp. Shown for Given Inside RH												
Inside RH	30%		35%		40%		45%		50%		55%	
Mixed Air Temp. °F	Outside Air °F	Max. Load	Outside Air °F	Max. Load	Outside Air °F	Max. Load	Outside Air °F	Max. Load	Outside Air °F	Max. Load	Outside Air °F	Max. Load
50	42	7.7	50	10.7	50	14.2	50	17.7*	50	21.2*	50	24.7*
55	42	5.8	52	8.0	55	11.4	55	14.9	55	18.4	55	22.0*
60	42	3.8	52	5.4	60	8.2	60	11.7	60	15.2	60	18.7
65	0	1.9	52	2.7	65	4.4	65	7.9	65	11.4	65	15.0

Table 30-3. With 75°F Return Air

Desired Mixed Air Temp. °F	% Outside Air Required at Temperature Shown														
	-10°	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°
50	30	33	36	38	42	45	50	56	62	71	83	100	—	—	—
55	23	26	28	31	33	36	40	44	50	57	67	80	100	—	—
60	18	20	21	23	25	27	30	33	37	43	50	60	75	100	—
65	12	13	14	15	16	18	20	22	25	29	33	40	50	67	100

Table 30-4. With 75°F Return Air

Max. Humidification Load (given in lbs. of vapor/hr/1,000 CFM of total air) Occurs at Outside Air Temp. Shown for Given Inside RH												
Inside RH	30%		35%		40%		45%		50%		55%	
Mixed Air Temp. °F	Outside Air °F	Max. Load	Outside Air °F	Max. Load	Outside Air °F	Max. Load	Outside Air °F	Max. Load	Outside Air °F	Max. Load	Outside Air °F	Max. Load
50	46	11.2	50	15.2	50	19.3*	50	23.5*	50	27.7*	50	31.9*
55	46	8.9	55	12.4	55	16.6	55	20.8*	55	24.9*	55	29.1*
60	46	6.7	60	9.3	60	13.4	60	17.5	60	21.7	60	25.9*
65	46	4.5	65	6.2	65	9.6	65	13.7	65	17.9	65	22.1*

*Humidification loads will exceed 90% RH in duct at temperature indicated. Booster humidification is recommended.

Steam Humidifiers in Central Systems

Proper location, installation and control of humidifiers is essential to achieve totally satisfactory, trouble-free performance. The primary objective is to provide the required relative humidity without dripping, spitting or condensation. Liquid moisture, even in the form of damp spots, cannot be tolerated in the system. Aside from the hazards to the structure caused by water in the ducts, there is an even more critical health hazard if breeding grounds are provided for bacteria.

In addition to the need for proper humidifier design and performance, several other factors deserve close attention. The humidifier must be the proper capacity for the system; properly located in relation to other components of the system; properly installed and piped in a manner that will not nullify all the other precautions taken. In sizing humidifiers you should be sure that they deliver the amount of steam per hour called for in the design calculations. Steam pressure to the humidifiers must be kept relatively constant to assure sufficient capacity. Double-check to be sure you're not trying to put more moisture into the air stream than it can hold at its existing temperature. Use of Psychometrics can be a helpful aid in determining moisture potential in your application.

Proper location of humidifiers in the system is most important, although sometimes the design of the system makes this difficult to achieve. The following examples of typical systems demonstrate proper humidifier location.

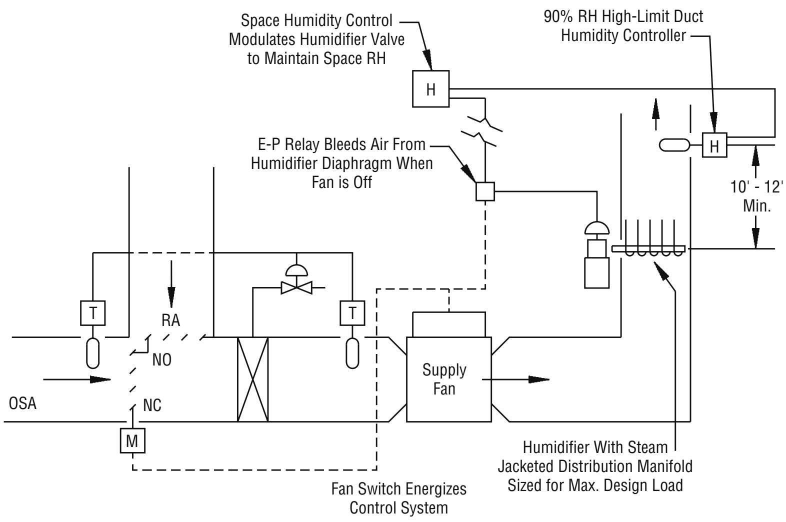
System 1

This is a simple ventilating system. We assume final duct air temperature to be slightly above desired room temperature. The desirable location of the steam jacketed distribution manifold of the primary humidifier is downstream from the supply fan. This humidifier would be sized for maximum design load. If the humidifier were located between the coil and the fan, it might interfere with the temperature sensing bulb. The indicated use of a high-limit duct humidity controller shown is optional. It is advisable if the capacity of the humidifier at design loads could possibly overload air when outside air moisture content is higher than the design. The high-limit controller should be 10 to 12 feet downstream from the humidifier. Place the high-limit controller where it will see the same temperature as the humidifier. A cooler temperature at the humidifier would allow saturation if the high-limit controller were in warmer air.

This is shown as a pneumatic control system. The fan switch activates the control system and the electric pneumatic relay bleeds air from the humidifier actuator diaphragm when the fan is off. The following examples also show pneumatic control—if the systems were electric, control locations would remain the same.

System 1

Figure 31-1.
Ventilation system with primary humidification



Features of this system and the following systems include:

A. Accurate control is possible because of immediate response of steam humidifier.
B. Control can be modulating electric or pneumatic (shown).
C. No need for drain pans or eliminator plates; makes locations of humidifier more flexible.
D. Addition of moisture is accomplished with no appreciable change in duct dry-bulb temperature.
E. The humidifier's integral steam jacketed control valve with parabolic plug is accurately sized to meet capacity requirements.

Glossary of Symbols

EA_________Exhaust Air
E-P relay____Electric-Pneumatic relay
H___________Humidity controller
M __________Damper motor
MA _________Mixed air
NC _________Normally closed
NO _________Normally open
OSA ________Outside Air
RA _________Return Air
T ___________Temperature Controller

Steam Humidifiers in Central Systems, continued...

System 2

This is a typical 100% outside air system with preheat and reheat coils. The preheat coil heats outside air to a duct temperature controlled at 50° to 60°F. The reheat coil adds more sensible heat depending on the space heat requirement. Here the desirable location for the primary humidifier is downstream from the reheat coil to introduce moisture into the highest level of dry-bulb air temperature.

Note the humidity controller location in the exhaust air duct. When a good pilot location for a humidity controller is not available in the space humidified, one placed in the exhaust air duct as close to the outlet grille as possible serves the purpose very well.

Again, the high-limit controller is optional but generally recommended.

Glossary of Symbols

EA	Exhaust Air
E-P relay	Electric-Pneumatic relay
H	Humidity controller
M	Damper motor
MA	Mixed air
NC	Normally closed
NO	Normally open
OSA	Outside Air
RA	Return Air
T	Temperature Controller

System 3

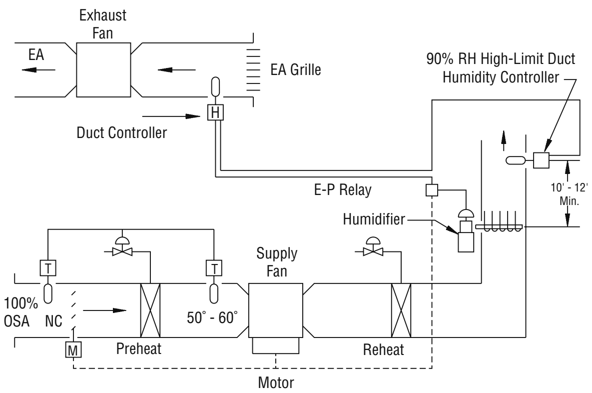
This system is similar to the previous one. It also shows 100% outside air and preheat and reheat coils. But here two humidifiers are used and are controlled in sequence from a single space or exhaust air duct humidity controller. The two humidifiers are indicated as V-1 and V-2.

V-1 will deliver one-third of the total capacity with a 4 to 7 psig spring range. V-2 is sized for two-thirds of the capacity, with a spring range of 8 to 13 psig. This sequencing control arrangement allows closer moisture input control, particularly when operating conditions vary considerably from design, thus preventing the possibility of overrun and duct saturation. With milder outdoor air conditions, V-1 can satisfy space conditions by introducing only a portion of the total design capacity.

As the outdoor air becomes colder and drier, humidifier V-1 will not satisfy demand so the V-2 unit starts to open in response to the additional demand. This gives much closer control in all kinds of outside air conditions, as well as preventing a super-saturated condition in the duct at minimum design. Again the high-limit controller is optional but desirable.

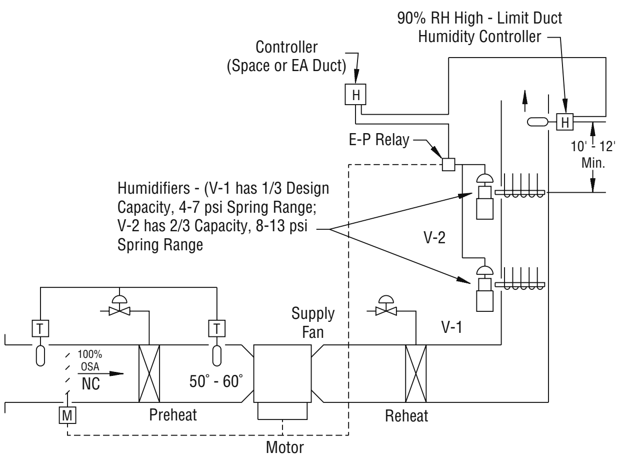
System 2

Figure 32-1.
100% OSA heat-vent system with primary humidification.



System 3

Figure 32-2.
100% OSA heat-vent system with sequence control on primary humidification.



System 4

Here is another 100% outside air system. In this case, the air leaving the preheat coil is held at a constant dry-bulb temperature in the 55° to 60°F range. This system indicates the use of two humidifiers—one as a primary humidifier and the second as a booster or secondary humidifier.

This system allows a primary humidifier to be controlled directly from a duct humidity controller at a level high enough to maintain a space condition of about 35% RH at a space temperature of 75°F. The booster unit, located downstream from a reheat coil and fan, can then be sized and controlled to produce the necessary moisture to raise the space RH from 35% to some higher condition, say 55%, where and when desired. This allows individual humidity control for each zone at a higher level than otherwise possible.

This is an important combination because the use of the primary unit allows the capacity of the booster unit to be small enough so that super saturation and visible moisture may not occur, even when the units are located as close as three feet from the discharge grille. For more information, consult your local Armstrong representative or download Armstrong's Humid-A-ware™ Humidification Sizing and Selection software at www.armstrong-intl.com.

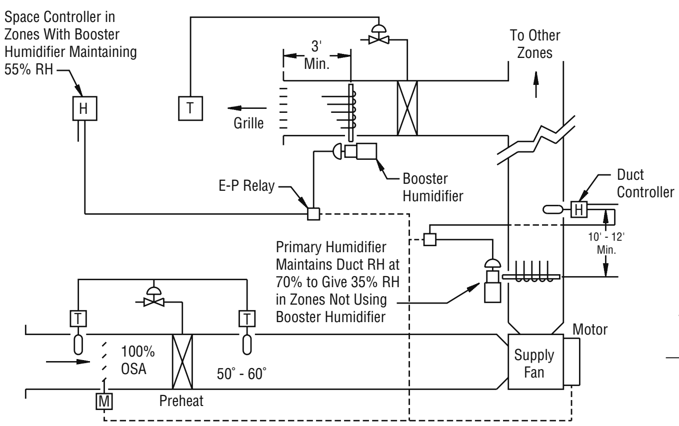
In this typical air handling system, it would not be psychrometrically possible to introduce enough humidity into the air temperature downstream from the preheat coil to give the maximum required condition in excess of 35% RH in the space. See Example 2, Page 15. The use of both primary and booster humidifiers is the only method for controlling the relative humidity in space at any level above approximately 35%.

System 5

Here is a single zone packaged heating and ventilating unit with internal face and by-pass dampers. The humidifier should be positioned downstream from the mixing dampers so that moisture is introduced into the final leaving air temperatures of the heating ventilating unit. This location permits a high level of space relative humidity to be maintained without duct saturation. This humidifier location is preferred compared to just ahead of the coils because of higher air temperature and better mixing conditions. Again a high-limit controller is recommended to prevent possible duct saturation, installed 10 to 12 feet downstream from the humidifier.

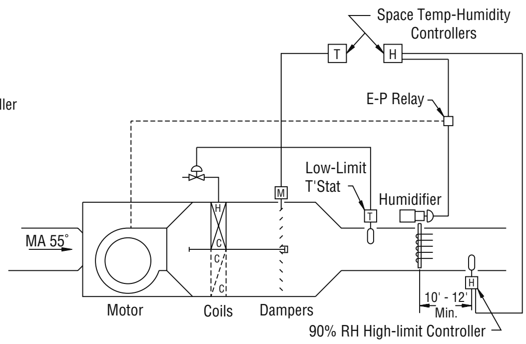
System 4

Figure 33-1.
100% OSA heat-vent system with primary and booster humidification.



System 5

Figure 33-2.
Single zone heat-vent unit with internal face and by-pass dampers—primary humidification.



Steam Humidifiers in Central Systems, continued...

System 6

This is a multi-zone heating/ventilating unit with face and by-pass dampers on each zone. The example shows a method and location for primary humidification, but it should be restricted to design conditions of "comfort humidification" of, say, 35%. These systems are normally package units and it is standard practice to incorporate the humidifier ahead of the coils as shown. This location of the humidifier will provide equal moisture distribution in hot or cold decks before heat zone takeoff, but it does limit the amount of moisture that can be added to the 55° air. Design conditions above 35% RH risk impingement of visible vapor on the coils. See Example 2, Page 15.

With these units, it is sometimes possible to use two humidifiers at this location with baffles between zone takeoff and sized for different conditions of relative humidity in their respective sections. Booster humidifiers can be used in individual zones for a higher relative humidity where required.

Glossary of Symbols

EA	Exhaust Air
E-P relay	Electric-Pneumatic relay
H	Humidity controller
M	Damper motor
MA	Mixed air
NC	Normally closed
NO	Normally open
OSA	Outside Air
RA	Return Air
T	Temperature Controller

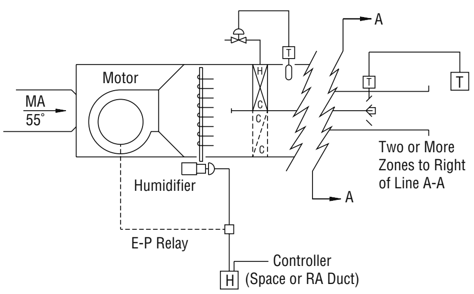
System 7

Here is a high-velocity dual duct system with primary and booster humidification shown. Like System 6, the primary humidifier is capable of providing "comfort humidification" only—30% to 35% RH. Because of space limitations, the primary humidifier, sized to maintain a duct condition of, say, 90% RH in the mixed air temperature, can be located as shown ahead of the fan. The humidifier should be located as far as possible upstream—no closer than three feet from the face of the supply fan—to ensure good air mixing and to allow the duct controller ample time to sense the condition short of saturation. The use of multiple manifolds will help provide good air mixing.

Note that the primary humidifier in this case should not be controlled from a space controller or an exhaust air duct controller, but rather from the supply duct controller as indicated. Since each zone has its own temperature-controlled mixing box, a location of the primary humidifier controller in the space or exhaust duct could not provide accurate control. Further, the distance between the humidifier and the controller could cause delayed response or override.

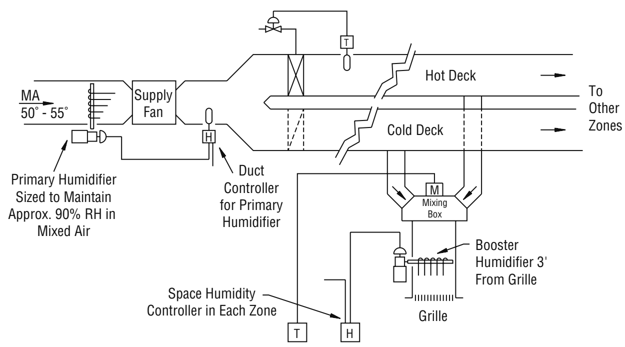
System 6

Figure 34-1.
Multi-zone heat-vent unit with internal face and by-pass dampers for each zone—primary humidification.



System 7

Figure 34-2.
High-velocity dual duct system with primary and booster humidification.



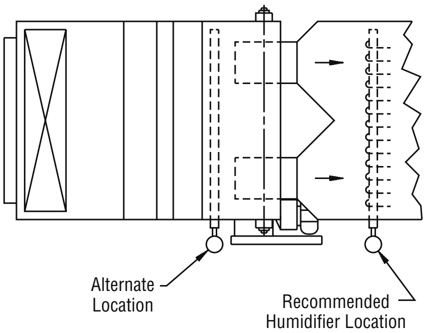
Packaged Air Conditioner Installations

Humidifiers frequently must be installed in packaged central station air conditioners. This can present some unusual location requirements due to the close quarters within the packaged units.

In the horizontal discharge draw-thru type packaged unit shown in Figure 35-1, the recommended location of the humidifier is at the fan discharge. In some instances this may not be possible. Note that with the alternate location, the humidifier manifold is installed to discharge upward into the area of greatest air turbulence. This permits the air to achieve optimum mixing before reaching the fan blades. A high-limit controller, set at 80%, should be located as shown when the humidifier is installed at the alternate location.

Recommended humidifier locations for a vertical discharge draw-thru type air conditioner (Figure 35-2) are identical to the horizontal unit. If the alternate location must be used, a high-limit controller set at 80% is desirable. The humidifier manifold should discharge upward, as with the horizontal discharge unit.

Figure 35-1.
Horizontal Discharge
With humidifier installed at recommended location, high-limit duct controller should be set at 90% RH maximum—alternate location at 80% RH maximum.



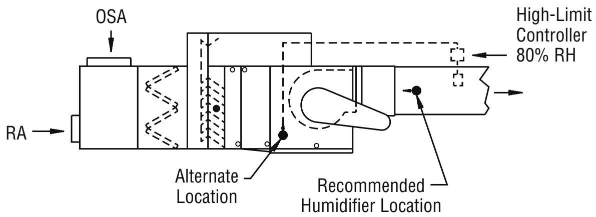
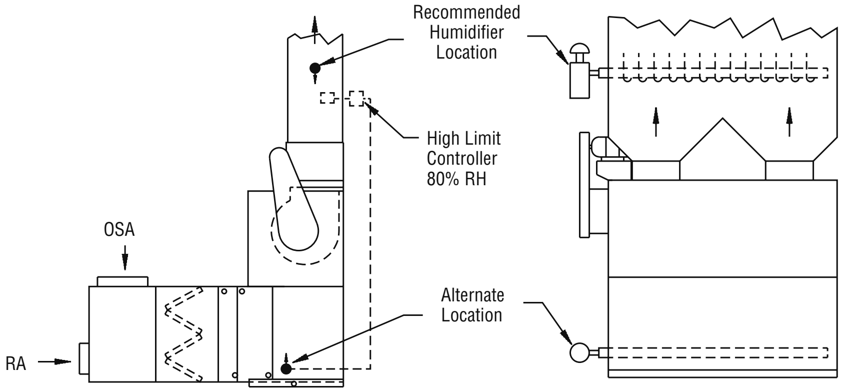


Figure 35-2.
Vertical Discharge



Steam Humidifiers in Central Systems, continued...

In a low pressure blow-thru type, multi-zone, packaged air conditioner (Figure 36-1), the recommendations are much the same. However, to avoid overloading the cold deck and to avoid impingement of discharge, the manifold is installed to discharge upward instead of directly into the fan discharge.

As with the draw-thru units, a high-limit controller set at 90% should be installed. In a high pressure blow-thru type packaged unit (Figure 36-2), again the recommended location is as close to the fan as possible, with the manifold discharging directly into the fan discharge. A high-limit controller set at 90% is desirable.

In either high or low pressure systems, where the humidifier is installed at the alternate location, set the high-limit humidity controller at 80% RH.

Figure 36-1.
Low pressure system

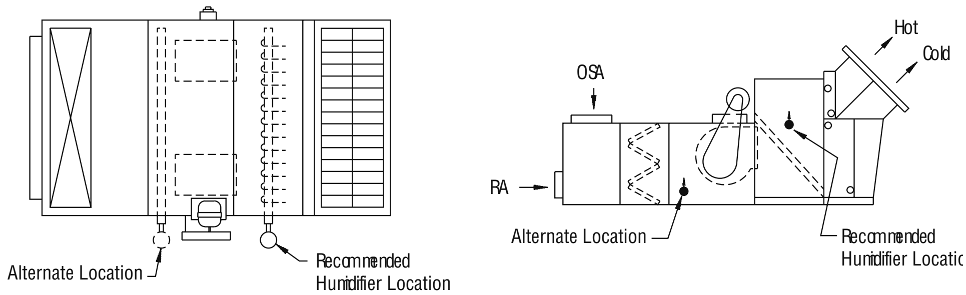
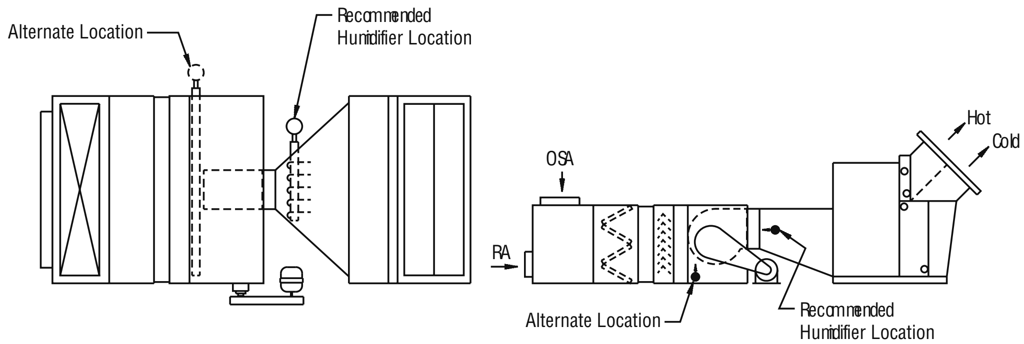
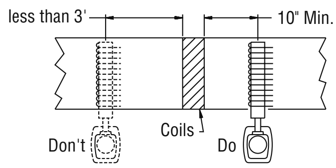


Figure 36-2.
High pressure system

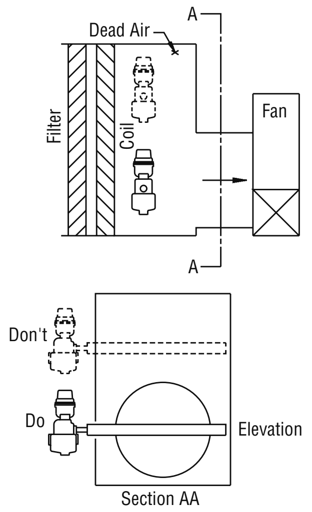


Installation Do's and Don'ts

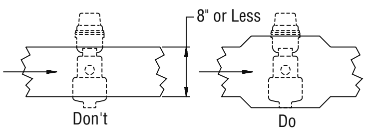
In discussing the systems, we mentioned a few location "do's and don'ts." Let's review these precautions that may help to keep you out of trouble. For example, whenever possible, install the distribution manifold downstream from coils. If you have more than three feet of distance available between the manifold and the coil on the upstream side, the manifold can be installed at this location (greater than three feet for higher velocity systems).



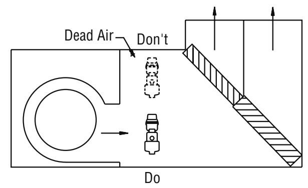
When it is necessary to place the humidifier in the coil section ahead of the fan, locate the manifold in the most active airflow and as far upstream from the fan inlet as possible.



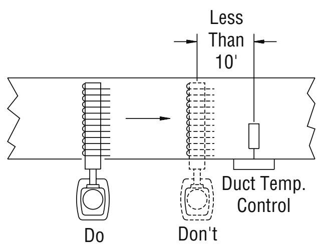
Don't risk restriction of the airflow in ducts 8" or less in depth. Use an expanded section as shown.



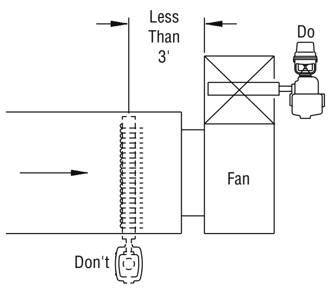
When it is necessary to place the humidifier discharge into a packaged multi-zone air handling system, install the distribution manifold into the center of the active air flow and as close to the fan discharge as possible.



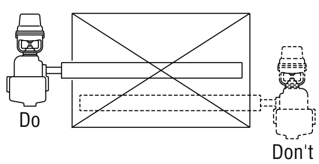
Do not install a distribution manifold closer than 10 feet upstream from a temperature controller or you may get false signals.



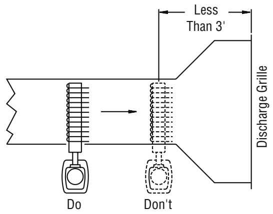
The distribution manifold should never be placed within three feet of an air fan intake. The best location is at the fan discharge.



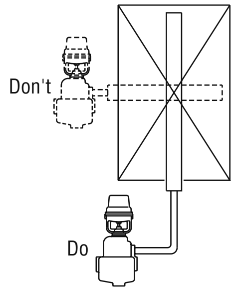
Whenever possible, install the distribution manifold into the center of the duct.



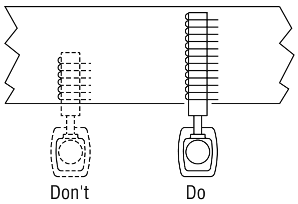
Always install distribution manifolds as far upstream from discharge air grilles as possible—never less than three feet upstream.



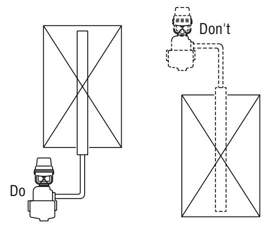
Always size and install the distribution manifold to span the widest dimension of the duct section.



Always select the stream distribution manifold length that will span the maximum width of the duct.



The manifold should never be installed vertically downward from the humidifier. This presents a condensate drainage problem in the jacket of the manifold. Vertical upward installation is permissible.



NOTE: All dimensions shown in the above figures are based on duct temperature of 65°F or higher and duct velocities of 800 ft/min, or lower. If duct air is cooler or velocities are higher, these dimensions should be greater or multiple manifolds considered.

Application of Unit Humidifiers for Direct Discharge

A survey of your requirements should be taken to determine the amount of steam needed for humidification, the number, size and type of units required, and the location of both humidifier and humidity controllers.

Sizing and Location with Natural Ventilation

These are the average industrial humidification applications with:

Room temperatures—65° to 80°F.
Relative humidities—35% to 80%.
Natural ventilation—i.e., infiltration around windows and doors.

Selection Data Required

Minimum Outdoor Temperature: For most jobs, figure 10°F above the lowest recorded temperature for your locality. The lowest temperatures are seldom encountered for more than a few hours.

- Indoor Temperature
- RH Desired
- Pressure of Steam Available for Humidification
- Number of Cubic Feet in Room
- Air Changes Per Hour: air changes taking place under average conditions exclusive of air provided for ventilation or regain of hygroscopic materials.

Rooms, 1 side exposed ______________1
Rooms, 2 sides exposed __________1-1/2
Rooms, 3 or 4 sides exposed _________2
Rooms with no windows or
outside doors _____________1/2 – 3/4

Typical Problem:
Design outdoor temperature ________0°F
Indoor temperature_______________70°F
RH required ____________________40%
Air changes per hour ________________2
Steam pressure available__________5 psi

Room size 400' x 160' with 10' ceiling
Natural ventilation
Heated by: Unit heaters-fan on-off control

Step I: Steam required for humidification. Our room contains (400' x 160' x 25') or 1,600,000 cu ft.

From the 70°F Table 38-1, read across from 0°F outside temperature to the 40% RH column where you find the figure .409 lbs of steam/hour per 1,000 cu ft of space for each air change. Then, 1,600 times .409 times 2 equals 1,309 lbs of steam/hour installed humidification capacity required.

Step II: Electric or air-controlled units. The large floor area calls for multiple humidifiers. No explosion hazard has been specified so use of air-controlled units is not required. Electric units are recommended.

Step III: Number of humidifiers for job. Divide steam required by capacity of humidifiers at steam pressure available.

Step IV: What size humidifier to use. For this example, a large number of smaller capacity units is recommended. Larger capacity units could cause condensation on the low ceiling. Also, because of the large floor area, the humidistats for fewer units would be widely spaced which could result in less accurate control than desirable.

Step V: What type humidifier to use. In this example, integral fan units are preferable to steam jet units installed in conjunction with unit heaters. Since the unit heater fans are on or off to control temperature, it follows that the humidistat may call for steam when the nearest unit heater is not running. With the low ceiling, the discharge from a steam jet humidifier might rise to the ceiling and produce condensation. Therefore, the integral fan type should be used.

Step VI: Location of humidifiers. Several patterns are possible, and actual location can usually conform with the existing steam supply and return lines to make an economical installation with a minimum of new piping.

Pounds of steam per hour, per air change for each 1,000 cu ft of space to secure desired indoor relative humidity at 70°F with various outdoor temperature (outside air 75% saturated).

Table 38-1. 70°F Humidification

Outdoor Temp.	70°F - Relative Humidity Desired Indoors - 70°F										
	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%
*30	.079	.136	.194	.251	.309	.367	.424	.482	.539	.597	.654
20	.154	.212	.269	.327	.385	.441	.499	.557	.615	.672	.730
10	.204	.262	.319	.377	.434	.492	.549	.607	.665	.722	.780
0	.237	.294	.352	.409	.467	.524	.582	.639	.697	.754	.812
-10	.257	.314	.372	.430	.487	.545	.602	.660	.717	.775	.832
-20	.270	.327	.385	.442	.500	.557	.615	.672	.730	.787	.844

In our problem of a 400' x 160' x 25' room, there would likely be steam lines along both sides of the room, and humidifiers can be located as shown in black in Figure 39-1. If the supply lines run down the center of the room the line pattern would be practical. Runouts to integral fan units in a 160' wide room would be about 20' long. If the room were only 60 or 80 feet wide, runouts need be no longer than required for actual hookup.

Step VII: Location of humidistat. This should be from 20 to 30 feet away from the humidifier and slightly to one side of the air stream from the unit. The humidistat should "see" its humidifier and be in "active" air. Do not hide it behind a post or in the channel of an H-beam. It must get a good sample of the air to control the humidity.

Sizing and Location with Forced Ventilation

Typical Jobs: Mill and sanding rooms in furniture factories. Here, the problem of selecting and installing humidifiers is much the same as previously described except for:

1. Determining the number of air changes.
2. Location of humidifiers and humidistats.

Air Changes: These can be determined from the exhaust fans' capacities. The cubic feet per hour capacity of the fans, divided by the cubic feet of space to be humidified, will give the number of air changes.

Where the capacity of fan or fans is not known, air changes can be measured with velometer readings at all open doors, elevator shafts, etc. leading to the room and with fans operating at full capacity. Your Armstrong Representative can determine air changes for you.

Humidifier Location: Bear in mind that humidifiers will have to control the humidity 24 hours a day, seven days a week during the heating season. Exhaust fans may operate only 40 hours or 80 hours per week. Thus the humidifiers and humidistats must be located for good distribution of humidity during fan-off periods as well as when the fans are operating.

Figure 39-1. Where practical, locate humidifiers to minimize piping. Locations shown in black where steam supply lines are along outer walls; in white where supply is in center of room.

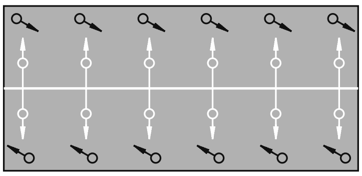
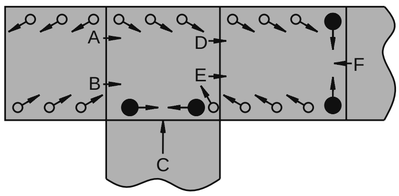


Figure 39-2. Outlines a typical requirement. Schematic layout of humidifiers in wood-working plant where exhaust fans are used. Arrows indicate air flow induced by fans. Humidifiers are sized for load conditions imposed by fan. Humidifiers are located to give uniform distribution of humidity when fans are off or when fans are running.



Pounds of steam required per hour per air change for each 1,000 cu ft of space to secure desired indoor relative humidity at 75°F with various outdoor temperatures (outside air 75% saturated).

Table 39-1. 75°F Humidification

Outdoor Temp.	75°F - Relative Humidity Desired Indoors - 75°F										
	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%
*30	.129	.196	.264	.331	.399	.466	.533	.601	.668	.736	.803
20	.204	.271	.339	.406	.474	.541	.609	.676	.744	.811	.879
10	.254	.321	.389	.456	.524	.591	.659	.726	.794	.861	.929
0	.286	.354	.421	.489	.556	.624	.691	.759	.826	.894	.961
-10	.307	.374	.442	.509	.577	.644	.711	.779	.846	.914	.981
-20	.319	.387	.454	.522	.589	.657	.724	.792	.859	.927	.994

*Note: When outdoor design temperatures exceed 30°F, use Table 7-1, Page 7.

Application of Unit Humidifiers for Direct Discharge, cont.

Sizing for High or Low Temperature Humidification

Where air temperatures are well above 75°F or below 70°F, it is impractical to use Tables 38-1, Page 38, or 39-1, Page 39. Humidification requirements must be figured from Table 7-1, Page 7, showing grains of water per cu ft of saturated air at various temperatures. Typical problem: How much steam per hour is required to humidify 60,000 cu ft of space with four air changes per hour to 40% RH when the air temperature is 90°F? Assume that any makeup air will come from outdoors at 0°F, 75% saturated.

90°F saturated air = 14.9 gr/cu ft saturated = 5.976 gr/cu ft at 40% RH

Outdoor air 0°F saturated = .475 gr/cu ft

75% saturated = .356 gr/cu ft

5.976 minus .356 = 5.620 grains to be added per cu ft

$$\frac{5.620 \times 1{,}000}{7{,}000} = .803 \text{ lb per M cu ft per air change}$$

NOTE: 7,000 gr = 1 lb

With four air changes in a 60,000 cu ft room, then .803 x 60 x 4, or 193 lbs steam would be required per hour. Humidifier capacity required for temperatures below 70°F is determined in exactly the same manner.

NOTE: For high temperature air in particular, air volume changes dramatically with RH. Armstrong Humid-A-ware™ Humidification Sizing and Selection Software will provide greater accuracy in humidifier sizing for these applications.

Explosion Hazard Humidification

Sizing air-operated humidifiers for areas where explosion hazard exists is done exactly as for other requirements except that they should be sized for the most severe conditions of makeup air, RH required and minimum steam pressure.

Humidifiers should be located to get the best possible dispersal and distribution of vapor in the area.

Special Purpose Industrial Applications

In some industrial operations, a stratum of high relative humidity is required in close proximity to a fast moving sheet or film of paper, thin gauge plastic, fabric, cellophane, etc. The objective may be to prevent accumulation of static electricity charges, or to prevent loss of moisture from the material. If the sheet or film is hot, as it very well might be, it tends to give up its moisture very quickly. By using steam shower humidifiers expressly adapted for this application to create a laminar zone of high humidity adjacent to the sheet, moisture loss is prevented and moisture content of the material is properly maintained.

For this application, the humidifier must be interlocked with the drive of the machine, and it is essential that the steam be discharged in a dry state, with no water droplets or liquid spray.

Considerations in Selection of Cool Fog Systems

Unlike other Armstrong humidification products, selection and sizing of Cool Fog system components is performed almost exclusively “in house.” The selection process requires detailed information for each application that must be supplied by the customer.

Water Quality and Materials of Construction:

Cool Fog Systems (CF) may be used with potable tap water if the levels of calcium and other dissolves solids are not excessive. If water testing indicates that purification is required, a reverse osmosis water treatment system should be considered. The “CF” designation indicates that the fogger manifold bars are made of copper tubing with 316 SS foggers, and the water valves are made of brass.

When de-ionized water is required for laboratory or clean room humidification, Pure Fog Systems (PF) should be used. The “PF” designation indicates that the fogger manifolds, bars, foggers, and water valves are made of stainless steel.

Figure 41-1. Air Handling Unit Side View

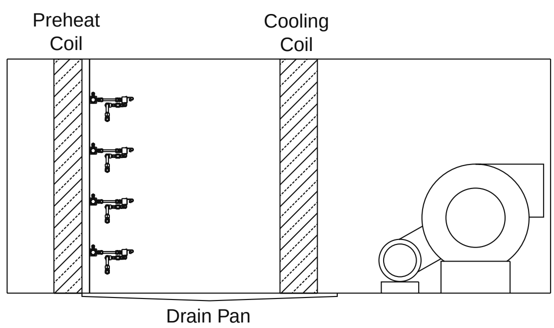
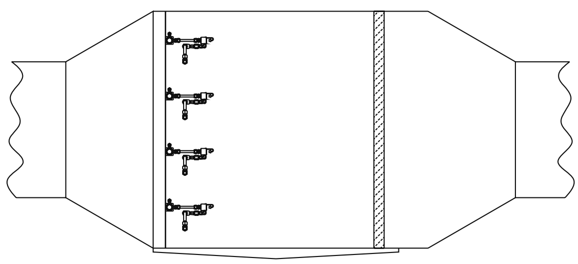


Figure 41-2. Fog Chamber Side View



Fogger Location:

Foggers may be applied in air handlers or ducts where the air velocity is less than 750 FPM. For duct applications, if the air velocity is in excess of the recommended maximum, a fogging chamber with fog eliminator and drain pan should be considered.

When a fogging system cannot be practically applied to the existing mechanical system, a Direct Area Discharge Fogging System (DDF) might be the logical alternative. The “DDF” designation indicates that foggers are individually located within an enclosed area such as a warehouse or factory floor, and fog is directly discharge into the open space.

Control Types:

The Standard Proportional Control System (STD) simultaneously modulates both air and water output pressures to modulate humidification output while maintaining a fixed air/water differential. This type of system is most appropriate for small to medium air handler systems where compressed air consumption is not a critical consideration.

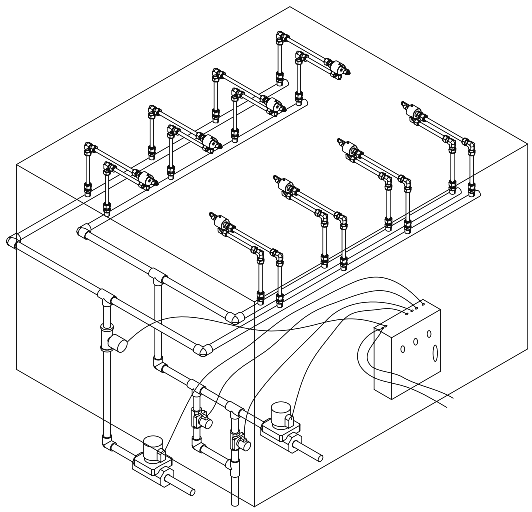
For larger air handler systems where compressed air consumption can be a significant expense, the Variable Differential Control System (VDC) should be considered. Because the “VDC” system proportionally reduces the air/water output differential along the upper half of the control range, the compressed air consumption is reduced by as much as 50% reducing the required air compressor size and operating cost.

For air handlers with stable loads and fixed outside air percentages, the HumidiComp (HC) “On/Off” Control System is an economical alternative to the STD or VDC systems.

Direct Area Discharge Fogging systems (DDF) are controlled by “ON/OFF” control panels, which do not modulate the fog output as in the Standard Proportional or Variable Differential Control panels.

All control panels require a control input (on/off, 4-20 mA, or 0-10 vdc) that is typically supplied by the Building Automation System.

Figure 41-3. Direct Area Discharge Fogging System (Side View)



Basic Application Principles

A properly applied fogging system will meet the following requirements:
1. Air entering the fogging chamber must be warm enough and slow enough.
2. Adequate evaporation distance must be available.
3. The compressed air plant must supply adequate PSIG and SCFM of clean air.
4. The water system must supply adequate PSIG and GPM of clean water.
5. Un-evaporated water and dissolved solids need to be removed from the air stream.

Air Temperature and Preheat:

As illustrated in Figure 18-1, Page 18, when atomized water is evaporated into an air stream, there is a dry bulb cooling effect. The magnitude of the dry bulb cooling depends on the evaporation rate of the water. This is determined by the actual output of the fogger heads and the evaporation efficiency.

In order to discharge the supply air at the desired dry bulb temperature and relative humidity, the air entering the fogging chamber (i.e. mixed air) must be mixed or preheated to the wet bulb temperature of the desired supply air. This requires that the mixed air damper and/or preheat coil be proportionally controlled.

Although each application is different, minimum incoming air temperature requirements for air handlers with economizer are 60-65°F. For make-up air units, it is not unusual for air to be pre-heated to 100°F or more.

Air Velocity:

The air velocity in the fogging chamber of an air handler must be slow enough to allow adequate time for the atomized water to evaporate before leaving the fogging chamber and impinging on any downstream surfaces (500 FPM or less is optimal). See Figure 41-1, Page41.

Airflow in ducts is typically too fast. Therefore, duct applications usually require a “Fogging Chamber” that is of adequate height and width to reduce the FPM to an acceptable level, and of adequate length to allow the fog to evaporate. See Figure 41-2, Page 41.

Evaporation Area:

Because there is usually little air movement near the fogger heads in Direct Area Discharge Fogging (DDF) applications, 200 cubic feet of free space and a 10 foot vertical drop to the nearest surface are minimum requirements. See Figure 42-2.

Evaporation Efficiency AND Fog Elimination:

Some applications do not allow enough fog chamber length to assure 100% evaporation of the fog.

Figure 42-1. Standard Proportional Control/ Variable Differential Control

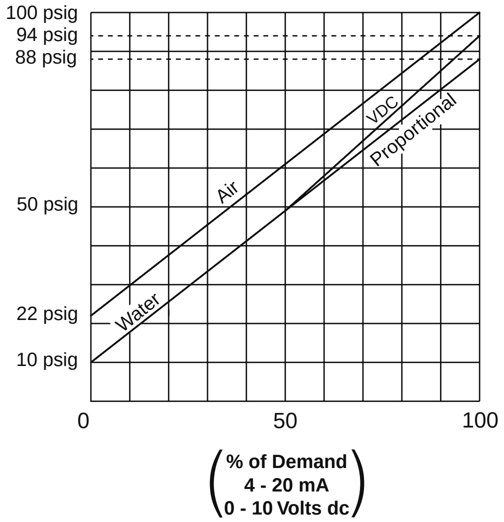
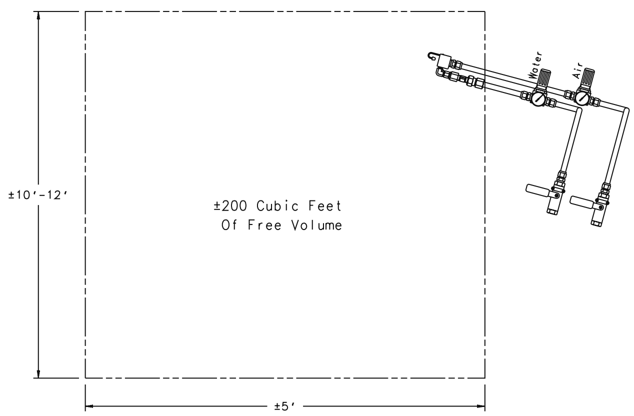


Figure 42-2. Direct Area Discharge Area View



For air handler or duct installations where no un-evaporated fog can be allowed downstream of the fogging chamber, a cooling coil with drain pan or a "fog eliminator" with drain pan will be required. See Figure 41-2, Page 41.

No practical means of catching unevaporated fog exists for direct area discharge applications. Therefore,direct area discharge (DDF) systems should not be used in clean room environments where unevaporated fog could cause potential damage to sensitive processes or products.

Water Supply:

Adequate water pressure and capacity (GPM) must be consistently available to supply the waterside of the fogger manifold bars.

Only in rare cases is tap water determined to be of adequate purity for fogging. In such cases an air filter needs to be installed downstream of the fogging chamber to catch dissolved solids that do not evaporate with the water.

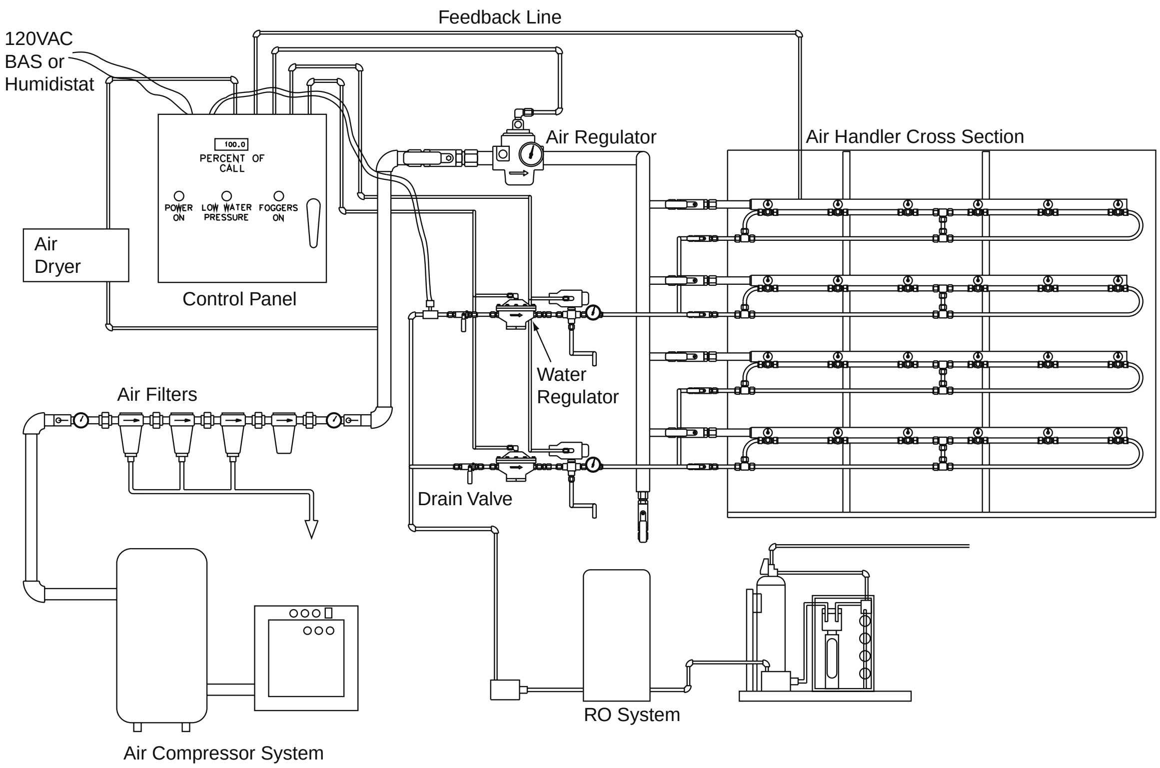
Compressed Air Supply:

Clean air must be available in sufficient capacity (SCFM) and pressure to supply the airside of the fogger manifold bars. An oil filled, rotary screw compressor with pre-filter and 4-stage final filter is a minimum requirement.

Instrument Air:

Standard proportional and variable differential control panels require an "instrument air quality" pneumatic supply. ON/OFF Panels require no pneumatic supply.

Figure 43-1. Standard Proportional Control (STD) or Variable Differential Control (VDC)



Cool Fog Sizing

Sizing humidification loads for fogger systems differ from steam humidification systems in several ways.

Fogging humidification systems require outside air to be pre-heated, or mixed, to the WB temperature of the supply air.

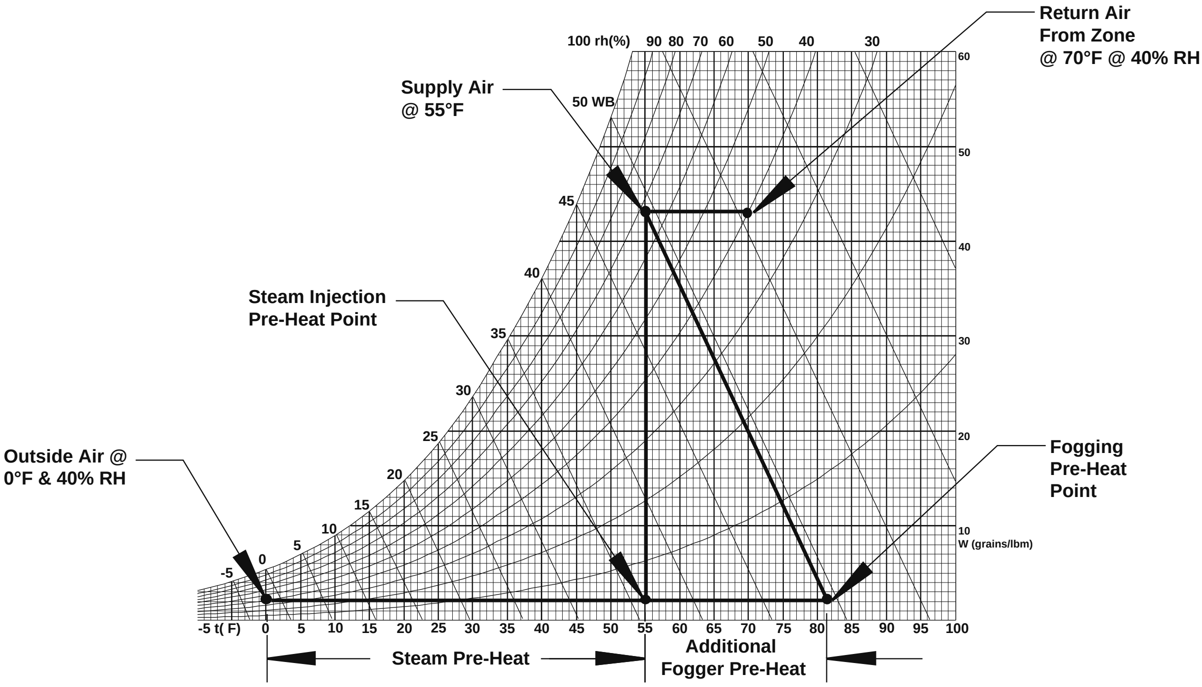
Steam humidification systems require outside air to be preheat-ed, or mixed, to the DB temperature of the supply air.

Due to the dry bulb cooling effect of fogging systems, air must be mixed or preheated to a higher dry bulb temperature than with steam systems. While this does not effect the actual load, it is an important part of the psychrometric evaluation and it does impact the sizing of the pre-heat coil.

Example 1: 100% outside air, assume:
10,000 CFM outside air at 0°F and 40% RH needs to discharge from an air handler at 55°F and 49% RH in order to maintain a 70°F @ 40% RH in the zone.

As in the steam sizing example on Page 28, The load is 246 lbs./hr for both steam and fogger humidification systems. However the air for the steam humidification system only needs to be heated to 55°F before steam is injected into the air stream. For the fogging system, the air needs to be preheated to 82°F in order to discharge at the desired conditions.

Figure 44-1. Example 1: 100% Outside Air



Note: Psychrometric chart representations do not include fan heat gains, duct losses, infiltration losses or cooling coil dehumidification.

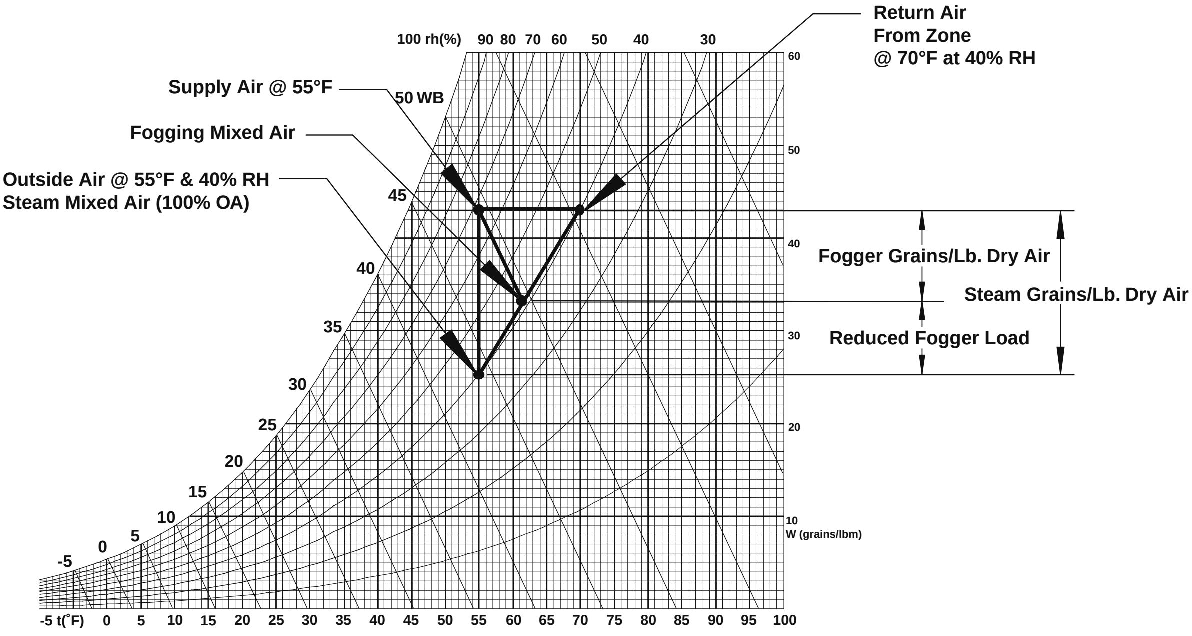
Economizer Cycles:

Because fogging systems require outside air to be mixed, or preheated, to the WB temperature of the supply air, less outside air is required to achieve the supply air temperature. This results in a significant reduction in the humidification load.

Example 2: economizer, assume:
40,000 CFM of air in an economizer system with 10% minimum outside air needs to discharge at 55°F to maintain 70°F in the space. The desired space design is 40% RH and the outdoor air design is 40% RH. As in the economizer example on Page 30, the calculated steam load is 456 lbs./hr.

Due to the cooling effect of the fogging system, the required mixed air temperature needs to be 61°F to achieve a discharge temperature of 55°F. Due to the reduction in outside air, the grains added per pound of dry air is reduced from 17.8 for steam to 10 resulting in a load of 258 lbs./hr maximum load for the fogging system.

Figure 45-1. Example 2: Economizer



Note: Psychrometric chart representations do not include fan heat gains, duct losses, infiltration losses or cooling coil dehumidification.

Cool Fog Sizing, continued...

Minimum Outside Air and Preheat

When the minimum outside air requirement drives the maximum mixed air temperature below the dry bulb temperature required to achieve a discharge air temperature of 55°F, preheat will be required. This typically happens when outside air requirements are above 20% or the outside air design is below –10°F.

Example 3: preheat, assume:
40,000 CFM of air in an economizer system with 25% minimum outside air needs to discharge at 55°F to maintain 70°F in the space. The desired space design is 40% RH and the outdoor design is –20 F at 40% RH.

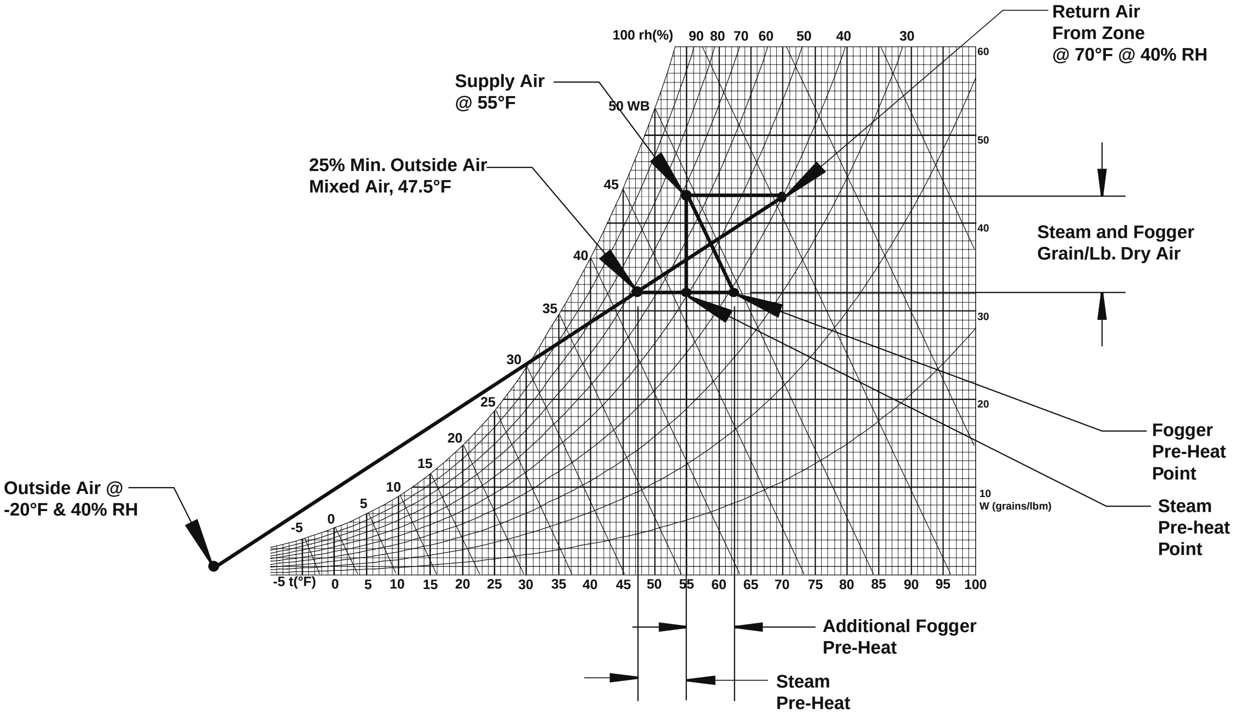
The pschycrometric chart indicates that the maximum mixed air temperature that can be attained when the outside air temperature is –20°F is 47.5°F. In this case, the maximum humidification load for both the steam and the fogger system is the same (i.e. 280 lbs/hr). The steam system needs to be preheated to 55°F, whereas the fogger system needs to be preheated to 62.5°F in order to achieve a discharge air temperature of 55°F.

Example 4: Direct Area Discharge, assume:
Room size 400’ x 160’ with a 25’ ceiling
Natural ventilation
Heated by unit heaters

The steam load is calculated exactly the same way as in the steam example on Page 38 (1,309 lbs./hr).

The maximum recommended output per fogger head is 25 lbs./hr, so this application would require 53 fogger heads. Foggers should be evenly distributed and located where adequate evaporation area and vertical drop to the nearest surface are within the recommended minimums. See Figure 42-2. Page 42.

Figure 46-1. Example 3: Preheat



Note: Psychrometric chart representations do not include fan heat gains, duct losses, infiltration losses or cooling coil dehumidification.

Ionic Bed Technology™

Armstrong offers (3) Three Unique Steam Humidification Solutions when Boiler Steam is not available or Chemical Free Steam is desired.

HumidiClean encompasses (3) three forms of steam generating humidifiers: electric, gas, and steam-to-steam.

HumidiClean Humidification from Armstrong begins with the Ionic Bed, a fibrous medium located in the HumidiClean steam generation tank. Simple in appearance, the Ionic Bed offers a practical solution to the traditional goal of minimizing mineral build-up in tanks of self-contained, steam generating humidifiers.

Contractors, engineers, and owners no longer need to focus on adjusting water quality to an acceptable range of conductivity or hardness in order to secure satisfactory humidifier performance.

HumidiClean (electric, gas, or steam-to-steam) humidifiers utilizing Ionic Bed Technology are naturally adaptable to a broad range of water quality. Have hard water? Have softened water? Have reverse osmosis (RO) or deionized (DI) water? It doesn't matter, the versatile HumidiClean line of humidifiers operates perfectly with any type of water.

For additional information on ionic bed technology and the models in which they are supported please refer to pages 113 and 125.

How Armstrong Reduces Humidifier Maintenance Using Ionic Bed Technology

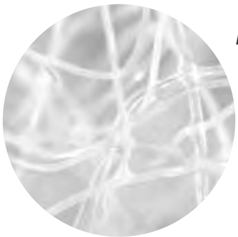
Ionic Beds Stop Solids

Ionic beds consist of a fibrous medium that attracts solids from the water as its temperature rises, minimizing the buildup of solids on the heat exchanger and inner tank walls. Once the ionic beds have absorbed their capacity of solids, an indicator on the humidifier's control panel signals it's time to replace the ionic beds. Changing the beds takes only about 15 minutes. Use of the ionic beds:

- Reduces cleaning of the tank exchanger or heating elements
- Keeps the drain screen cleaner longer – allowing effective tank blowdown
- Helps maintain humidifier output without building excessive heat exchanger surface temperatures
- Requires less frequent blowdown, conserving water and energy
- Eliminates the need for wasteful surface skimmers that must be checked weekly for possible plugging
- Reduces downtime
- Has years of field-proven success in thousands of humidifier applications

Better Here than in your Humidifiers

These photos show how the ionic bed fibers (magnified 52.5x) collect solids throughout their service life. A new ionic bed weighs between 1/3 and 1/2 pound, depending on the humidifier type. When it reaches its capacity, an ionic bed may weigh more than 2-1/2 pounds.



New ionic bed

After 400 hours

After 800 hours

Sanitary - Clean Steam Applications

TC Series Clean Steam Thermostatic Traps

For Clean Steam Systems

For Pressures to 120 psig (8 bar)…Capacities to 3,775 lb/hr (1,712 kg/hr)

Armstrong offers a complete range of T-316L stainless steel clean steam thermostatic traps to handle the special requirements of clean steam systems. Different body configurations allow for choice of piping and ease of cleaning.

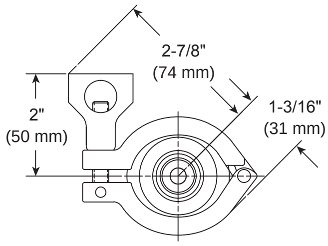
The thermostatic design is free-draining and can operate close to steam temperature at any given pressure.

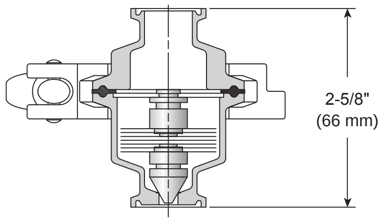
Features

- Constructed of 316L stainless steel for corrosion resistance
- Highly polished for cleanability
- Self-draining to minimize contamination
- Compact and lightweight
- Easy to install
- Provide easy disassembly for cleaning

Typical Applications

- Fermentors
- Sterilizers/autoclaves
- Process piping
- Block and bleed
- Bioreactors
- CIP/SIP systems
- Equipment sterilization
- Sterile barriers





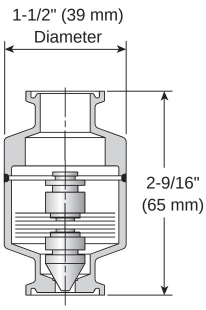
How to Order:

Specify:
- Model number
- Pipe connection size
- End connection type

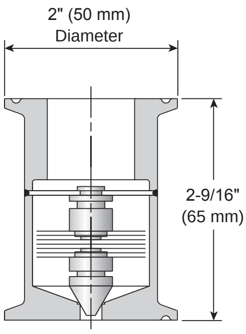
Example:
TC-C, 1/2" sanitary end connections.

For a fully detailed certified drawing, refer to:
TC-C CD #1161
TC-R CD #1162
TC-S CD #1163

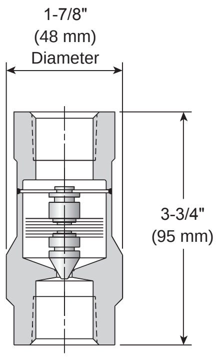
Model TC-C Clamp
With Sanitary Body Clamp
1/2" (15 mm), 3/4" (20 mm), 1" (25 mm)
Sanitary End Connections



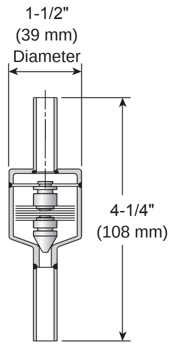
Model TC-S Sealed
1/2" (15 mm), 3/4" (20 mm)
Sanitary End Connections



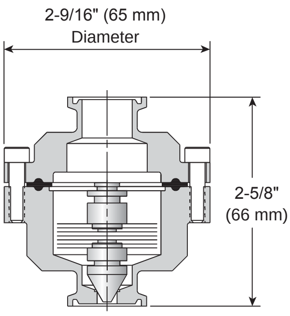
Model TC-S Sealed
1" (25 mm)
Sanitary End Connections



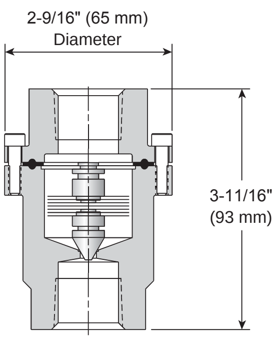
Model TC-S Sealed
1/2" (15 mm), 3/4" (20 mm)
Threaded End Connections



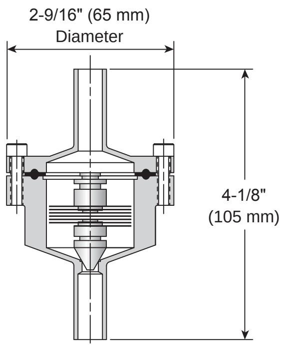
Model TC-S Sealed
1/2" (15 mm), 3/4" (20 mm)
Tube End Connections



Model TC-R Repairable
With Bolted Body and Cap
1/2" (15 mm), 3/4" (20 mm), 1" (25 mm)
Sanitary End Connections



Model TC-R Repairable
With Bolted Body and Cap
1/2" (15 mm), 3/4" (20 mm)
Threaded End Connections



Model TC-R Repairable
With Bolted Body and Cap
1/2" (15 mm), 3/4" (20 mm)
Tube End Connections

TC Series Clean Steam Thermostatic Traps

For Clean Steam Systems

For Pressures to 120 psig (8 bar)…Capacities to 3,775 lb/hr (1,712 kg/hr)

Materials

Model	TC-C Clamp	TC-R Repairable	TC-S Sealed
Cap and body	ASTM A479 316L		
Bellows	316L Stainless Steel		
Body gasket	Viton®		—
Retainer	Stainless Steel		
Clamp	Stainless Steel	—	—
Screws	—	Stainless Steel	—
Finish	180 grit electro polish to 20 µin Ra or below inside, and 150 grit electro polish to 30 µin Ra or below on outside		Mechanical finish to 63 µin Ra interior and 32 µin Ra exterior

NOTE: µin = microinches

Physical Data

Model	TC-C Clamp	TC-R Repairable	TC-S Sealed
Maximum Allowable Pressure (Vessel Design)	120 psig (8.3 bar)		150 psig (10 bar)
Maximum Allowable Temperature	350°F (177°C)		366°F (186°C)
Maximum Operating Pressure	100 psig (7 bar)		120 psig (8.3 bar)
Weight lb (kg)	1-1/4 (0.57)	1-1/2 (0.68)	3/4 (0.34)

TC Series Clean Steam Trap Capacities					
psig	bar	10°F (5.6°C) Subcool		20°F (11.2°C) Subcool	
		lb/hr	kg/hr	lb/hr	kg/hr
5	0.35	180	82	320	145
10	0.70	360	163	645	293
20	1.4	676	307	1,108	503
30	2.1	1,009	458	1,563	709
40	2.8	1,236	561	1,830	830
50	3.5	1,542	699	2,016	915
60	4.1	1,845	837	2,505	1,136
70	4.8	2,037	924	2,668	1,210
80	5.5	2,360	1,071	2,990	1,356
90	6.2	2,460	1,116	3,237	1,468
100	6.9	2,547	1,155	3,450	1,565
110	7.6	2,610	1,184	3,640	1,651
120	8.3	2,660	1,206	3,775	1,712

SANITARY PRESSURE REDUCING VALVE

P-130

DESCRIPTION

The ADCA P-130 series ***direct acting, spring-loaded diaphragm sensing ,*** pressure reducing valves, are designed for use on compressed air, water and other gases or liquids compatible with the materials of construction .

MAIN FEATURES

Compact design.
Completely machined from barstock material, no castings or forgings used on the standard version.
No rising stem

STANDARD SURFACE FINISH
Internal wetted parts: 0,5 microns Ra
External :
Body and cover– Fine machined
(mechanical or electro polished as option)

St.Steel hand wheel

OPTIONS: Self relieving
Leakage line connection 1/8” (captured vent).
Panel mounting version (thread M45)
Gauge connection on body
Different soft valves for liquids and gases.
Casted cover (CF8M) with rising stem handwheel for economic reasons.
Special execution for steam.

USE: Compressed air, water and other gases and liquids compatible with the construction.

AVAILABLE MODELS: P-130

SIZES: DN1/2” to DN 1” ; DN15 to DN25

OUTLET SPRING RANGES: 0,2 – 1,5 bar; 0,3 – 3 bar; 0,8 – 8 bar.

CONNECTIONS: Clamp ends or others on request

INSTALLATION: Horizontal installation.

ORDER REQUIREMENTS: Type of fluid
Maximum operating temperature
Inlet pressure and required outlet pressure
Capacity (maximum and minimum).

Aluminium hand wheel

CE MARKING (PED - European Directive 97/23/EC)	
PN 16	Category
DN1/2" to DN 1"	SEP - art. 3, paragraph3

LIMITING CONDITIONS	
Valve model	P-130
Body design conditions	PN 16
Max.upstream pressure	16 bar
Max.downstream pressure	8 bar
Min.downstream pressure	0,2 bar
Max.design temperature *	150 ºC

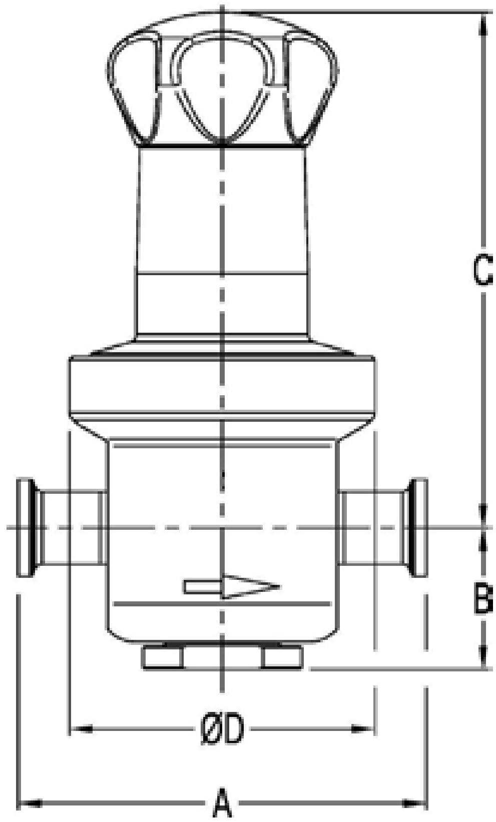
*Other on request.

SANITARY PRESSURE REDUCING VALVE

P-130

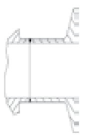
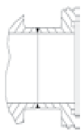
DIMENSIONS (mm)							
SIZE DN	A ASME BPE	A ISO 1127	B	C	D	WGT. Kgs BPE	WGT. Kgs ISO
1/2" - 15	130	115	37	135	80	2,7	3,2
3/4" - 20	130	115	37	135	80	2,9	3,2
1" - 25	130	115	37	135	80	3,3	3,3

Valves with aluminium hand wheel weights less 0,24 kgs
Different dimensions and standards on request.
Consult factory for certified dimensions and weights.



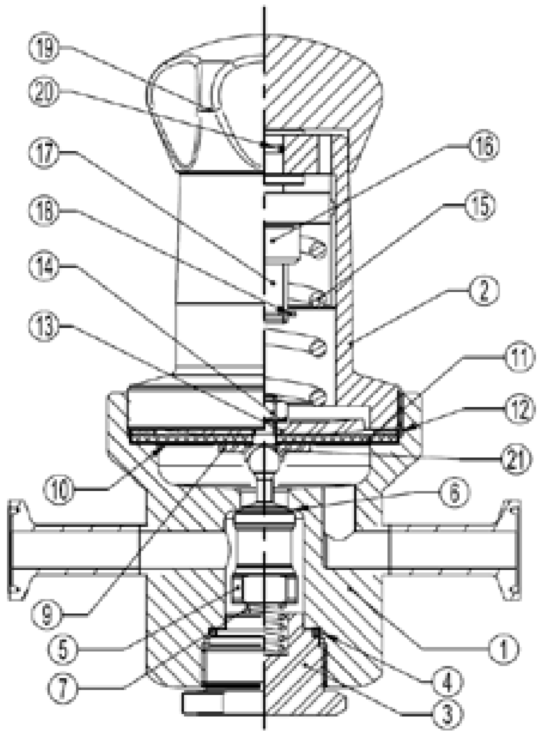
CAPACITIES			
Valve Size	1/2" - 15	3/4" - 20	1" - 25
KVs (m3/h)	3	3,2	3,3

Reduced Kv on request

Connection examples		
Clamp	Round thread	Flange
		

MATERIALS		
POS.	DESIGNATION	MATERIAL
1	Valve body	AISI316L / 1.4406
2	Cover	AISI316L / 1.4404
3	Seat cover	AISI316L / 1.4404
4	* O-ring	Viton / EPDM
5	*Piston	AISI316L / 1.4404
6	* Valve head	AISI316L / 1.4404 ; Viton ,PTFE
7	* Valve spring	AISI302 / 1.4300 (Polished)
9	Pusher disc	AISI 316L / 1.4404
10	* Lower diaphragm	PTFE
11	* Upper diaphrag	EPDM
12	Washer	AISI304 / 1.4301
13	Spring plate	AISI304 / 1.4301
14	Nut	St.steel A2-70
15	* Adjustment spring	AISI302 / 1.4300
16	Spring plate	AISI304 / 1.4301
17	Adjustment screw	AISI304 / 1.4301
18	Retaining ring	St.steel A2-70
19	Handwheel	AISI316L / 1.4404
19	Handwheel	Aluminium white painted
20	O-ring	EPDM
21	** O-ring	EPDM

* Available spare parts. ** On request
Remarks: FDA/USP Class VI seals certificate on request
All valves have a serial number. In case of non-standard



PRESSURE REDUCING VALVE - Clean Steam

P-160

DESCRIPTION

The ADCA P-160 series ***direct acting, spring-loaded diaphragm sensing ,*** pressure reducing valves, are designed for use on clean steam, compressed air, water and other gases or liquids compatible with the materials of construction .

MAIN FEATURES

Compact design.
Completely machined from barstock material, no castings or forgings used on the standard version.
No rising stem

STANDARD SURFACE FINISH
Internal wetted parts: 0,5 microns Ra
External :
Body and cover– Fine machined
(mechanical or electro polished as option)

OPTIONS: Leakage line connection 1/8” (captured vent). Different soft valves for liquids and gases. Casted cover (CF8M) with rising stem handwheel for economic reasons. Lock system, allows clean-in-place (CIP) and sterilization-in-place (SIP) operations with valve in line.

USE: Clean steam, compressed air, water and other gases and liquids compatible with the construction.

AVAILABLE MODELS: P-160

SIZES: DN3/4”, 1”, 11/2”, 2” ; DN 20, 25, 40, 50

OUTLET SPRING RANGES: 0,8 – 1,5 bar; 1 – 3 bar; 1,5 – 5 bar.

CONNECTIONS: Clamp ends or others on request

INSTALLATION: Horizontal installation. Inlet vertical and horizontal outlet angle connection.

ORDER REQUIREMENTS: Type of fluid
Maximum operating temperature
Inlet pressure and required outlet pressure
Capacity (maximum and minimum).

LIMITING CONDITIONS	
Valve model	P-160
Body design conditions	PN 16
Max.upstream pressure	8 bar DN 2" only 4bar**
Max.downstream pressure	5 bar
Min.downstream pressure	0,8 bar
Max.design temperature *	150 ºC

*Other on request.
**Special execution on request with lower Kvs

CE MARKING (PED - European Directive 97/23/EC)	
PN 16	Category
DN 3/4" to 2"	SEP - art. 3, paragraph3

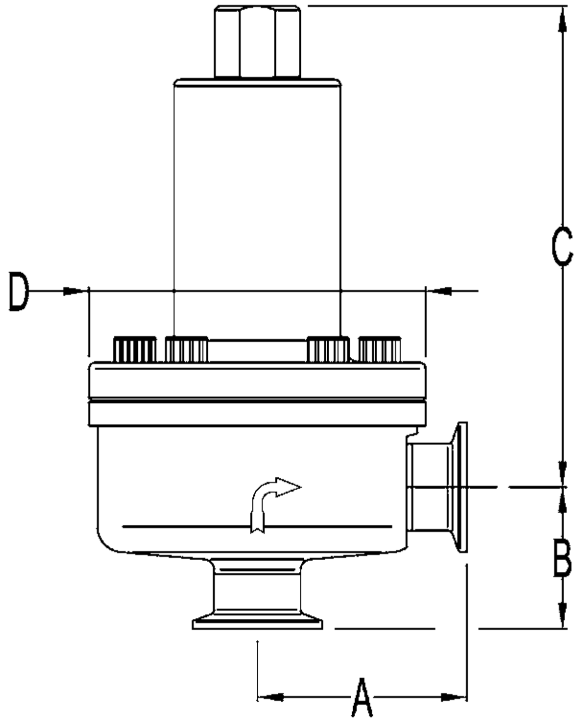
PRESSURE REDUCING VALVE - Clean Steam

P-160

DIMENSIONS (Clamp conn.)

SIZE DN	A	B	C	D	WGT. Kgs
3/4"-20	85	55	200	130	6,7
1"-25	85	55	200	130	6,8
11/2"-40	85	65	210	130	7,6
2"-50	85	70	210	130	7,8

* Different lenghts on request.
Consult factory for certified dimensions
Dimensions subject to change without notice

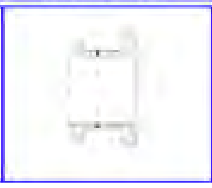


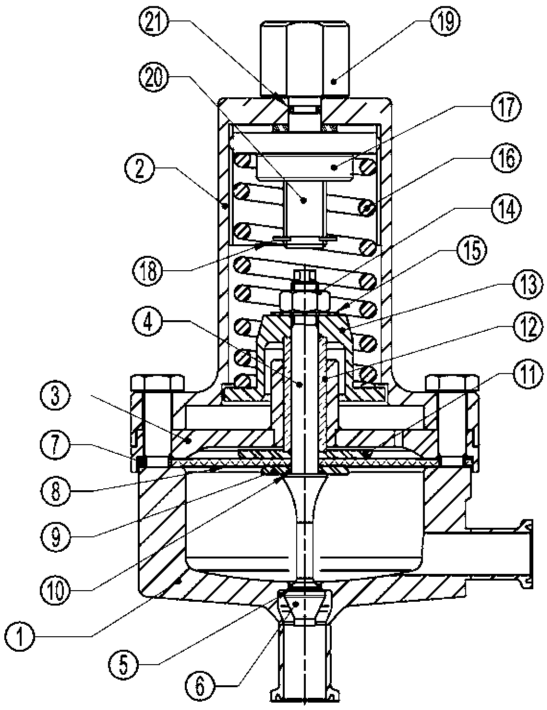
CAPACITIES

Valve Size	3/4"-20	1"-25	11/2"-40	2"-50
KVs (m3/h)	1,3* - 3	3,5* - 4,5	5,3	** 5,5 - 8,5

*Max.available Kvs with ASME BPE clamp connection
** On request, for maximum inlet pressure higher than 4 bar

Connection examples

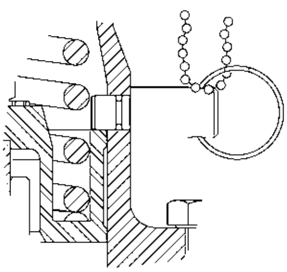
Clamp	Round thread	Flange
		



MATERIALS

POS.	DESIGNATION	MATERIAL
1	Valve body	AISI316L / 1.4404
2	Cover	AISI316L / 1.4404
3	Centering plate	AISI316L / 1.4404
4	* Valve stem	AISi316L/1.4404
5	* Soft plug	EPDM; PTFE **
6	* Valve plug	AISI316L / 1.4404
7	* Upper diaphragm	EPDM;VITON**
8	* Lower diaphragm	PTFE
9	Diaphragm plate	AISI316L / 1.4404
10	* O-ring	EPDM
11	Diaphragm plate	AISI316L / 1.4404
12	Stem guide	AISI316 / 1.4401
13	Spring plate	AISI316 / 1.4401
14	Nut	St.Steel A2 - 70
15	Washer	AISI316 / 1.4401
16	* Adjustment spring	AISI 302 / 1.4300
17	Top spring plate	AISI316 / 1.4401
18	Retaining ring	St.Steel A2 - 70
19	Regulating nut	AISI316L / 1.4404
20	Adjustment screw	AISI304 / 1.4301
21	O-ring	EPDM

* Available spare parts; **Others according to the fluid
FDA/USP Class VI seals certificate on request
Viton diaphragm only with FDA approval (Pos.7)
Remarks: All valves has a serial number. In case of non-standard valves this number must be supplied if spare parts are ordered.



Lock system

PNEUMATIC CONTROL VALVES - PV 928

(V928 angle type valves with linear actuators PA series)

DESCRIPTION

The PV928 are two or three way control valves with angle connections, specially designed for food, chemical pharmaceutical and cosmetic industries among others. The PA pneumatic actuator is rubber diaphragm and multi-springs. It's action can be DA - direct action (air to close) or RA-reverse action (air to open). The PV928 valves have been designed to assure an accurate control in any process condition and they have self draining design.

MAIN FEATURES

Quick disassembling through clamp body bonnet coupling
Metal to metal or soft sealing.
Self draining design

STANDARD SURFACE FINISH
Internal parts: 0,8 microns Ra
0,4 microns Ra on request
External:
Body:
Fine machined (mechanical or electro polished as option)
Actuator:
Stainless steel satin bead blast finish – 1,6 microns Ra
Steel painted

OPTIONS:	Soft sealing Steam barrier Position transmitter Pneumatic pilot positioner Air filter regulator Top-work manual handwheel
USE:	Saturated steam liquids and gases compatible with the construction
AVAILABLE MODELS:	PV928A-Two way angle valve PV928H-Two way horizontal valve PV928M-Three way mixing valve PV928D-Three way diverting valve
VALVE SIZES:	DN1/2" to DN4" ; DN15 to DN100
CONNECTIONS:	Tube weld, screwed, flanged and sanitary clamp.
PNEUMATIC ACTUATORS:	PA-205,PA-280,PA-340,PA-435
ACTUATOR CONN:	¼" NPT-F
CONTROL SIGNAL:	0,2 – 1bar; 0,4 – 1,2 bar; 0,4 – 2 bar
ELECTRIC ACT.:	Consult catalogue IS EL20.00 E

MAX.AIR SUPPLY:	3,5 bar
AMBIENT TEMPERATURE:	-20ºC ….+70ºC
STEM SEALING:	EPDM or PTFE Considering the medium and temperature
PLUG TYPES:	Equal percentage (EQP) Linear (PL) On-Off (PT)
PORT:	Full port as standard Reduced or microflow on request

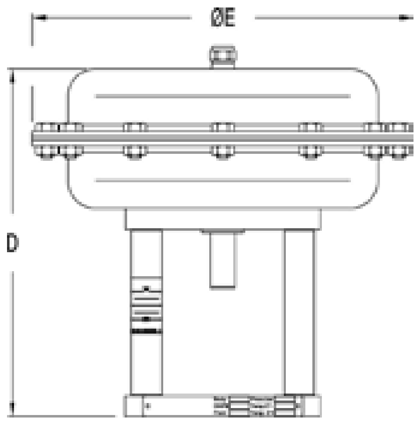
VALVE BODY LIM. CONDITIONS	
PRESSURE/TEMPERATURE	
10 bar	-10/170ºC

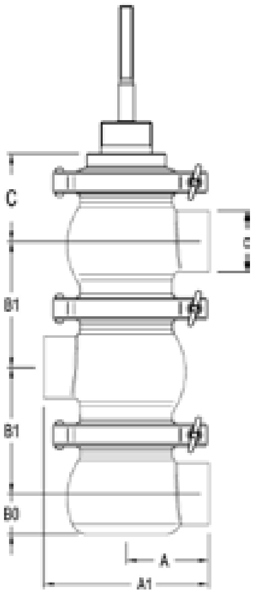
Higher limits on request

CE MARKING (PED - European Directive 97/23/EC)	
PN 10	Category
DN1/2" to DN4" - DN15 to DN100	SEP - art. 3, paragraph3

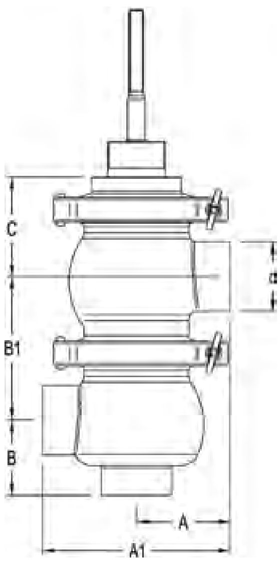
MATERIALS	
DESIGNATION	***MATERIAL***
Valve Body	AISI316L / 1.4404
Bonnet	AISI316L / 1.4404
Actuator (Steel)	S235JRG2 / 1.0038
Actuator (Stain.steel)	AISI304 / 1.4301
* Diaphragm	NBR 70
Yoke (Steel)	C45E / 1.1191
Yoke (Stainless steel)	AISI304 / 1.4301
*Valve plug	Metal, EPDM, PTFE,VITON
*Valve Seal	EPDM,FEP,VMQ
*Packing	EPDM,PTFE,VITON

* Available spare parts

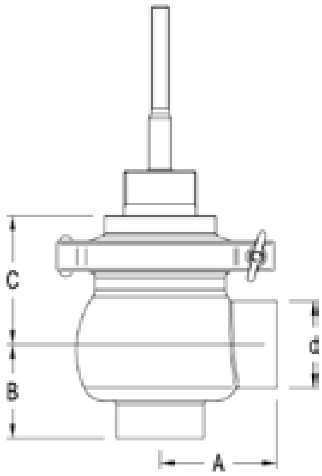




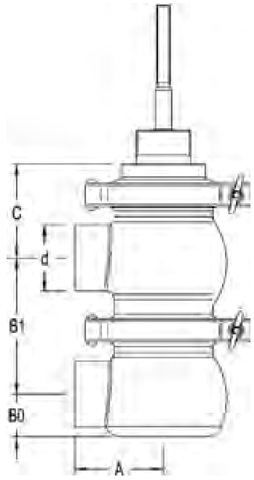
V928D



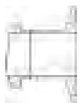
V928M



V928A



V928H

Connection examples		
Clamp	***Round thread***	***Flange***
		

DIMENSIONS AND FLOW RATE												
VALVE BODY										ACTUATOR		
DN	***Kvs m3/h***	***Stroke mm***	***ø d * DIN 11850***	***A (mm)***	***A1 (mm)***	***B (mm)***	***B0 (mm)***	***B1 (mm)***	***C (mm)***	***Type***	***D (mm)***	***ø E (mm)***
1/2"-15	4,2	20	18	38	76	38	14	66	38	PA-205	235	210
3/4"-20	6,8	20	22	38	76	38	16	66	38	PA-280	240	275
1"-25	11	20	28	52	104	52	22	72	52	PA-340	265	335
11/4"-32**	15	20	34	56	112	56	25	78	56	PA-435	295	430
11/2"-40	22	20	40	64	128	64	28	86	64			
2"-50	38	20	52	72	144	72	34	96	72			
21/2"-65	61	30	70	86	172	86	45	114	86			
3"-80	89	30	85	109	218	109	54	135	109			
4"-100	136	30	100	119	238	119	61	152	119			

* Tube weld , other connections and standards on request. ** Not available with ASME BPE
Consult factory for certified dimensions. Dimensions subject to change without notice.

PNEUMATIC CONTROL VALVES - PV926

(V926 angle valves series with linear actuators PA series)

DESCRIPTION

The PV926 control valves are single seated, two-way body constructed with angle connections. The PA pneumatic actuator is rubber diaphragm and multi-springs. It's action can be DA - direct action (air to close) or RA-reverse action (air to open). The PV926 valves have been designed to assure an accurate control in any process condition. The self draining design is ideally suited to applications in clean steam service.

MAIN FEATURES

Single seated, two way, direct or reverse action valve.
Valve top flange permanently attached to the body, removal is unnecessary for replacing the actuator.
Metal to metal or soft sealing.
Self draining design

STANDARD SURFACE FINISH
Internal parts: 0,5 microns Ra
External:
Body
Fine machined (mechanical or electro polished as option)
Actuator
Stainless steel satin bead blast finish – 1,6 microns Ra
Steel painted

OPTIONS: Soft sealing
Position transmitter
Pneumatic pilot positioner
Air filter regulator
Top-work manual handwheel

USE: Saturated steam
Hot and superheated water
Air and gases compatible with the construction

AVAILABLE MODELS: PV926

VALVE SIZES: DN1/2” to DN2” ; DN15 to DN50

CONNECTIONS: Clamp ends or other on request

PNEUMATIC ACTUATORS: PA-205,PA-280,PA-340,PA-435

ACTUATOR CONN: ¼” NPT-F

CONTROL SIGNAL: 0,2 – 1bar; 0,4 – 1,2 bar; 0,4 – 2 bar

ELECTRIC ACT.: Consult catalogue IS EL20.00 E

MAX.AIR SUPPLY: 3,5 bar

AMBIENT TEMPERATURE: -20ºC ….+70ºC

STEM SEALING: VITON/PTFE O-Rings 170ºC

PLUG TYPES: Equal percentage (EQP)
Linear (PL)
On-Off (PT)

PORT: Full port as standard
Reduced or microflow on request

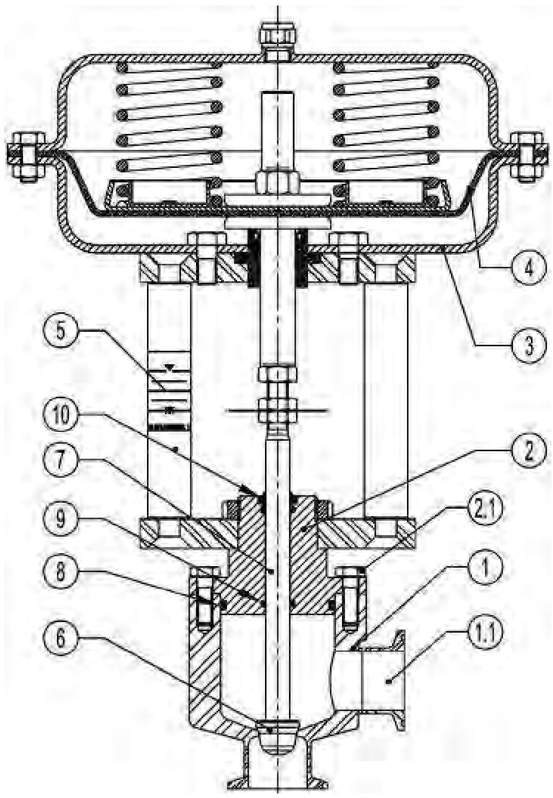
CE MARKING (PED - European Directive 97/23/EC)	
PN 16	Category
DN1/2" to DN2"	SEP - art. 3, paragraph3

HOW TO SELECT: Never size the valve according to the pipe diameter in which it has to be fitted, but according to the required actual flow of steam or water. Refer to the valve calculation data sheet or consult the factory.

PNEUMATIC CONTROL VALVES - PV926

(V926 angle valves series with linear actuators PA series)

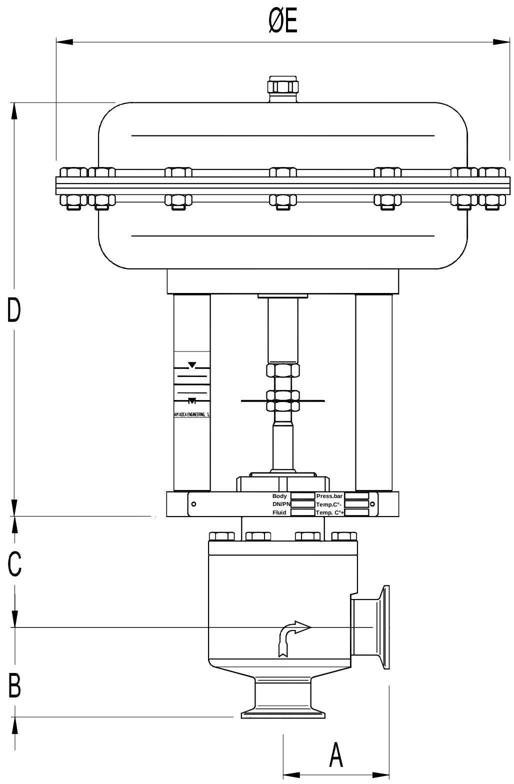
MATERIALS		
POS.	*DESIGNATION*	*MATERIAL*
1	Valve Body	AISI316L / 1.4404
1.1	Ferrule	AISI316L / 1.4404
2	Bonnet	AISI316L / 1.4404
2.1	Bolts	DIN 933 A-2
3	Actuator (Steel)	S235JRG2 / 1.0038
	Actuator (Stainless steel)	AISI304 / 1.4301
4	* Diaphragm	NBR 70
5	Yoke (Steel)	C45E / 1.1191
	Yoke (Stainless steel)	AISI304 / 1.4301
6	Valve Seal	PTFE
7	Standard packing	AISI316L / 1.4404
8	O-ring	EPDM
9	O-ring	VITON
10	Seal washer	VITON



VALVE BODY LIM. CONDITIONS	
PRESSURE/TEMPERATURE	
16 bar	100 ºC
15 bar	150 ºC
14 bar	200 ºC

DIMENSIONS (Clamp conn.)						
VALVE BODY				ACTUATOR		
DN	*A (mm)*	*B (mm)*	*C (mm)*	*Type*	*D (mm)*	*ø E (mm)*
1/2"-15	60	49	62,5	PA-205	235	210
3/4"-20	60	49	62.5	PA-280	240	275
1"-25	60	49	62,5	PA-340	265	335
11/4"-32*	60	65	75,5	PA-435	295	430
11/2"-40	67,5	70	84			
2"-50	67,5	80	77,5			

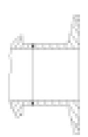
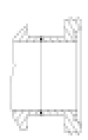
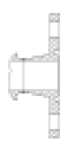
Consult factory for certified dimensions.
Dimensions subject to change without notice.
*Not available with ASME BPE



FLOW RATE COEFFICIENTS						
	SIZES					
	1/2"-15	*3/4"-20*	*1"-25*	*11/4"-32*	*11/2"-40*	*2"-50*
Kvs	1,7* - 3	3,7*- 5,1	6,3* - 9,4	15,4	19,2*-22,2	27,7*-40,1

* Max. available Kvs with ASME BPE clamp connections
Kvs in m3/h , see data sheet IS PV10.00 E ;
For conversion Kvs = Cv(US) x 0,855

ACTUATOR STROKE IN mm						
	SIZES					
	1/2"-15	*3/4"-20*	*25-1"*	*11/4"-32**	*11/2"-40*	*2"-50*
Stroke	20	20	20	20	20	20

Connection examples		
Clamp	*Round thread*	*Flange*
		

Free of particles and sterile

■ Compressed air, technical gases and liquids require a certain purity in most applications. In most cases, the media has to be free of particles.

■ Especially the food and beverage, pharmaceutical or chemical industries require a special degree of puritiy of the used media. Compressed air and technical gases must be free of particles, but also free of bacteria, microorganism and viruses.

■ As opposed to their size, microorganism are a serious problem for most sensitive production areas. As living organisms, they are able to proliferate in the right ambient condition and to contaminate the production.

■ Only a few viable organism in a clean or sterile production process can result in immense damages. Not only resulting in a lower product quality but also by complete uselessness of the production charge.

Sterile filter elements and filter housings from ultrafilter

■ ultrafilter offers a complete range for process filtration of compressed air, technical gases and liquids.

■ ultrafilter GmbH offers a wide range of sterile filters for different applications. Depending on the application a wide range of filter elements with nominal or absolute retention rates can be offered.

■ Within the production of our process filters, only the highest quality materials are used.

■ All process filters are made of inert materials, without adhesives, additives or surface active components.

■ ultrafilter GmbH offers a wide range of stainless steel filter housings for the individual filtration requirements.

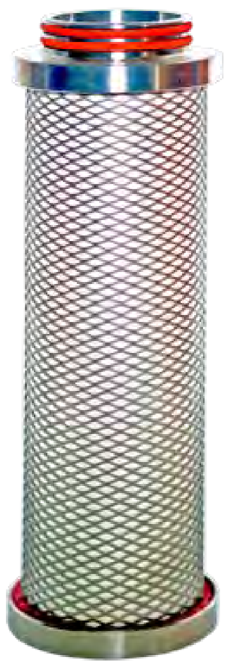
■ All ultrafilter stainless steel filter housings are build and designed according to international requirements.

■ Depending on the requirements, stainess steel filter housings can be offered in different stainless steel qualities (304, 316L) and different connections.

■ ultrafilter filter housings achieve high volumes flow at low differential pressures due an improved construction.

■ Due to the modular design different element types can be installed.

Sterile filter P-SRF
for compressed air and technical gases



ultrafilter P-SRF

- The P-SRF is a wounded depth filter with inner and outer guard end caps made of stainless steel. Consisting of a threedimensional borosilicate depth media, the P-SRF achieves a void volume of 95 %, ensuring a high containment capacity at high flow rates and low differential pressure. A retention rate of > 99.99998 % related to 0.01 µm is achieved during operation.

- All components meet the FDA requirements for the contact with food in accordance with the CFR requirements (code of federal regulations) tilte 21.

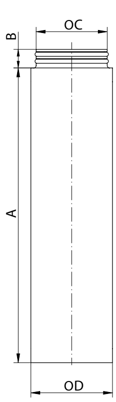
Features and advantages

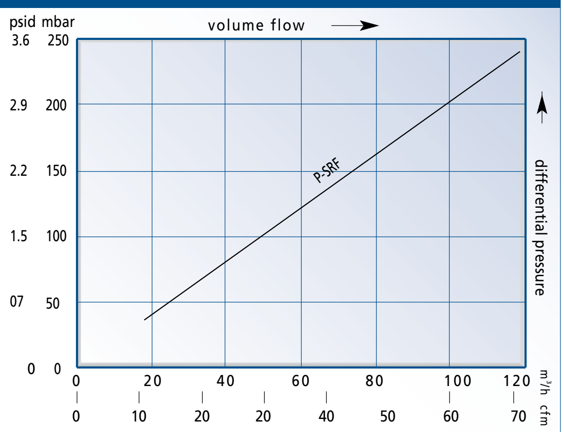
- Non-fibre releasing filter element.
- Manufactured without use of binders or other chemical additives.
- Corresponds to cGMP requirements (current Good Manufacture Practice) and is manufactured according to DIN EN ISO 9001.
- P-SRF has passed the toxicological test according to USP XX Class VU for plastics.

Applications

- Packing industry
- Biotechnology
- Breweries
- Chemical industry
- Diaries
- Fermentation processes
- Food & beverage industry
- Pharmaceutical industry
- Hospitals

element size	A mm	B mm	Ø C*	Ø D mm	CF
03/10	76	12	3/4"	42	0,12
04/10	104	12	3/4"	42	0,17
04/20	104	14	1"	52	0.19
05/20	104	14	1"	52	0,19
05/25	128	14	1"	62	0,32
07/25	180	14	1"	62	0,47
05/30	128	16	2"	86	0,46
07/30	180	16	2"	86	0,68
10/30	254	16	2"	86	1,00
15/30	381	16	2"	86	1,55
20/30	508	16	2"	86	2,10
30/30	762	16	2"	86	3,28
30/50	762	16	2"	140	5,89





Vent filter P-BE
for storage tanks

■ All components meet the FDA requirements for the contact with food in accordance with the CFR requirements (code of federal regulations) tilte 21.

Features and advantages

- Non-fibre releasing filter element.
- Manufactured without use of binders or other chemical additives.
- Corresponds to cGMP requirements (current Good Manufacture Practice) and is manufactured according to DIN EN ISO 9001.
- P-BE has passed the toxicological test according to USP XX Class VU for plastics..

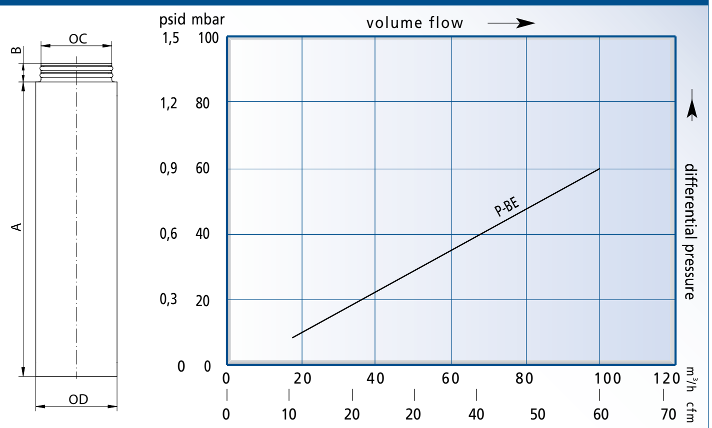
Applications

- Chemical Industry
- Aseptic packing
- Pharmaceutical Industry
- Biotechnology
- Cosmetics Industry
- Breweries
- Dairies
- Food and beverages
- Water treatment systems
- Fermentation processes

ultrafilter P-BE

■ The P-BE is a wounded depth filter with inner and outer guard end caps made of stainless steel. Consisting of a threedimensional borosilicate depth media, the P-BE achieves a void volume of 95 %, ensuring a high containment capacity at high flow rates and low differential pressure. A retention rate of > 99.999 % related to 0.01 µm is achieved during operation.

element size	A mm	B mm	Ø C*	Ø D mm	CF
03/10	76	12	3/4"	42	0,12
05/25	128	14	1"	62	0,32
05/30	128	16	2"	86	0,46
10/30	254	16	2"	86	1,00
20/30	508	16	2"	86	2,10
30/30	762	16	2"	86	3,28



P-GS filter of sintered stainless steel
for gases, liquids and steam

Features and advantages

- Good durability against most liquids, aggressive gases and steams.
- The porosity level is more than 50 % ensuring high particle and dirt load capacity as well as a good flow rate at a low differential pressure.
- Regeneration by ultrasonic bath.

Applications

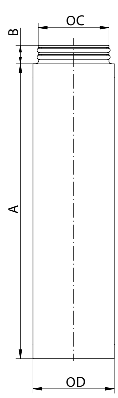
- Aseptic packing
- Breweries
- Chemical Industry
- Dairy industry
- Electronic industry
- Fermentation processes
- Food and beverages
- Pharmaceutical Industry
- Plastic industry

ultrafilter P-GS

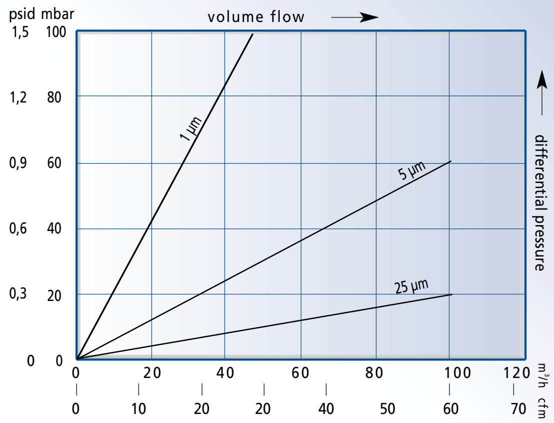
- The ultrafilter P-GS filter ist designed for removal of particles from gases, liquids and steam.

- The P-GS consists of a regenerable weldless filter pipe made from sintered stainless steel. The retention rate extends from 1 µm to 25 µm.

element size	A mm	B mm	Ø C*	Ø D mm	CF
03/10	76	12	¾"	42	0,12
04/10	104	12	¾"	42	0,17
04/20	104	14	1"	52	0.19
05/20	128	14	1"	52	0,19
05/25	128	14	1"	62	0,32
07/25	180	14	1"	62	0,47
05/30	128	16	2"	86	0,46
07/30	180	16	2"	86	0,68
10/30	254	16	2"	86	1,00
15/30	381	16	2"	86	1,55
20/30	508	16	2"	86	2,10
30/30	762	16	2"	86	3,28
30/50	762	16	2"	140	5,89



volume flow of a 10" P-GS element
ati 121 °C saturated steam



P-SM sterile filter
made of stainless steel mesh

ultrafilter P-SM

- Pre and final filter with absolute retention rate for particle removal from ageous solutions, water and other liquids, as well as gases.

- The P-SM consists of a regenerable stainless steel mesh, with stainless steel outer guard and endcaps. The retention rate extends from 5 µm up to 250 µm.

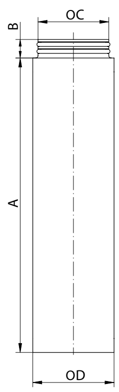
Features and advantages

- The P-SM offers an especially economical pre- and final filtration.
- Regeneration of stainless steel mesh by ultrasonic bath or back flush.
- Welded contact points, guaranteeing a constant pore diameter, even under extreme operating conditions.
- Also suitable for high viscosity liquids.
- Withstands a differential pressure of up to 5 bar (flow from outside to inside).
- Suitable for operating temperatures of up to 200 °C.

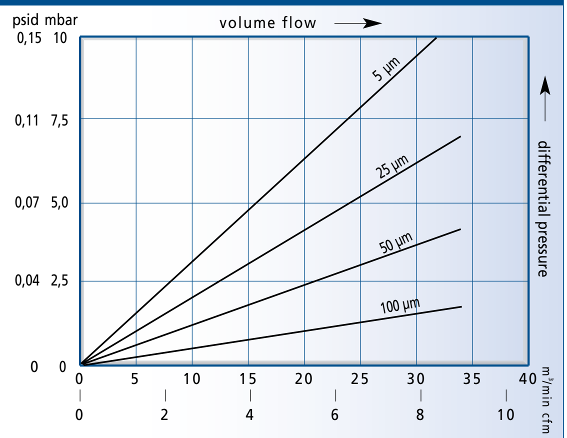
Applications

- Water filtration
- Chemicals
- Solvents
- Biological liquids
- Pharmaceutics
- Cosmetics
- Oils
- Food and beverages
- Syrup
- Collants
- Compressed air and other gases

element size	A mm	B mm	Ø C*	Ø D mm	CF
03/10	76	12	¾"	42	0,12
04/10	104	12	¾"	42	0,17
04/20	104	14	1"	52	0.19
05/20	128	14	1"	52	0,19
05/25	128	14	1"	62	0,32
07/25	180	14	1"	62	0,47
05/30	128	16	2"	86	0,46
07/30	180	16	2"	86	0,68
10/30	254	16	2"	86	1,00
15/30	381	16	2"	86	1,55
20/30	508	16	2"	86	2,10
30/30	762	16	2"	86	3,28
30/50	762	16	2"	140	5,89



volume flow of a 10" P-SM element for water



PP-TF process filter
for particle retention out of liquids

ultrafilter PP-TF

- Depth filter for particle removal from water and aqueous solutions with a nominal retention rate of 1 µm to 50 µm.

- The PP-TF is a pleated polypropylene filter with an inner and outer guard of polypropylene.

- This filter element distinguishes itself by an exceedignly high dirt hold capacity as well as a high flow rate with a low differential pressure and a long service life.

Features and advantages

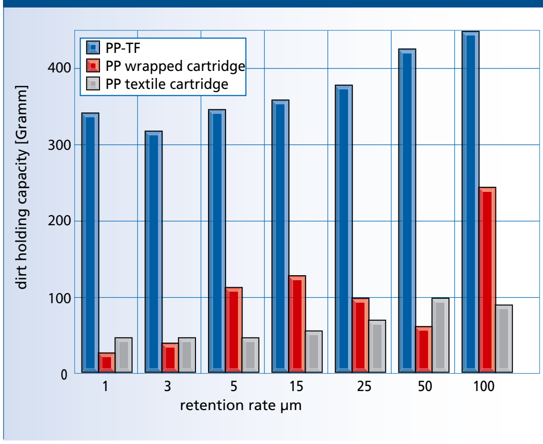
- Manufactured in accordance with cGMP requirements (current Good Manufacture Practice).
- no migration of filter medium, non-fibre releasing
- thermally, binderfree welded without chemical additives

Applications

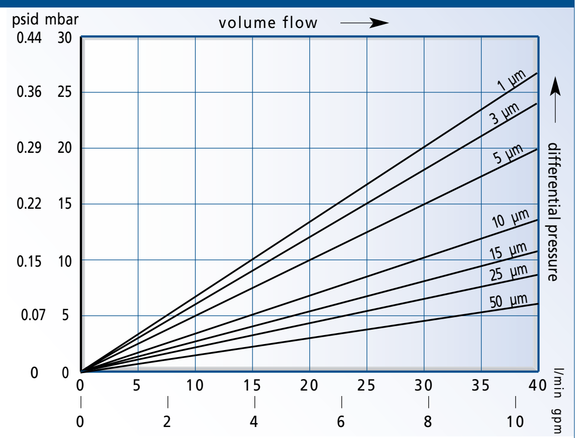
Particle removal from

- Biological liquids
- Chemicals
- Collants
- Compressed air and other gases
- Cosmetics
- Etchants
- Food and beverages
- Jet printer inks
- Oils
- Photolithografical liquids
- Pharmaceutics
- Solvents
- Water

Dirt holding capacity of a PP-TF element



volume flow of a 10“ PP-TF element



PP process filter
depth filter for particle retention out of liquids

ultrafilter PP

■ Depth filter for particle removal from water and aqueous solutions and gases with a nominal retention rate of 1 µm to 30 µm.

■ The P-PP is a pleated polypropylene filter with an inner and outer guard of propylene.

■ This filter element distinguishes itself by an exceedignly high dirt hold capacity as well as a high flow rate with a low differential pressure and a long service life.

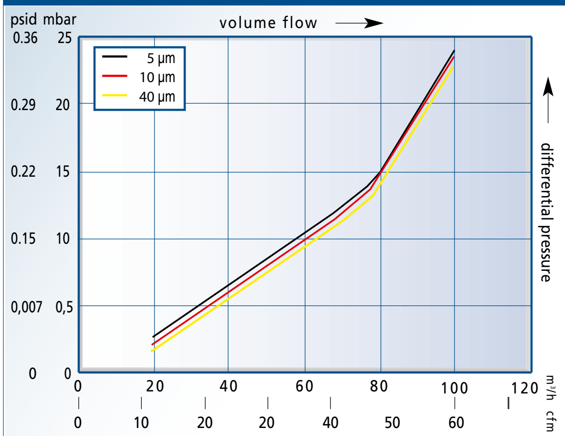
Features and advantages

- Manufactured in accordance with cGMP requirements (current Good Manufacture Practice) and complies with FDA requirements for the contact with food.
- no migration of filter medium, non-fibre releasing
- thermally, binderfree welded without chemical additives
- Pre-rinsed with 18MΩ • cm water, which leads to extremely low extractables

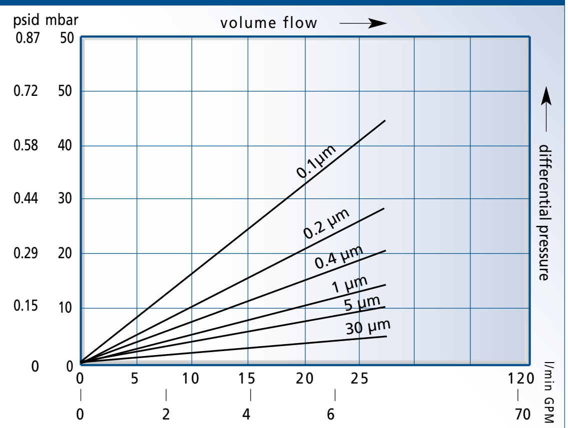
Applications

- Biological liquids
- Chemicals
- Collants
- Compressed air and other gases
- Cosmetics
- Etchants
- Food and beverages
- Jet printer inks
- Oils
- Pharmaceutics
- Syrup
- Solvents
- Water

volume flow of a 10" element - air



volume flow of a 10" element - water



PP100 process filter
for particle retention out of liquids

ultrafilter PP100

Depth filter for particle removal from water and aqueous solutions with an absolute retention rate of 0.45 µm to 40 µm.

The PP100 is a pleated polypropylene filter with an inner and outer guard of propylene.

This filter element distinguishes itself by an exceedignly high dirt hold capacity as well as a high flow rate with a low differential pressure and a long service life.

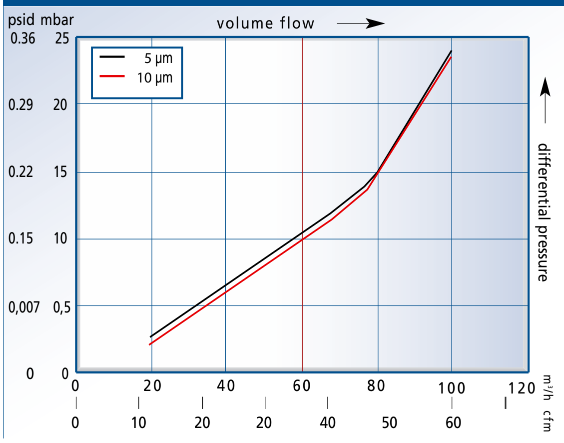
Features and advantages

- Manufactured in accordance with cGMP requirements (current Good Manufacture Practice) and complies with FDA requirements for contact with Food in accordance with CFR Title 21.
- no migration of filter medium, non-fibre releasing
- thermally, binderfree welded without chemical additives
- Pre-rinsed with 18MΩ • cm water, which leads to extremely low extractables

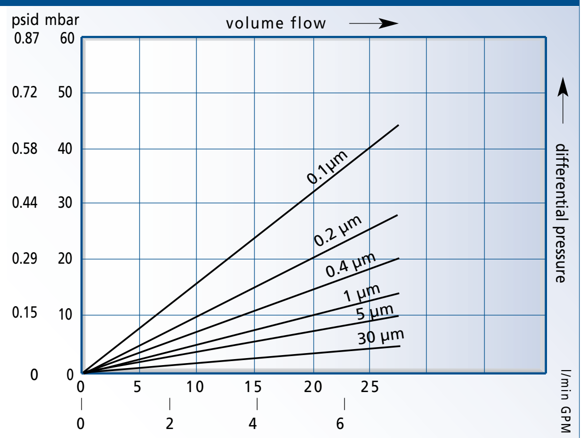
Applications

- Biological liquids
- Chemicals
- Collants
- Compressed air and other gases
- Cosmetics
- Etchants
- Food and beverages
- Jet printer inks
- Pharmaceutics
- Serums
- Syrup
- Solvents
- Water

volume flow of a 10“ element - air



volume flow of a 10“ element - water



PF-BEV process filter
membrane filter with absolute retention rate

ultrafilter PF-BEV

- Membrane filter for particle removal from water and aqueous solutions with an absolute retention rate of 0.2 µm to 0.45 µm.

- The P-PF-BEV is a polyethersulfone membrane filter with an inner and outer guard of propylene.

- The filter media polyethersulfone is inherently hydrophilic and distinguishes itself by having an asymetrically designed pore structure. The pore size steadily decreases towards the center of the medium.

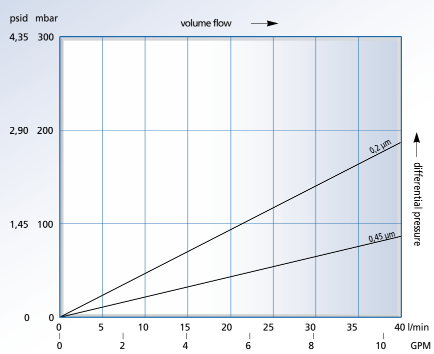
Features and advantages

- Manufactured in accordance with cGMP requirements (current Good Manufacture Practice).
- P-PF-BEV meets the FDA requirements for the contact with food in accordance with CFR (Code of Federal Regulations) Title 21. P-PF-BEV has passed the USP XX Class VI tests for plastics.
- thermally, binderfree welded without chemical additives

Applications

- Food and beverages
- Rinsing or cleaning water
- Sterile water
- Mixing or blending water

volume flow of a 10" element - water



PF-PES process filter
for sterile filtration of aqueous solutions

ultrafilter PF-PES

■ Membrane filter for particle removal from water and aquaeous solutions and solvents with an absolute retention rate of 0.04 µm to 0.6 µm.

■ The P-PF-PES is a polyethersulfone membrane filter with an inner and outer guard of propylene.

■ The filter media polyethersulfone is inherently hydrophilic and distinguishes itself by having an asymetrically designed pore structure. The pore size steadily decreases towards the center of the medium.

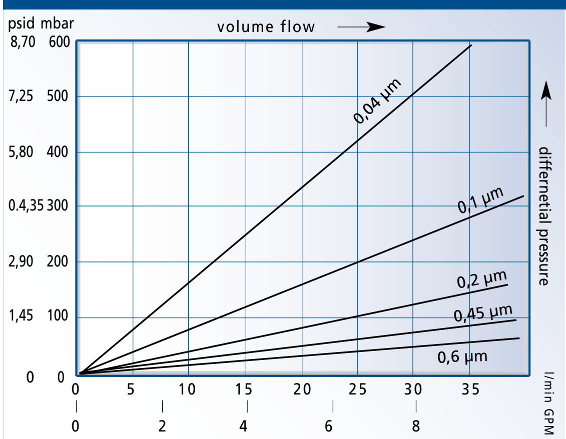
Features and advantages

- Manufactured in accordance with cGMP requirements (current Good Manufacture Practice).
- P-PF-PES meets the FDA requirements for the contact with food in accordance with CFR (Code of Federal Regulations) Title 21. P-PF-PES has passed the USP XX Class VI tests for plastics.
- Pre-rinsed with 18MΩ - cm water, which leads to extremely low extractables

Applications

- Serum & blood-based products
- Antibiotics
- Injectables
- Diagnostic reagents
- Deionised water
- Sterile water
- Chemically treated water
- Acids and bases
- Alcohols
- Aldehydes
- Ketones etc.

volume flow of a 10" element - water



PF-PP process filter
membrane filter with absolute retention rate

ultrafilter PF-PP

■ Membrane filter for filtration of solvents, alcohols, chemicals and gases with an absolute retention rate of 0.04 µm to 0.2 µm.

■ The P-PF-PP is a pleated propylene membrane filter with an inner and outer guard of propylene.

■ The filter media propylene is inherently hydrophobic with a highly porous membrane structure.

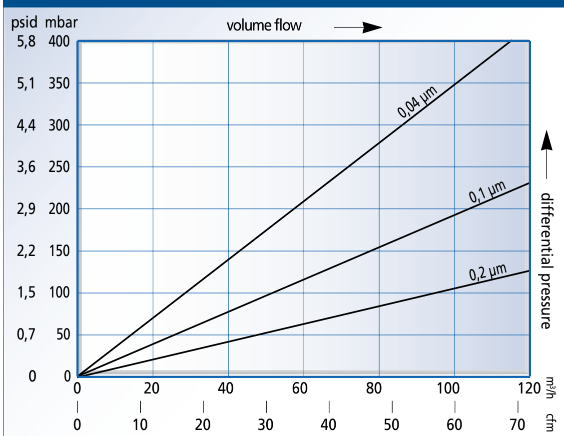
Features and advantages

- Manufactured in accordance with cGMP requirements (current Good Manufacture Practice).
- P-PF-PP meets the FDA requirements for the contact with food in accordance with CFR (Code of Federal Regulations) Title 21. P-PF-PP has passed the USP XX Class VI tests for plastics.
- The membrane is non-fibre realising and thermally welded without use of binders or chemical additives

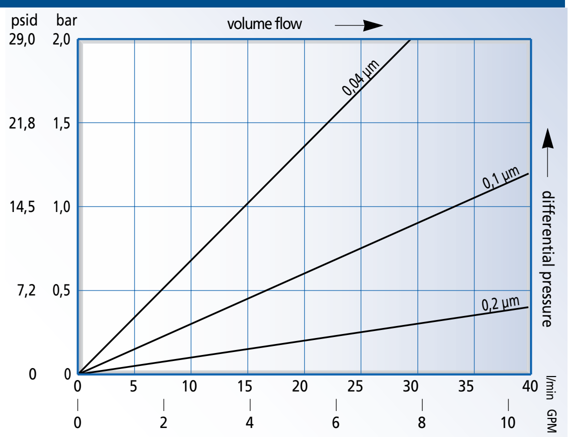
Applications

- Alcohols
- Bases
- Etchants
- Solvents
- Photoresists
- Photo-lithografical solutions
- Fermentation gases
- Technical gases
- Tank ventilation
- Compressed air

volume flow of a 10" element - air



volume flow of a 10" element - water



PF-PT process filter
for aggresive liquids and gases

ultrafilter PF-PT

■ Pleated membrane filter for particle removal from aggressive solvents, chemicals and gases with a nominal retention rate.

■ The PF-PP filter is a high quality Teflon filter media, offering maximum assurance of filtration performance and durability against chemicals in severe process conditions.

■ The retention rate extends from 0.1 µm to 1 µm. The Teflon® filter media is inherently hydrophobic with a highly porous membrane structure.

■ All components meet the FDA requirements for the contact with food in accordance with the CFR (Code of FederalRegulations) Title 21. PF-PT filter elements have passed the toxicological tests according to USPXX Class VI forplastics. In particular, the requirements of the chemical, biological, cosmetic, electronic and the pharmaceutical industries are fulfilled.

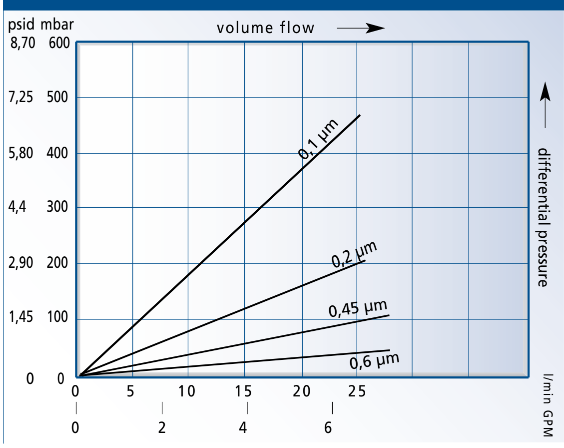
Features and advantages

- Manufactured in accordance with cGMP requirements (current Good Manufacture Practice).
- The membrane is non-fibre realising and thermally welded without use of binders or chemical additives

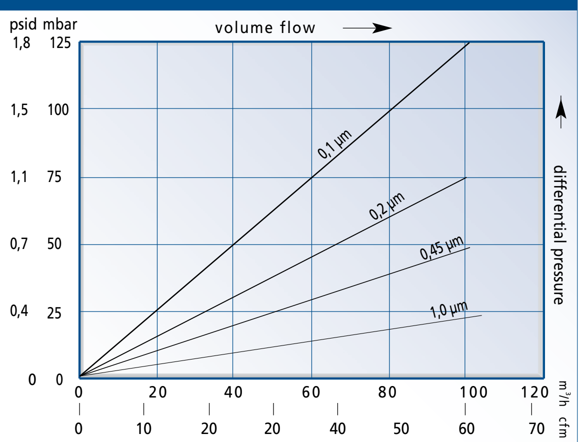
Applications

- Particle removal from water
- Chemicals
- Biological liquids
- Solvents
- Cosmetics
- Photo-lithografical solutions
- Paints & dyes
- Jet printer inks
- Coatings

volume flow of a 10" element - water



volume flow of a 10" element - air



process filter
Conformity and durability

Chemical durability of filter media

Media	Filtertyp			
	PP 100 PP	PF-PES PF-BEV	PF-PP	PP-PT
acetone	1	3	1	1
benzole	3	1	3	2
benzyl alcohol	1	-	1	1
butanol	1	1	1	1
chloroform	2	3	2	2
cyclohexanon	1	3	1	1
steam	1	1	1	1
acetic acid	1	1	1	1
ethanole	1	1	1	1
hydrogen fluoride 50 %	1	-	1	1
formamide	1	-	1	1
formaldehyde	1	1	1	1
fluorosilicic acid	2	-	2	2
hydraulic fluid	1	2	1	1
caustic potash 32 %	1	1	1	1
kerosine	1	-	1	1
adhesives	-	1	-	-
paint	-	1	-	-
methanole	1	1	1	1
motor oil	-	1	-	-
caustic soda 32 %	1	1	1	1
n-hexane	2	1	2	1
ozone	-	1	-	-
perchloric acid 25 %	1	-	1	1
vegetable oil	-	1	-	-
phosphoric acid 25 %	1	-	1	1
phosphoric acid 85 %	1	-	1	1
pyridine	2	3	2	1
nitric acid 25 %	1	3	1	1
lubricant	1	1	1	1
sulfuric acid 25 %	1	1	1	1
sulfuric acid 98 %	2	3	1	1
silicone	1	1	1	1
toluole	3	3	3	2
trichloroacetic acid 25 %	1	-	1	1
water	1	1	1	1
citric acid	1	1	-	-

1 = recommended
2 = limited recommendable
3 = not recommended
- = not tested

A complete list for all filter elements and media can be achieved upon request.

Declaration of Conformity

- Quality starts with the right choice of raw materials. Only the best materials are used in our production. We pay total attention to ensuring the highest quality and efficiency levels. This is ensured by continuous quality approvals.

- All products perfectly match to each other and comply highest quality requirements. System solutions with highest operational safety and efficiency can be achieved at any time.

- All process filters are made of inert materials, without adhesives, additives or surface active components.

- To comply with the stringent regulations of the FDA for contact with food the ultrafilter plastic filters have passed the toxicological tests according to USP Class VI and are biologically inert.

- All ultrafilter sterile filter are integrity tested to ensure highest operational safety and continously high quality.

P-EG stainless steel housing
for sterile filtration of gases

ultrafilter P-EG

- The P-EG stainless steel housing was developped for purification of compressed air an other technical gases.

- With the optimized construction they offer low differential pressure at high flow rates.

Features and advantages

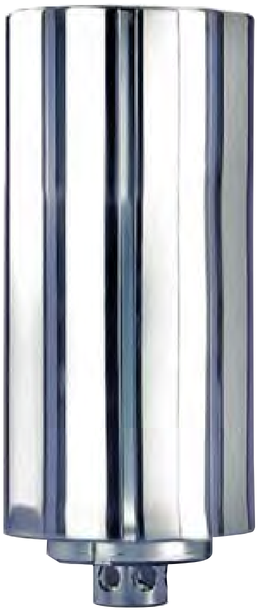
- 18 different sizes for operating volumes from 60 to 23.040 Nm³/h related to 7 bar.
- Complies to the requirements of the European directive 97/23/EG for pressure vessels.
- Plug connection guarantees that the elements remain safely fixed at all times.
- Different element sizes can be installed due to the modular design.

Applications

- Chemical & pharmaceutical Industry
- Aseptic packing
- Biotechnology
- Cosmetics Industry
- Breweries
- Dairies
- Food and beverages
- Water treatment systems

type P-EG	volume flow at 7 bar m³/h		connect.	filter element		dimension in mm					weight in kg
	nom	max		size	qty.	A	B	C	D	E	
0006	60	90	R ¹/₄"	03/10	1	215	105	70	55	90	1,7
0009	90	120	R ³/₈"	04/10	1	243	105	70	55	120	1,9
0012	120	180	R ¹/₂"	04/20	1	243	108	70	55	120	1,9
0018	180	270	R ³/₄"	05/20	1	266	125	70	55	150	2,0
0027	270	360	R 1"	05/25	1	293	125	85	74	150	2,6
0036	360	480	R 1 ¹/₄"	07/25	1	344	140	85	74	200	3,0
0048	480	720	R 1 ¹/₂"	07/30	1	386	170	104	94	200	4,3
0072	720	1080	R 2"	10/30	1	460	170	104	94	280	4,8
0108	1080	1440	R 2"	15/30	1	587	170	104	94	450	5,3
0144	1440	1920	R 2 ¹/₂"	20/30	1	732	216	129	106	580	9,0
0192	1920	2880	R 3"	30/30	1	987	216	129	106	850	10,8
0288	2880	4320	R 3"	30/50	1	1026	240	154	119	850	16,2
0432	4320	5760	DN 100	20/30	3	1090	410	219,1	200	580	43
0576	5760	7680	DN 100	30/30	3	1350	410	219,1	200	850	44
0768	7680	11520	DN 150	30/30	4	1410	480	273	240	850	70
1152	11520	15360	DN 150	30/30	6	1460	540	323,9	250	850	80
1536	15360	19200	DN 200	30/30	8	1600	660	406,4	300	850	135
1920	19200	23040	DN 200	30/30	10	1600	660	406,4	300	850	135

P-BE stainless steel vent filter
for aeration of storage tanks



ultrafilter P-BE

- P-BE filter are used to ensure 100 % sterility in the storage of pharmaceutical products, chemicals, food or of fermenters.

- The two-part housing is user-friendly designed and has a splash protection to prevent liquids come in contact with the filter media.

Features and advantages

- 12 different sizes for operating volumes from 3 to 1980 Nm^3/h related to 1 bar.
- Complies to the requirements of the European directive 97/23/EG for pressure vessels.
- Different element sizes can be used due to the modular design. Apart from sterile filters, polypropylene or Teflon* membrane filters can be used.

Applications

- Chemical & pharmaceutical Industry
- Biotechnology
- Cosmetics Industry
- Breweries
- Dairies
- Food and beverages
- Fermentation processes

type P-BE	volume flow in m³/h at		connect.	filter element		dimensions in mm		weight in kg
	Δp20 mbar	Δp40 mbar		size	qty.	height	ø	
0006	4,5	9	DN 32	03/10	1	110	85	1,5
0027	12	24	DN 40	05/25	1	168	104	2,2
0032	17	35	DN 50	05/30	1	186	114	2,4
0072	35	70	DN 50	10/30	1	312	114	3,3
0144	70	140	DN 80	20/30	1	550	154	9,2
0192	105	210	DN 80	30/30	1	805	154	11,6
0432	210	420	DN 100	20/30	3	670	219	43
0576	315	630	DN 100	30/30	3	925	219	44
0768	420	840	DN 150	30/30	4	950	273	70
1152	630	1260	DN 150	30/30	6	950	324	80
1536	840	1680	DN 200	30/30	8	960	406	135
1920	1050	2010	DN 200	30/30	10	960	406	135

PG-EG stainless steel housing
for gas filtration in sanitary quality

ultrafilter PG-EG

- The PG-EG stainless steel housing was developped for purification of compressed air and other technical gases in pharmcaceutical, biotechnology or chemical industry.

- PG-EG housings are first choice in critical applications in sterile filtration.

Features and advantages

- 14 different sizes for operating volumes from 7,5 to 2.700 Nm³/h related to 7 bar.
- Complies to the requirements of the European directive 97/23/EG for pressure vessels.
- Plug connection guarantees that the elements remain safely fixed at all times.
- Different element sizes can be installed due to the modular design.
- Condensate drain and de-aeration are equipped with pharma valves

Applications

- Chemical & pharmaceutical Industry
- Biotechnology
- Breweries
- Food and beverages
- Water treatment systems
- Fermentation processes

type PG-EG	volume flow at 1 bar m³/h	connect.	filter element		dimensions in mm					weight in kg
	nom		size	qty.	A	B	C	D	E	
0006	7,5	DN 10	03/10	1	260	120	70	98	90	1,2
0018	22,5	DN 15	05/20	1	315	120	70	98	150	1,4
0032	45	DN 25	05/30	1	360	160	114,3	136	150	2,8
0048	60	DN 32	07/30	1	410	160	114,3	126	200	3,1
0072	90	DN 40	10/30	1	485	160	114,3	117	280	3,5
0108	135	DN 50	15/30	1	610	160	114,3	125	450	4,0
0144	180	DN 65	20/30	1	820	185	129	150	580	7,0
0192	270	DN 80	30/30	1	1080	185	129	150	850	8,8
0432	540	DN 100	20/30	3	1090	410	219,1	200	580	43
0576	810	DN 100	30/30	3	1350	410	219,1	200	850	44
0768	1080	DN 150	30/30	4	1410	480	273	240	850	70
1152	1620	DN 150	30/30	6	1460	540	323,9	250	850	80
1536	2160	DN 200	30/30	8	1600	660	406,4	300	850	135
1920	2700	DN 200	30/30	10	1600	660	406,4	300	850	135

PF-EG stainless steel housing
for filtration of liquids

ultrafilter PF-EG

- The PF-EG stainless steel housing was developped for purification of liquids in pharmaceutical, biochemical and chemical processes, as well as for beverages.

- PF-EG housings are first choice in critical applications in sterile filtration.

Features and advantages

- 11 different sizes for operating volumes from 3 to 600 l/min.
- Complies to the requirements of the European directive 97/23/EG for pressure vessels.
- Bajonet-connection guarantees that the elements remain safely fixed at all times.
- Different element sizes can be installed due to the modular design.
- DN 40 clamp connection at housing top

Applications

- Chemical & pharmaceutical Industry
- Biotechnology
- Breweries
- Dairies
- food and beverages
- Water treatment systems
- Fermentation processes

type PF-EG	volume flow in l/min.	connect.	filter element		dimensions in mm		weight in kg
			size	qty.	height	ø	
0003	3	DN 10	03/10	1	280	180	1,4
0012	12	DN 25	5/3 Code 7	1	375	250	3,9
0025	25	DN 25	10/3 Code 7	1	505	250	4,8
0050	50	DN 25	20/3 Code 7	1	765	250	6,1
0075	75	DN 25	30/3 Code 7	1	1025	250	7,4
0080	75	DN 40	10/3 Code 7	3	690	330	14,1
0150	150	DN 40	20/3 Code 7	3	935	330	16,5
0225	225	DN 40	30/3 Code 7	3	1205	330	19,6
0250	250	DN 50	20/3 Code 7	5	965	400	20,6
0375	375	DN 50	30/3 Code 7	5	1215	400	23,6
0400	400	DN 65	20/3 Code 7	8	985	500	33,6
0600	600	DN 65	30/3 Code 7	8	1235	500	37,9

Clean Steam Centrifugal Separator - S-10HV

(Horizontal inlet – Vertical outlet)

DESCRIPTION
When wet steam is used in sterilization, moisture in suspension reduces the heat transfer efficiency and the validity of the sterilization process can be compromised.
S-10HV series centrifugal separators remove moisture from steam pipelines. Steam passing through the separator and as a result of centrifugal forces, impact and swirling effects, separate the particles with a heavier specific gravity, such as water droplets and moisture in suspension.
The condensate collected at the bottom of the separator, must be automatically drained by a suitable steam trap.

MAIN FEATURES
316L stainless steel construction
No moving parts.
Self draining design

STANDARD SURFACE FINISH

Internal parts: 0,5 microns Ra
External : Satin bead blast finish – 1,6 microns Ra
Mechanical polished as option

OPTIONS: Different kind of connections and dimensions

USE: Steam, compressed air and other gases (Group 2).

AVAILABLE MODELS: S10HV

SIZES: DN1/2”, 3/4”,1”, 11/2” and 2”

PIPE CONNECTIONS: Clamped ends ASME BPE
Other sanitary clamp or tube weld connections available on request.

INSTALLATION: Always with the condensate discharge pointing downwards.

HOW TO SELECT: Generally, in an existing plant it is advisable to fit a separator with the same size of the pipe line. Pressure drop is normally negligible. For approximate pressure drop calculation please consult.

LIMITING CONDITIONS		
Rating	Press. bar	Temp. ºC
PN10	10	50
	8 *	175
	7,4	200

*PMO-Max.operating pressure for saturated steam.
Minimum operating temp.: -10ºC.
Design code: AD-Merkblatt

CE MARKING - GROUP 2 GASES CAT.		
RATING	SIZE	CAT.
PN10	DN1/2" to DN2"	SEP

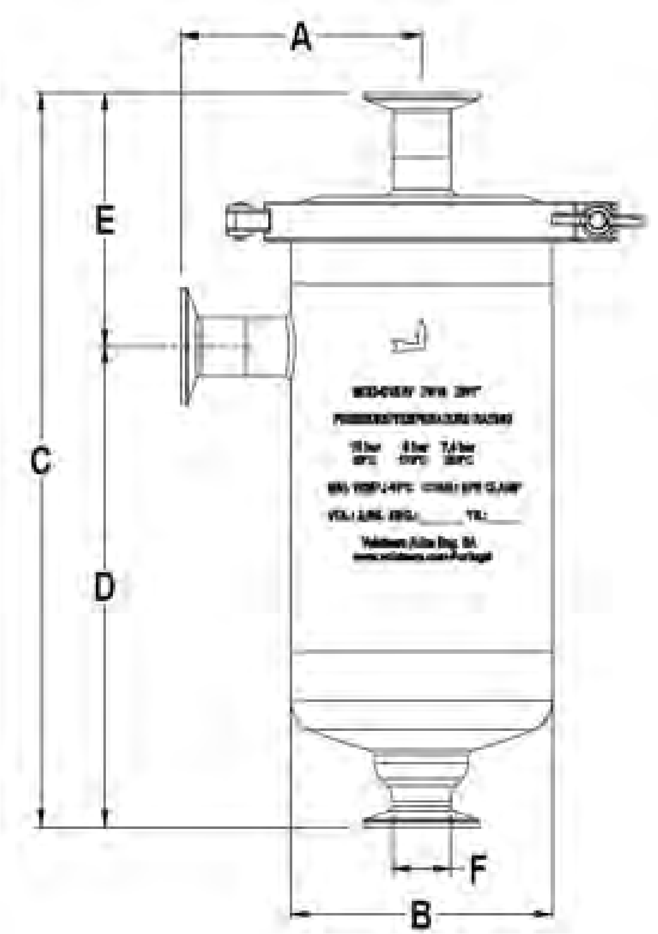
CE Marking
This product has been designed for use on water, steam, air and other gases which are in Group 2 of the PED- European Pressure Equipment Directive 97/23/EC and it complies with those requirements.
The product carries the CE mark when falling in category 1 and above.

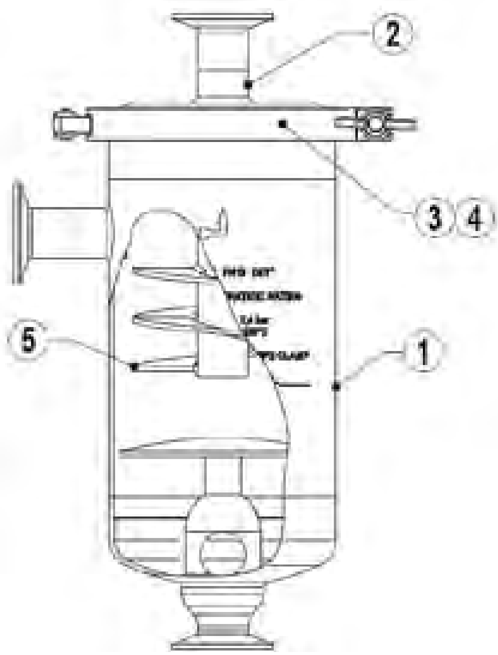
Clean Steam Centrifugal Separator - S-10HV

(Horizontal inlet – Vertical outlet)

APPROXIMATE DIMENSIONS (mm)								
SIZE DN	*A*	*B*	*C*	*D*	*E*	*F*	*VOL. dm3*	*WGT Kg*
1/2"	105	114	307	195	112	1"	2,84	3,8
3/4"	105	114	307	195	112	1"	2,87	3,9
1"	105	114	320	210	112	1"	2,9	4,2
11/2"	120	141	400	260	140	1"	5,82	7,25
2"	120	141	400	260	140	1"	5,93	7,28

Consult factory for certified dimensions. Dimensions subject to change without notice.





MATERIALS		
POS.	*DESIGNATION*	*MATERIAL*
1	Body	AISI 316L / 1.4404
2	Cover	AISI 316L / 1.4404
3	*Clamp	AISI 316L / 1.4404
4	*Seal	VITON
5	Internals	AISI 316L / 1.4404

* Available spare parts.

EN10204 3.1 certificate available if requested along with the order.

Remarks: FDA/USP Class VI seals certificate on request.

All separators have a serial number. In case of non-standard separator this number must be supplied if spare parts are ordered.

Heating Coils

Why Leaky Coils Are a Losing Proposition

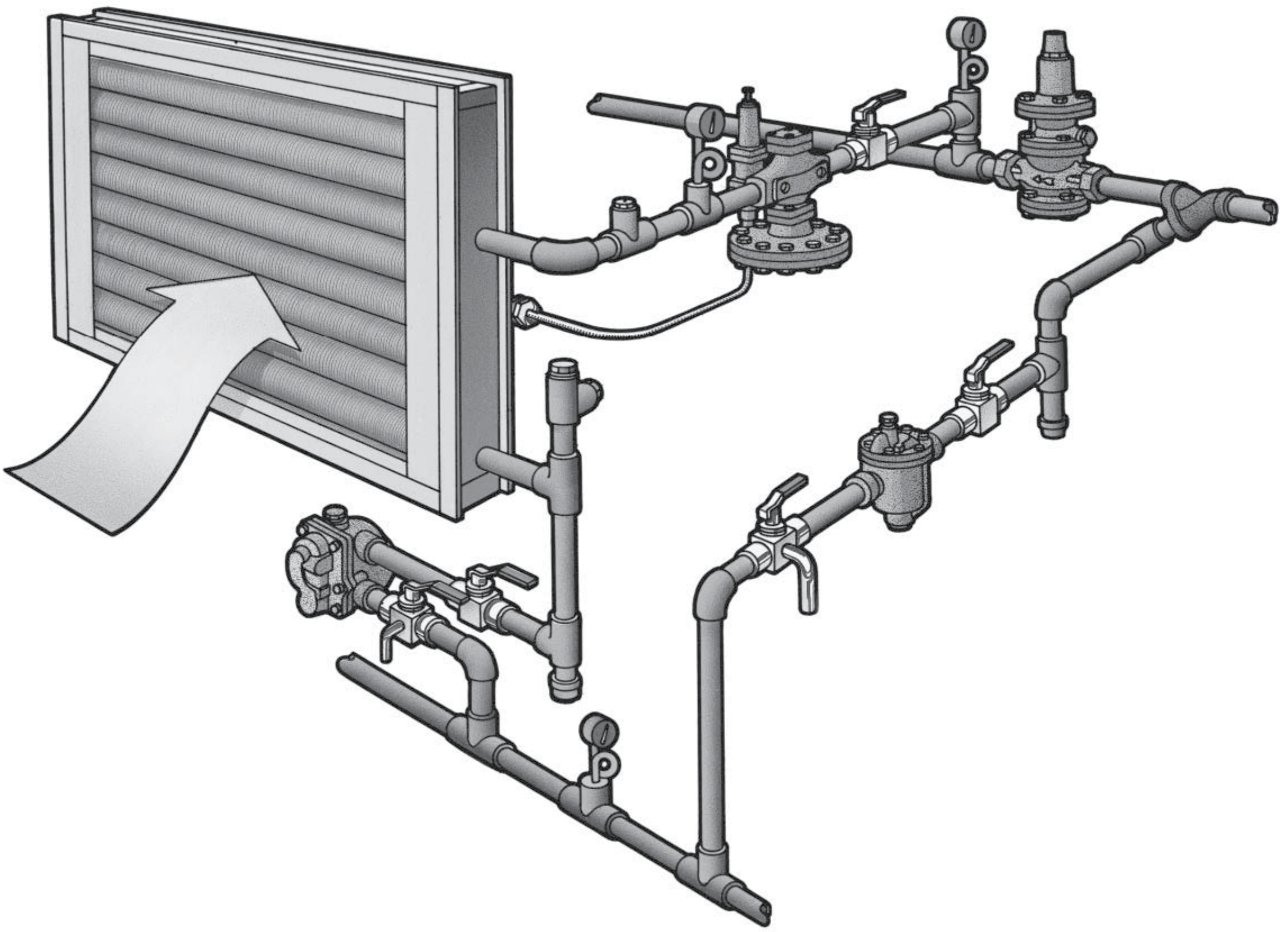
Leaky coils can be the beginning of the end for efficient heat transfer. Although coils may fail for a variety of reasons, mechanical failure and corrosion are the culprits in the majority of cases. When coils corrode, unwanted moisture and contaminants may foul the air stream or exhaust gases. And a steam leak from a badly corroded coil simply blows precious energy off into the atmosphere.

External corrosion. Contaminants in the airstream cause external corrosion. Dirt buildup intensifies corrosive action by trapping contaminants in concentrated pockets. And it's accelerated when dirt becomes strong airborne mist. Factors such as inappropriate fin pitch, fabricating techniques and material selection may also fuel external corrosion.

Internal corrosion. Retention of contaminated condensate or inadequate venting of non-condensable gases are major causes of internal corrosion. When CO_2 gas dissolves in condensate that has cooled below steam temperature, it forms highly corrosive carbonic acid. Likewise, oxygen left to stagnate in the system fosters corrosive action by pitting iron and steel surfaces. Joining pipes/tubes in headers of dissimilar materials may spawn galvanic action. Internal stresses due to improper welding may also hasten corrosion damage.

Armstrong to the Rescue

Armstrong's help in coil selection and design is one of the best defenses against external corrosion. We offer a wide selection of fin pitches to help combat dirt buildup. What's more, sturdy fins lend extra strength to withstand high-pressure cleaning without damage or distortion. As a defense against non-environmental factors, Armstrong fabricates coils in a full range of metals and alloys. You may also specify special coatings to increase external corrosion resistance.



Why Leaky Coils Are a Losing Proposition

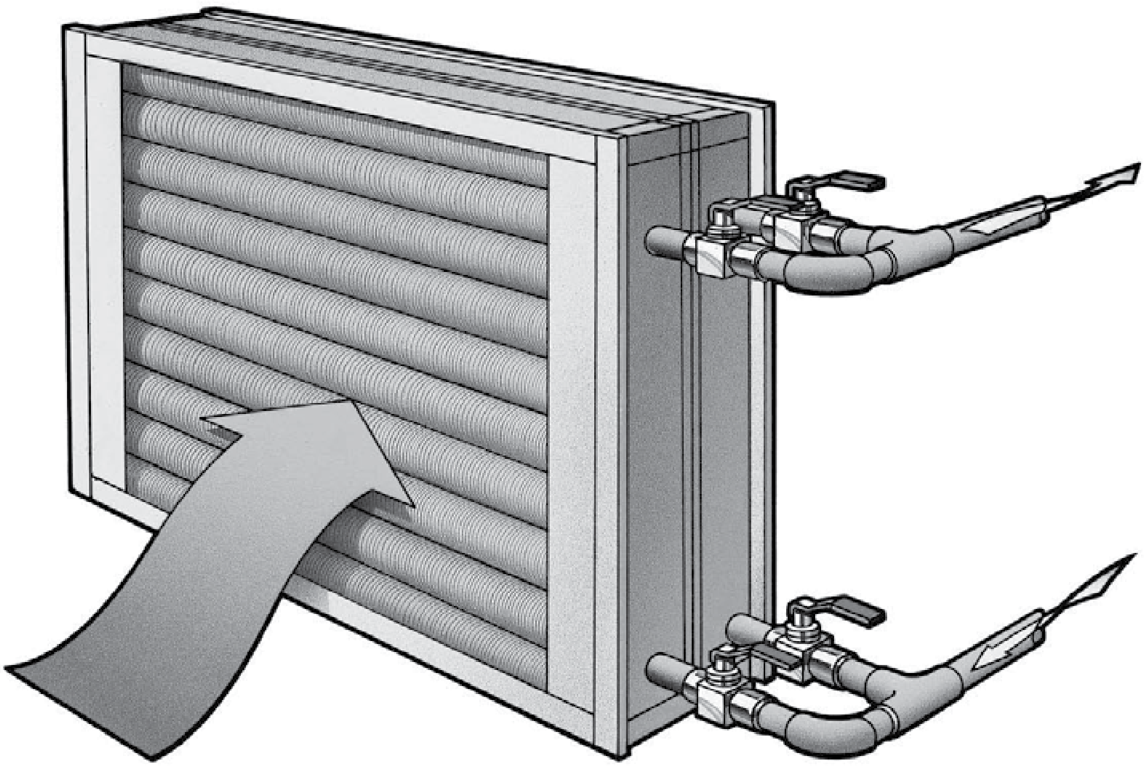
Proper trapping and venting—a specialty of your Armstrong Representative—is where defense against internal corrosion begins. Armstrong reps are steam specialists with more than 75 years of experience in properly sizing, locating and piping steam traps, strainers, vents and related equipment. That's why only Armstrong gives you quality steam coils—plus the installation and trapping help you need to make them work in your total system.

A System to Make Yours More Efficient

Today, the Armstrong "system" merges coil-building experience, practical knowledge and technical know-how from years of trapping coil installations. The result: coils that survive the rigors of high pressures, high temperatures and corrosive conditions.

For example, Armstrong fabricates standard steel heating coils from 1" OD 12 ga ERW Tube (.109" wall) helically wound with 0.024" thick steel fins at varying fin pitches. Each coil is tested during construction, and the completed unit is again tested hydrostatically to not less than 1.3 times the design pressure with a standard testing pressure at 450 psig for steel or stainless steel cores.

It's this simple: It takes one system to improve another. Exactly how the Armstrong system of product and service carefully matches coils to your specs and applications is the subject of the following pages.



Material Selection for Tubes, Headers and Connections

The choice of tube material depends upon several important factors:
- The corrosive quality of the steam or liquid medium
- The ability to pipe, trap and vent steam coils effectively
- The size and service requirements of the installation
- The external corrosion to which the coils are likely to be subjected

Generally speaking, the heat transfer characteristics of the tube material are of little consequence. The table on the next page illustrates the relative effect of tube materials on overall heat transfer. Because the fin area constitutes the vast majority of the heat transfer surface, it is the most important factor determining heat transfer effectiveness. Therefore, the choice of tube materials should be based on service requirements, not heat transfer efficiency.

Internal corrosion. The base material found in the 6000 Series coils is steel. The minimum wall thickness is .109" for steam coils and liquid coils, which affords both strength and corrosion resistance. All Armstrong coils are of monometallic design, which means that all wetted parts are made of the same materials. This precludes the likelihood of galvanic corrosion often experienced in coils made of dissimilar materials. For most applications, steel will provide very satisfactory service. In order to do this, however, steam coils must be carefully piped, trapped and vented to ensure good condensate and non-condensable gas evacuation.

The cross section of the coil on the right shows how internal corrosion caused by improper piping, trapping and venting may destroy coils from the inside out.

There are many cases where the steam cannot be conditioned enough to be non-corrosive or it is not possible to pipe, trap and vent the coils properly. For those areas, Armstrong recommends stainless steel wetted parts. Choosing which of these is most appropriate depends on the degree and type of problem as well as the steam pressure involved.

External corrosion. In the case of external corrosion, factors concerning the corrosiveness of the airstream enter into the decision. The choice of steel or stainless steel for the wetted parts depends on the compatibility of those materials with the contaminants in the airstream. In addition to the base materials available, Armstrong also offers hot dipped galvanizing, epoxy dip or baked phenolic coatings. These are frequently used when only external corrosion is a consideration.

Service requirements. These may be as important as the above considerations. Coil failures manifest themselves in many forms, but the most prevalent is failure of the tube-to-header joints. This failure occurs as a result of coil design defects, insufficient material at the tube-to-header joints or because of the method of connecting the tubes to the headers.

Armstrong 6000 Series coils are designed to accommodate the service requirements of the particular installation. They are built with enough material at the tube-to-header joints to make them strong. When differential expansion between tubes in steam coils is likely to over-stress the joints, centifeed type coils are recommended. Finally, Armstrong coils are always of welded construction, providing the best method of connecting the two parts together.

Computer-controlled equipment like this simplifies the process of drilling coil headers.

Tube Materials

The best combination of coil materials is the one that delivers maximum heat transfer **and** service life. Tubes, regardless of material, contribute little to heat transfer in extended-surface coils. It is the **fins**, fully exposed to the airstream, that provide the greatest contribution to heat transfer. Therefore, choose tube material on the basis of application.

Relative Heat Transfer Capacities of Identical Coils Using Different Tube Materials	
Tube Material	**Relative HT Capacity**
Copper	1.00
Aluminum	1.00
Steel	.98
Stainless Steel	.95

Material Selection for Fins

The heat transfer coil is essentially a tube on which fins are spirally wound or similarly attached. The fins produce an extended surface to improve heat transfer to or from air or other gases passing over the fins. The effective heat transfer of a coil is based on fin pitch (number of fins per inch), fin height, fin material and method of attachment.

Copper fins offer the best heat transfer, but aluminum fins provide the best overall value. Compared to aluminum fins, steel fins reduce heat transfer. Compared to aluminum and steel, stainless steel fins reduce heat transfer significantly. Fins may be of aluminum, copper, steel, or stainless steel, depending on contaminants, operating conditions and economic considerations.

The selection of fin materials should be based upon several considerations:
- The heat transfer characteristic desired
- The compatibility of the material with the air stream
- The amount and type of particulate matter in the air stream
- The frequency and aggressiveness of coil cleaning

The table below illustrates the heat transfer effectiveness of various fin materials with Armstrong coils. Note that these relative heat transfer capacities are for a specific set of conditions. The factors will vary with different conditions.

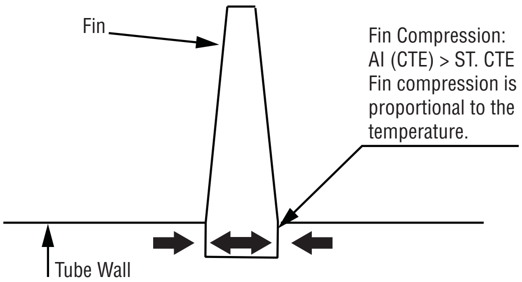
The fin/tube combinations available are listed on page 321.

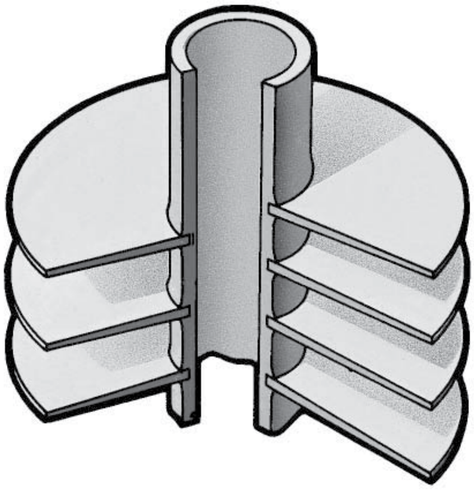
Relative Heat Transfer Capacities of Armstrong Coils With Tubes and Fins of Various Materials*		
Tube Material	**Fin Material**	**Relative HT Capacity**
Steel	Copper yfin	Ke 1.05
Steel	Aluminum yfin	Ke 1.00
Stainless Steel	Aluminum Keyfin	.94
Steel	Steel L Fin	.92
Stainless Steel	Stainless Steel L Fin	.58

*At 800 ft/min velocity, 7 fins/inch and 300°F steam temperature. Will vary at other conditions.

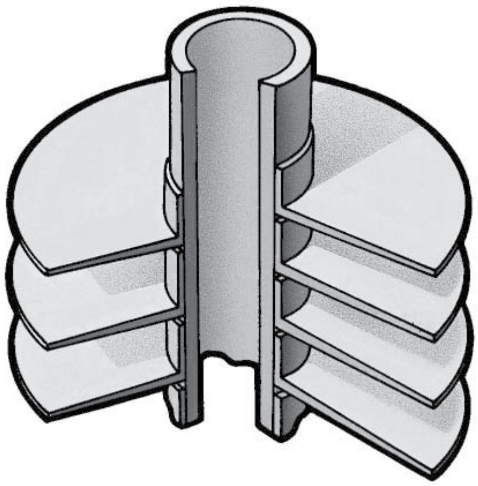
Fin Types

Keyfin
The keyfin is the standard design for Armstrong's most popular coils. Keyfin coils are manufactured by forming a helical groove in the tube surface, winding the fin into the groove and peening the displaced metal from the groove against the fin. This means a tight fit between the fin and the tube, providing for efficient operation over wide temperature ranges. Keyfin is the superior design for dissimilar fin and tube materials.

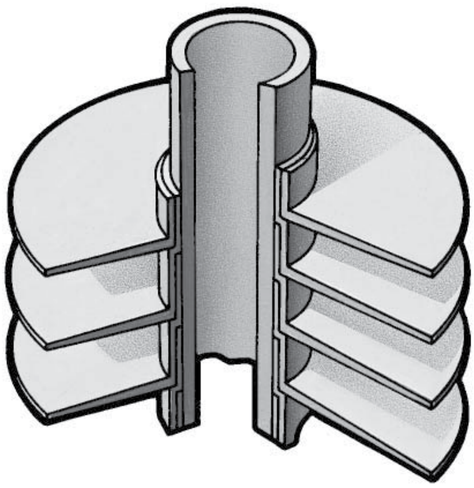




L Fin
The L fin has a "foot" at its base and is tension wound on knurled tube material. The L-shaped base provides a large contact area between the tube and the fin, ensuring effective, long-lasting heat transfer. The L fin is recommended when tubes and fins are of the same material.



Overlap L Fin
The overlap L fin is simply an L fin with an extended base. Each fin overlaps the foot of the previous fin, completely covering the tube surface. The overlap technique makes it possible to create a completely aluminumized coil for applications where exposed steel would be vulnerable to corrosion.



Why Settle for What's "Available" When You Can Specify Exactly What You Need?

Armstrong manufactures heavy-duty industrial coils in a wide range of sizes and materials to meet virtually any application demand. Dimensionally duplicated to fit your exact requirements, Armstrong coils are what you need. Whether it's off the shelf or off the wall. Other materials will be considered upon request.

Construction Features		
Tubes/Pipes		
Carbon Steel Tubes	Standard	12 ga A-214 ERW
	Optional	10 ga A-214 ERW
		12 ga A-179 seamless
		10 ga A-179 seamless
Carbon Steel Pipes	Optional	Sch 80 seamless; A-106 Gr 'B'
Stainless Steel Tubes	Standard	14 ga (1" OD) 12 ga (1-1/2" OD) A-249 type 304L
	Optional	14 ga (1" OD) 12 ga (1-1/2" OD) A-249 type 316L
Fins		
Steel	Standard	0.024" thick on 3/4" NPS pipes
		0.024" thick on 1" OD tubes
		0.036" thick on 1-1/2" OD tubes & 1" NPS & larger pipe
Aluminum	Standard	0.020" thick on all tube sizes
		0.016" thick on 1" OD
	Optional	0.030" heavy keyfin 1" & 1-1/2" OD steel and stainless steel tube
Stainless Steel		0.020" thick type 304 & 316 on all sizes
Copper		0.016" thick on all sizes
Connections		
Steel		Sch 80 (screwed), Sch 40 (flanged)
Stainless Steel		Sch 40 (screwed), Sch 10 (flanged)
Headers		
All coils have headers of the same material as tubing and are of welded construction.		
Casing		
Galvanized Steel	Standard	Minimum 12 ga galvanized for depth 7-1/2" and over
		Minimum 14 ga galvanized for depth under 7-1/2"
Stainless Steel	Optional	14 ga type 304 & 316 for all depths
Aluminum	Optional	12 ga for all depths
Other gauge material available on request. All casings have drilled flanges for duct mounting unless specified otherwise.		
Design Pressure		
Standard design pressure for steel coils is 300 psig @ 650°F, stainless steel coils 300 psig @ 500°F. Hot oil coil: 250 psig @ 750°F. Higher pressure and/or temperature construction is available on request. -20°F MDMT, lower MDMT available on request.		
Testing		
All coils are tested hydrostatically to at least 1.3 times the working pressure with a standard testing pressure at 450 psig on steel & stainless steel steam coils.		
Options		
Steel tube with steel fin coils can be supplied hot dip galvanized. Steel/steel and steel/aluminum coils can be supplied with baked phenolic or epoxy coatings. Coils are available with ASME Section VIII, Division I, "U" stamps or CRN approval.		

Model Number Selection Series 6000 Coils

MODEL NUMBER

S H 2 – A 09 – Q 08 – 30 x 72 x 6 –

TYPE OF COIL

L = Liquid
S = Standard
C = Centifeed
T = Tandem, Opposite-End Conns
P = Tandem, Same-End Conns

PIPE/TUBE/AIRFLOW ORIENTATION

H = Horiz. Tubes/Horiz. Air
V = Vert. Tubes/Horiz. Air
D = Horiz. Tubes/Vert. Down Air
U = Horiz. Tubes/Vert. Up Air

ROWS DEEP IN DIRECTION OF AIRFLOW

FIN TYPE AND METALLURGY

A = Aluminum Keyfin (.020")
B = Aluminum Heavy Keyfin (.030")
D = Aluminum G Fin (.020")
E = Aluminum Overlap L Fin (.020")
F = Copper Keyfin (.016")
G = Steel L Fin (.024") on 3/4" NPS Pipe and 1" OD Tube (.036") on 1-1/2" OD Tube and 1" Pipe
H = Steel G Fin (.024")
J = 304 Stainless Steel L Fin (.020")
K = 316 Stainless Steel L Fin (.020")
U = Aluminum Keyfin (0.016")

FINS PER INCH (FPI)

PIPE/TUBE TYPE AND METALLURGY

N = Sch 40 Seamless Steel Pipe (SA-106 Gr B)
P = Sch 80 Seamless Steel Pipe (A-106 Gr B)
Q = 12 ga Steel Tube (A-214 ERW)
R = 10 ga Steel Tube (A-214 ERW)
S = 12 ga Steel Tube (A-179 SMLS)
T = 10 ga Steel Tube (A-179 SMLS)
U = Sch 10 304L SS Pipe (A-312)
V = Sch 10 316L SS Pipe (CA-312)
W= 14 ga 304L SS Tube (A-249)
X = 12 ga 304L SS Tube (A-249)
Y = 14 ga 316L SS Tube (A-249)
Z = 12 ga 316L SS Tube (A-249)

PIPE NOMINAL BORE SIZE OR TUBE OD IN ONE-EIGHTHS OF AN INCH

CASING WIDTH (INCHES)

CASING LENGTH (INCHES)

CASING DEPTH (INCHES)

LIQUID COILS=NUMBER OF PASSES TH & PH TANDEM STEAM COILS= (L) OR (R) HAND OF COIL*

SPECIFY:

Number, Size and Type of Connections

Also call out non-standard items such as:
- Header Inside or Outside of Casing
- Special Casing Flange Width and Drilling
- Airtight Casing
- Mounting Plate (removable type)
- Coatings, etc.
- Number of Inlets
- Connection Location
- Fluid Circuiting (for Liquid Coil)

*Hand of coil is determined by the position of either the condensate connection or the leaving liquid connection when facing the coil with the airflow to your back.

Longer Life in the Harshest Environments

When it comes to long life under tough industrial conditions, Armstrong is all you need to know about unit heaters. Even in the most severe environments, where coil leaks and corrosion are costly problems, Armstrong coils maintain high efficiency and output.

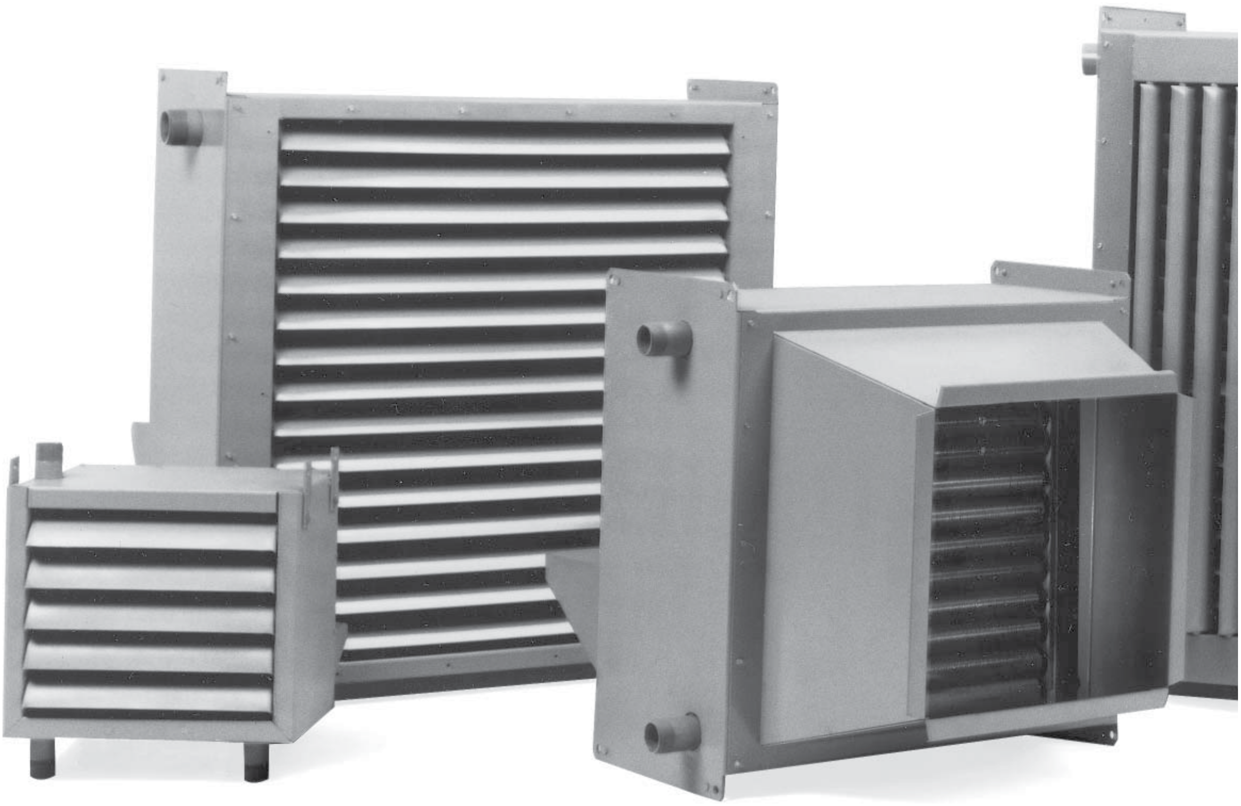
Armstrong: Why and How

The ability to maintain heat transfer efficiency and resist corrosion—both internally and externally—is why Armstrong unit heaters are uniquely dependable. How we construct them is your assurance of lasting performance, even in severe operating environments.

Consider these measurable benefits at work in your facility:

- **Heavy gauge enclosures:** Fabricated from 14-gauge steel for protection and durability.
- **Corrosion-resistant heating cores:** Cores are fabricated in a full range of materials, including steel, stainless steel, copper and others. Special coatings may be applied to increase resistance to external corrosion. Cores feature all-welded construction for durability and ease of repair. Cores can be steam or liquid compatible and can be used for steam, hot water or glycol heating mediums.
- **Standard NEMA frame TEFC ball bearing motors:** Supplied on all sizes, these heavy-duty motors are totally enclosed to lock out dirt for smooth performance. Quick access to the motor permits easy replacement.
- Thick fins and tubes: Constructed of high-strength, corrosion-resistant materials. Fins are available in a wide variety of thicknesses and pitches to withstand high pressure cleaning without damage or distortion.
- **Customizing to your needs:** Fans range in size from 10" to 48", and the wide selection of component materials means long, trouble-free service life.

Lightweight coils don't stand a chance in harsh environments. Armstrong coils survive because they're built as tough as your meanest application.

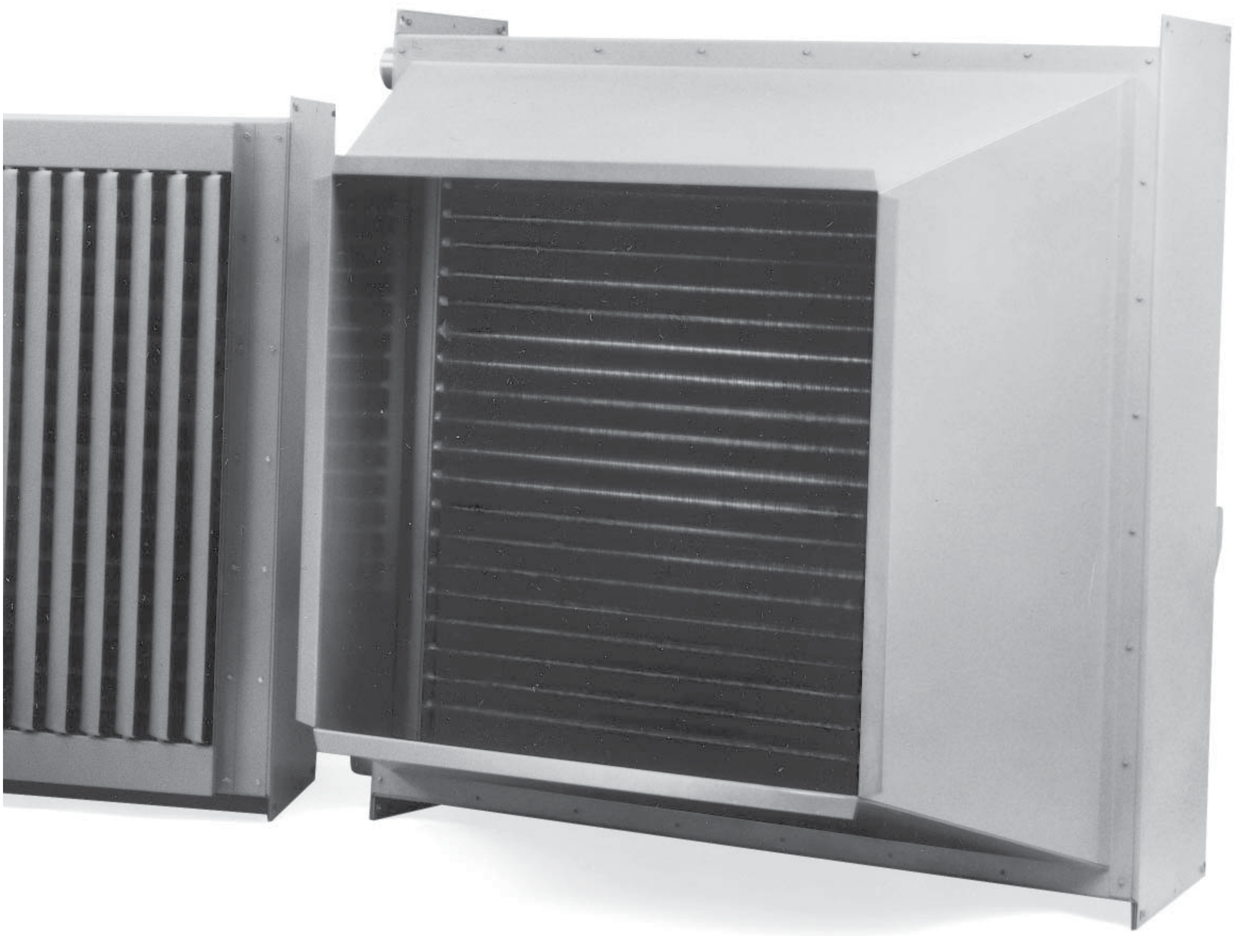


Your Steam Specialist

The first step toward ensuring trouble-free operation is proper unit selection. Your Armstrong Representative will help you select the right unit heater or door heater for any given application.

Our expertise as a manufacturer of unit heaters and door heaters is backed by over 70 years' experience in steam trapping, venting and condensate removal. To you, that means a superior product and an Armstrong Representative who understands how to make it work in your steam system.

If you're losing heat transfer due to deteriorating coils, contact your Armstrong Representative for a complete application analysis. You'll receive top-quality, reliable products from experts who know how to maximize your steam system efficiency.

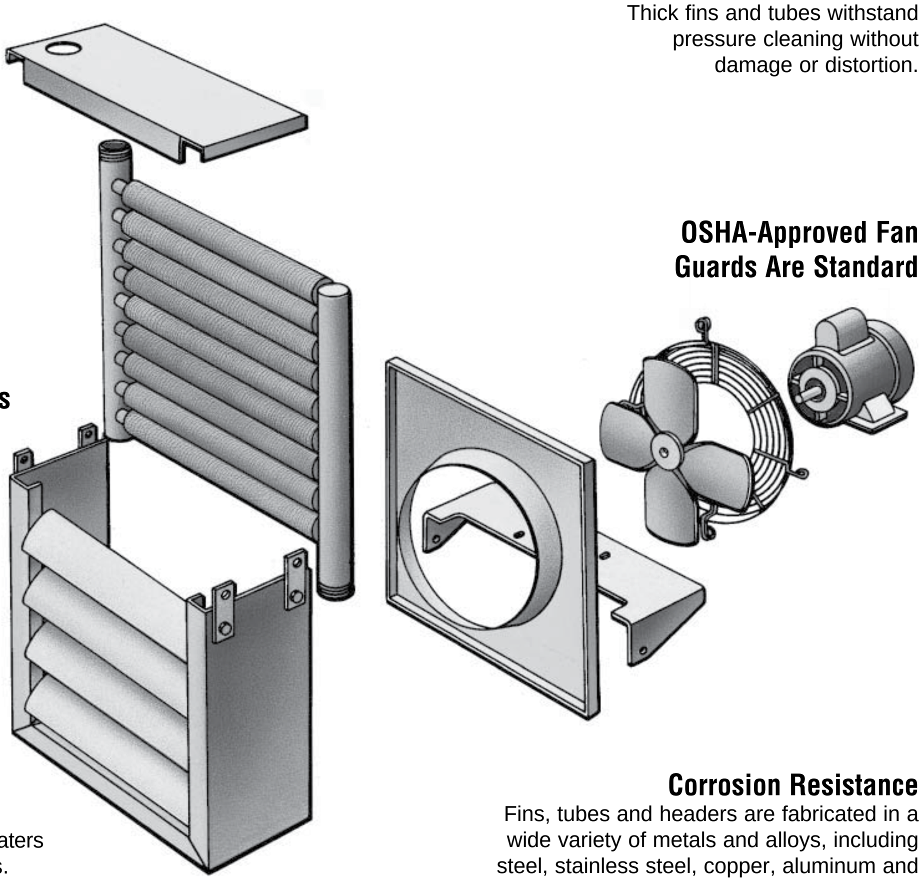


Compare the Benefits You Can't See

Many of the best reasons to insist on Armstrong unit heaters and door heaters are ones you never even see. Components like motors, bearings, tubes, enclosures and fins are built heavy-duty to ensure lasting performance.

Armstrong's options for fin material, pitch, height and type, for example, help explain why our heating cores last longer and perform with greater efficiency. These factors all have a bearing on heat transfer. Knowing how to balance these and other factors is the key to a cost-effective solution. That knowledge is perhaps the most important of Armstrong's many hidden benefits.

10"–20" Size



Sturdy Enclosures
Heavy-duty enclosures of 14-gauge steel provide a rigid structure. Aluminum, stainless steel and specially coated enclosures are also available as options.

Standard NEMA Frame TEFC Ball Bearing Motors
Supplied on all sizes, this rugged motor is built to last in tough industrial environments. If replacement is ever needed, motors are readily available from industrial supply dealers, and are easy to install.

Application Versatility
Because of their heavy-duty construction Armstrong unit heaters are used in many applications. These include product coolers, lube oil coolers, flash steam condensers, hot oil heaters and many others.

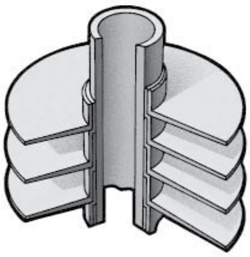
Cost-Reducing Strength
Thick fins and tubes withstand pressure cleaning without damage or distortion.

OSHA-Approved Fan Guards Are Standard

Corrosion Resistance
Fins, tubes and headers are fabricated in a wide variety of metals and alloys, including steel, stainless steel, copper, aluminum and others. Tubes and headers are of the same material to enhance strength and reduce the chance of leakage due to galvanic corrosion.

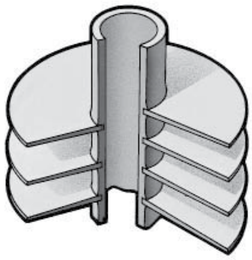
The L fin has a foot at its base and is tension wound on knurled tube material. The L-shaped base provides a large contact area between the tube and the fin, ensuring effective, long-lasting heat transfer. The L fin is recommended when tubes and fins are of the same material.

L Fin



The keyfin is manufactured by forming a helical groove in the tube surface, winding the fin into the groove and peening the displaced metal from the groove against the fin. This means a tight fit between the fin and the tube. The keyfin is the superior design for dissimilar tube and fin material.

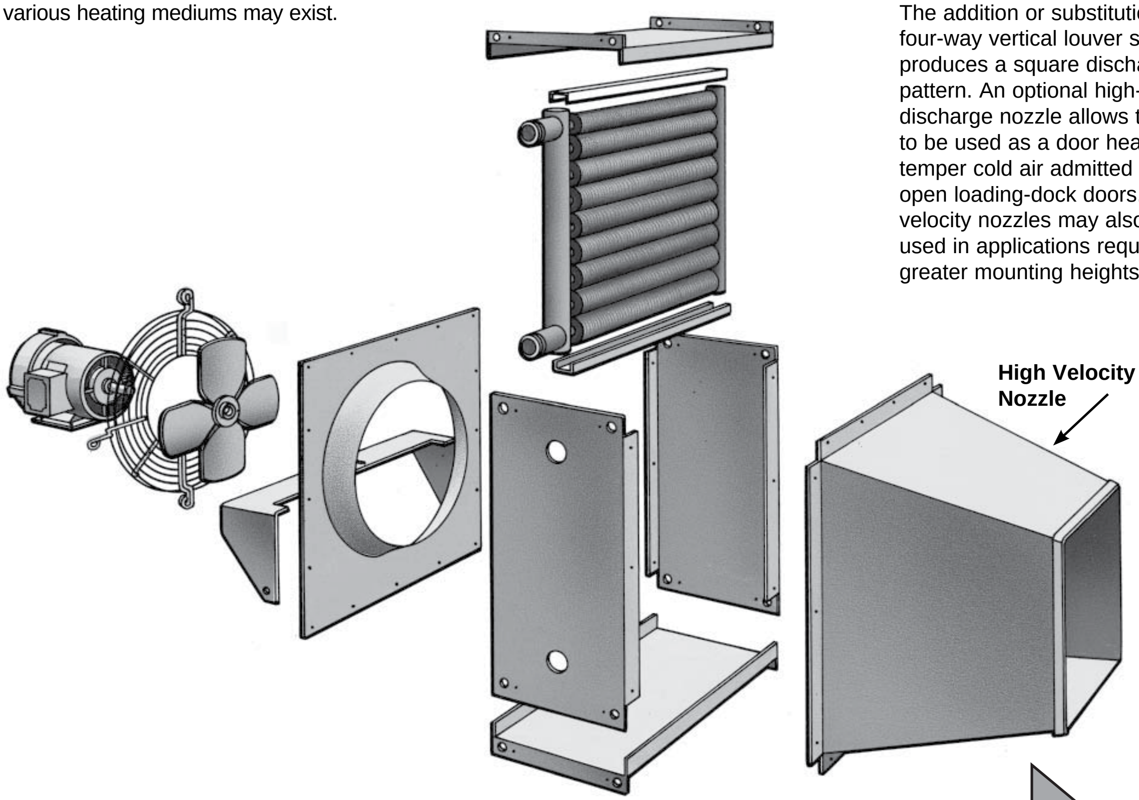
Keyfin



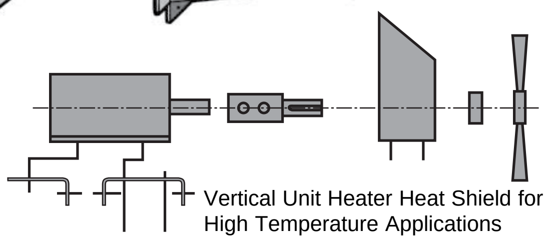
Steam or Liquid Compatible
Cores are available for steam or liquid, allowing units to be applied in different plant areas where various heating mediums may exist.

24"–48" Size

Mounting Flexibility
Basic units may be used in either horizontal or two-way vertical discharge configurations. The addition or substitution of a four-way vertical louver section produces a square discharge pattern. An optional high-velocity discharge nozzle allows the unit to be used as a door heater to temper cold air admitted through open loading-dock doors. High-velocity nozzles may also be used in applications requiring greater mounting heights.



Fan Size Flexibility
Armstrong unit heaters and door heaters are available in fan sizes ranging from 10" to 48".



Vertical Unit Heater Heat Shield for High Temperature Applications

Special purpose motor: 3b
(see page 375)

Model Number Selection

MODEL NUMBER

D A [ ] Q – 182 – HS – T 58

HOTBREATH TYPE

D = Dual (2 Fans)
See note 4 below.
F = Fixed
See note 5 below.

FIN TYPE

A = Aluminum Keyfin
B = Heavy Aluminum Keyfin
F = Copper Keyfin
G = Steel L Fin
J = 304 Stainless L Fin
K = 316 Stainless L Fin
P = Aluminum Platefin

NO. FINS/INCH (SEE NOTE 1)

TUBE MATERIAL

Q = 12 Ga. Steel Tube
R = 10 Ga. Steel Tube
W = 14 Ga. 304L SS Tube
(see note 3)
Y = 14 Ga. 316L Tube
(see note 3)

MODEL SIZE

Fan Diameter (in)

No. Rows of Tubes in Core

MOTOR ELECTRICAL CHARACTERISTICS (SEE NOTE 2)

*12 = 115-203/160
20 = 208/1/60
21 = 208/3/60
23 = 230-460/3/60
58 = 575/3/60

*Consult factory for single phase motor above 1hp. Additional charge could apply.

MOTOR TYPE

T = Totally Enclosed
Fab Cooled
X = Explosion Proof
M = Severe Duty
(3-phase motors only)

CORES

S = Steam Core
L = Liquid Core

DISCHARGE TYPE

H = 2 Way Louver
(Usually Hor. Discharge)
V = 4 Way Louver
(Usually Vert. Discharge)
N = High Velocity Nozzle
(Std. on Door Heaters)

Notes:

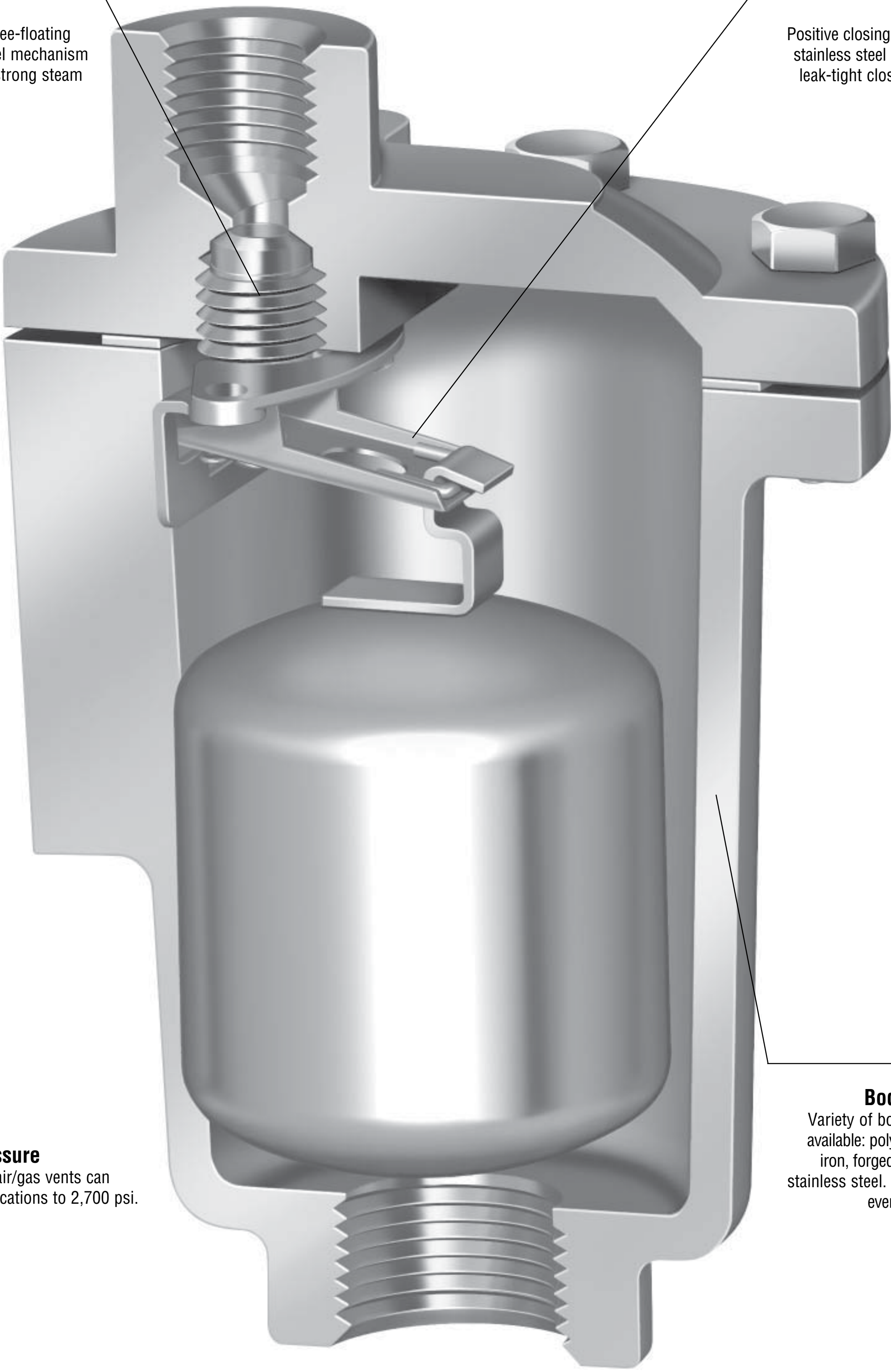
1. If the number of fins/inch is standard, the numbers between fin type and tube material will be missing.
2. If dual or triple voltage motors are supplied, the voltage shown on the model number will be the lowest specified. It is the responsibility of the installer to ensure that the motor is wired correctly in accordance with the motor manufacturer's instructions to preclude damage.
3. May be substituted with Sch. 10 SS pipe.
4. Add prefix 'D' for dual units (2 fans on wider core). For standard unit with one fan, the Hotbreath type will be missing.
5. F Models includes larger motors, cleanout lip, ports for sensors.

Air Vents &
Liquid Drainers

Air Vents

Proven
Same proven, free-floating all stainless steel mechanism as used in Armstrong steam traps.

Leak-tight
Positive closing, free-floating stainless steel lever ensures leak-tight closing under all conditions.



High pressure
Armstrong air/gas vents can handle applications to 2,700 psi.

Body options
Variety of body materials available: polysulfone, cast iron, forged steel and all stainless steel. A material for every application.

Selecting The Armstrong Air/Gas Vent

With the desired CFM capacity known, find the orifice size required from the table on this page. Then find the vent or vents with the correct orifice size on pages 447, 449, 451 or 459 that will operate at the required pressure with a liquid of the specific gravity being handled.

Example—Find a model number that will vent 52 cfm of air (including safety factor of 1.5 - 2.0) from a liquid with a specific gravity of 0.93 at 250 psi. Using the table below, follow the 250 psi line across to the number 60.9. Orifice size is 5/32". Now go to pages 447, 449, 451 or 459 checking the 5/32" orifice lines to locate a vent for 250 psi or higher with 0.90 gravity liquid.

NOTE: Since specific gravity falls between 0.95 and 0.90, use 0.90 gravity data. The model 3-AV on page 446 is the one to use.

$$V = \frac{W}{d} = \frac{2.05\ C\ A\ P_2 \times 60}{d}\sqrt{\frac{\left(\frac{P_1}{P_2}\right)^{.283}\left[\left(\frac{P_1}{P_2}\right)^{.283}-1\right]}{T}}$$

Where:

V	=	Volume flow rate, ft^3/min
W	=	Mass flow rate, lb/min
d	=	Density, 0.07494 lb/ft^3 at standard conditions
C	=	Flow coefficient = 0.65
A	=	Orifice area, in^2
P1	=	Upstream pressure, psia
P2	=	Pressure at throat orifice or downstream pressure = greater of 0.53 P1 or 14.7 psia
T	=	Upstream temperature = 530°R

Ref: Baumeister & Marks, Standard Handbook for Mechanical Engineers, 7th edition.

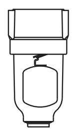
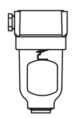
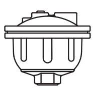
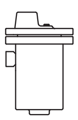
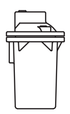
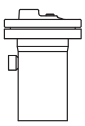
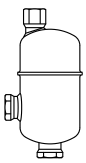
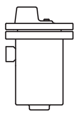
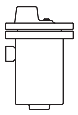
For Venting During Filling Only

If a vent is required only for getting rid of air when a system is started up, such as when starting up a deep well pump or filling an empty pipe, tank or other vessel, ability of the vent to open at operating pressure can be ignored. In these cases, a model number with a large orifice for fast venting may be selected, **but the vent will not open after air is expelled and the system reaches operating pressure.**

Discharge of Air Through an Orifice in Standard Cubic Feet per Minute at a Standard Atmospheric Pressure of 14.7 psia and 70°F

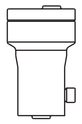
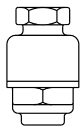
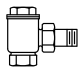
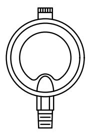
pressure psig	Orifice Diameter, inches																				
	1/16	5/64	3/32	#38	7/64	1/8	9/64	5/32	3/16	7/32	1/4	9/32	5/16	11/32	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1-1/6
5	0.64	1.00	1.44	1.54	1.96	2.56	3.24	4.00	5.76	7.84	10.2	13.0	16.0	19.4	23.0	31.4	41.0	51.9	64.0	92.2	125	185
6	0.70	1.09	1.57	1.69	2.14	2.80	3.54	4.37	6.30	8.57	11.2	14.2	17.5	21.2	25.2	34.3	44.8	56.7	70.0	101	137	202
7	0.75	1.18	1.70	1.82	2.31	3.02	3.82	4.71	6.78	9.23	12.1	15.3	18.8	22.8	27.1	36.9	48.2	61.1	75.4	109	148	218
9	0.85	1.33	1.91	2.05	2.61	3.40	4.31	5.32	7.66	10.4	13.6	17.2	21.3	25.7	30.6	41.7	54.4	68.9	85.1	122	167	246
12	0.98	1.52	2.19	2.35	2.99	3.90	4.94	6.10	8.78	11.9	15.6	19.8	24.4	29.5	35.1	47.8	62.4	79.0	97.5	140	191	282
15	1.09	1.70	2.44	2.62	3.33	4.34	5.50	6.79	9.78	13.3	17.4	22.0	27.2	32.9	39.1	53.2	69.5	88.0	109	156	213	314
20	1.27	1.98	2.86	3.06	3.89	5.08	6.42	7.93	11.4	15.5	20.3	25.7	31.7	38.4	45.7	62.2	81.2	103	127	183	249	367
25	1.45	2.27	3.27	3.50	4.45	5.81	7.35	9.07	13.1	17.8	23.2	29.4	36.3	43.9	52.3	71.1	92.9	118	145	209	285	420
30	1.63	2.55	3.68	3.94	5.01	6.54	8.28	10.2	14.7	20.0	26.2	33.1	40.9	49.5	58.9	80.1	105	132	163	235	320	472
35	1.82	2.84	4.09	4.38	5.57	7.27	9.20	11.4	16.4	22.3	29.1	36.8	45.4	55.0	65.4	89.1	116	147	182	262	356	525
40	2.00	3.13	4.50	4.82	6.13	8.00	10.1	12.5	18.0	24.5	32.0	40.5	50.0	60.5	72.0	98.0	128	162	200	288	392	578
45	2.18	3.41	4.91	5.26	6.69	8.73	11.1	13.6	19.6	26.7	34.9	44.2	54.6	66.0	78.6	107	140	177	218	314	428	631
50	2.37	3.70	5.32	5.70	7.25	9.46	12.0	14.8	21.3	29.0	37.9	47.9	59.2	71.6	85.2	116	151	192	237	341	464	684
60	2.73	4.27	6.15	6.58	8.37	10.9	13.8	17.1	24.6	33.5	43.7	55.3	68.3	82.6	98.3	134	175	221	273	393	535	790
70	3.10	4.84	6.97	7.46	9.49	12.4	15.7	19.4	27.9	37.9	49.6	62.7	77.4	93.7	112	152	198	251	310	446	607	895
80	3.46	5.41	7.79	8.34	10.6	13.9	17.5	21.6	31.2	42.4	55.4	70.1	86.6	105	125	170	222	281	346	499	679	1,001
90	3.83	5.98	8.62	9.2	11.7	15.3	19.4	23.9	34.5	46.9	61.3	77.5	95.7	116	138	188	245	310	383	551	750	1,107
100	4.19	6.55	9.44	10.1	12.8	16.8	21.2	26.2	37.8	51.4	67.1	84.9	105	127	151	206	268	340	419	604	822	1,212
110	4.56	7.13	10.3	11.0	14.0	18.2	23.1	28.5	41.0	55.9	73.0	92.4	114	138	164	223	292	369	456	657	894	1,318
125	5.11	7.98	11.5	12.3	15.6	20.4	25.9	31.9	46.0	62.6	81.7	103	128	155	184	250	327	414	511	736	1,001	1,477
150	6.02	9.41	13.6	14.5	18.4	24.1	30.5	37.6	54.2	73.8	96.4	122	151	182	217	295	385	488	602	867	1,181	1,741
200	7.85	12.3	17.7	18.9	24.0	31.4	39.8	49.1	70.7	96.2	126	159	196	238	283	385	503	636	785	1,131	1,539	2,269
250	9.68	15.1	21.8	23.3	29.6	38.7	49.0	60.5	87.1	119	155	196	242	293	348	474	620	784	968	1,394	1,897	2,798
300	11.5	18.0	25.9	27.7	35.2	46.0	58.3	71.9	104	141	184	233	288	348	414	564	737	932	1,151	1,657	2,256	3,326
400	15.2	23.7	34.1	36.5	46.4	60.7	76.8	94.8	136	186	243	307	379	459	546	743	971	1,228	1,517	2,184	2,973	4,383
500	18.8	29.4	42.4	45.3	57.6	75.3	95.3	118	169	231	301	381	471	569	678	922	1,205	1,525	1,882	2,711	3,689	5,440
600	22.5	35.1	50.6	54.1	68.8	89.9	114	141	202	275	360	455	562	680	809	1,102	1,439	1,821	2,248	3,237	4,406	6,497
750	28.0	43.7	62.9	67.4	85.6	112	142	175	252	343	447	566	699	846	1,007	1,370	1,790	2,265	2,797	4,027	5,481	8,082
1000	37.1	58.0	83.5	89.4	114	148	188	232	334	455	594	751	928	1,123	1,336	1,818	2,375	3,006	3,711	5,344	7,273	10,725

Air Vent ID Charts

Illustration	Type	Flow Direction	Connection Type	Max. Allow. Press. psig	TMA °F	Body Material	Model	Max. Oper. Press. psig	Connection Size 1/8"	1/4"	1/2"	3/4"	1"	1-1/2"	2"	Located on Page
	**Series 1-AVCW** See-Thru Free Floating Lever Air Vents for Ozone Applications		Screwed	150	150	PBT Cap (Polybutylene Terephthalate) Polysulfone Body	**1-AVCW**	150			▲	★★ ●				445
	**Series 1-AVC** See-Thru Free Floating Lever Air/Gas Vents		Screwed	150	150	Nylon Cap Polysulfone Body	**1-AVC**	150			●	★★ ●				444
	**Series 21-AR** Fixed Pivot Ball Float Air/Gas Vents		Screwed	250	450	ASTM A48 Class 30 Cast Iron	**21-AR**	250			●	●				459
	**Series 21-312** Fixed Pivot Ball Float Air/Gas Vents		Screwed Socketweld Flanged †††	600 or 500	100 or 750	ASTM A105 Forged Steel	**21-312AR**	68			●	●				459
							21-312VAR	600			●	●				
	**Series 1, 2, 3, 6** Free Floating Lever Air/Gas Vents		Screwed	300	200	ASTM A48 Class 30 Cast Iron	**1-AV†**	300			★ ●	★ ●				446
				250	450		**2-AV**	250			●	●				
							3-AV	250				●	●			
							3-AV	250						●	●	
	**Series 30** Free Floating Lever Air/Gas Vents		Screwed Socketweld Flanged †††	600 or 500	100 or 750	ASTM A105 Forged Steel	**32-AV**	600			●	●				448
				1,000 or 600	100 or 750		**33-AV**	900			●	●	●			
				1,000 or 600	100 or 750		**36-AV**	1000						●	●	
	**Series 10** Free Floating Lever Air/Gas Vents		Screwed Socketweld (22 and 13 only)	500 or 440	100 or 500	304-L Stainless Steel	**11-AV ††**	400			●	★★ ●				450
				555 or 475	100 or 500		**22-AV**	555				●				
				570 or 490	100 or 500		**13-AV**	570					●			
	**Series HLAR** High Leverage Air/Gas Vents		Screwed Socketweld Flanged †††	100 or 600	100 or 750	ASTM A105 Forged Steel	**2313 HLAR**	1,000			●	●	●			452
							2315 HLAR						●	1-1/4 ● 1-1/2 ●		
							2316 HLAR							●	●	
	**Series HLAR** High Leverage Air/Gas Vents		Screwed Socketweld Flanged †††	1,500 or 900	100 or 850	ASTM A182 Gr. F22 Forged Steel	**2413 HLAR**	1,500			●	●	●			452
				1,800 or 900	100 or 900		**2415 HLAR**	1,800					●	1-1/4 ● 1-1/2 ●		
							2416 HLAR	1,500						●	●	

★ 1/4" outlet connection ★★ 1/2" outlet connection † Side connection available ▲ Alternate inlet 1/2"
†† Side connection not available ††† Flange selection may limit pressure and temperature rating.

Air Vent ID Charts

Illustration	Type	Flow Direction	Connection Type	Max. Allow. Press. psig	TMA °F	Body Material	Model	Max. Oper. Press. psig	Connection Size 1/8"	1/4"	1/2"	3/4"	1"	1-1/2"	2"	Located on Page
	**Series HLAR** High Leverage Air/Gas Vents		Screwed Socketweld Flanged †††	2,120 or 1,700	100 or 900	ASTM A182 Gr. F22 Forged Steel	**25133G-HLAR**	2,125			●	●	●			452
				2,520 or 2,000	100 or 900		**25155G-HLAR**	2,500				●	●	1-1/4 ●		
				3,700 or 3,000	100 or 900		**26155G-HLAR**	2,700					●	1-1/4 ●		
	**Series TTF** Thermostatic Air Vents		Straight-Thru Right Angle	300	450	304-L Stainless Steel	**TTF-1** **TTF-1R**	300			●	●				454
	**Series TV-2** Thermostatic Air Vents		Screwed	125	350	ASTM B62 Cast Bronze	**TV-2**	125			●					455
	**Series TS-2** Thermostatic Air Vents		Threaded	50	300	ASTM B62 Bronze	**TS-2**	50			●	●				456
	**AV-11, AV-13** Air Vents		Screwed	50 150	210	Brass	**AV-11** **AV-13**	50 150	●		●	●				457
	**SV-12** Steam Radiator Air Vent		Threaded	15	250	Nickel Plated Brass	**SV-12**	15	●	●	●	●				458

★ 1/4" outlet connection ★★ 1/2" outlet connection † Side connection available ▲ Alternate inlet 1/2"
†† Side connection not available ††† Flange selection may limit pressure and temperature rating.

1-AVC See-Thru Air Vent

For Pressures to 150 psig (7 bar) or Specific Gravity Down to 0.80

A See-Thru Body—So You'll Know When It's Working
Now, you can literally see what you've been missing—the early warning signs of a system problem. Since you'll know the operating condition of the air vent, you won't have to waste time and money scheduling maintenance that isn't needed. In other words, you will be able to react to a condition before it becomes a problem.

A simple ball float mechanism requiring no electricity to operate, the new Armstrong 1-AVC discharges automatically only when air/gas are present. That means no liquid loss as with manual venting.

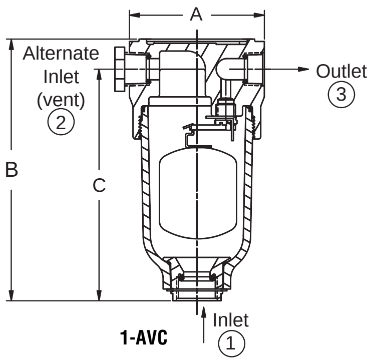
An Inside Look
See-thru body means you can observe changing conditions as they occur. See a problem in the making—instead of having to deal with it after the fact.

Efficient Operation
Simple ball float mechanism discharges only when air is present so it doesn't waste liquid.

Positive Seating
Free-floating valve mechanism assures positive seating so it prevents liquid loss. There are no fixed pivots to wear or create friction, and wear points are heavily reinforced for long life.

Reduced Maintenance
Stainless steel internals mean corrosion resistance and reduced maintenance.

Corrosion Resistance
Long-lasting polysulfone body and reinforced nylon cap resist corrosion and provide long, trouble-free service life.



1-AVC

How to Order

Inlet ①	Alternate Inlet ②	Outlet ③
3/4"	**1/2"**	**1/2"**
1/2" or 3/4"	1/2" or 3/4"	1/2"

NOTE: The Armstrong 1-AVC should not be used in an environment where there are high levels of ketones or chlorinated or aromatic hydrocarbons.

For a fully detailed certified drawing, refer to CD #1031.

List of Materials	
Name of Part	**Material**
Cap	Reinforced Nylon*
Body	Polysulfone
O-Rings (Body Cap and Fitting)	Nitrile Elastomer Compound
Float Lever and Screws	Stainless Steel
Valve & Seat	Stainless Steel
Fitting & Pipe Plug	Reinforced Nylon
Retainer Ring	Zinc Plated Steel

*UV sensitive.

Physical Data		
	in	**mm**
Inlet Connection	1/2, 3/4	15, 20
Outlet Connection	1/2	15
"A" Face-to-Face	3-1/2	89
"B" Height	6-3/4	171
"C" Bottom to ℄	6 1	52
Maximum Allowable Pressure (Vessel Design)	150 psig @ 150°F (10 bar @ 65°C)	
Maximum Operating Pressure	150 psi (10 bar)	
Specific Gravity Range	1.00 to 0.80	
Weight, lb (kg)	1 (.45)	

Model 1-AVC Capacity				
Differential Pressure		Orifice Size	scfm	m³/hr
psig	bar			
15	1.0	1/8"	4.3	7.3
30	2.0		6.5	11.0
50	3.5		9.5	16.1
75	5.0		13.1	22.2
100	7.0		16.9	28.7
125	8.5		20.5	34.8
150	10.5		24.2	41.3

NOTE: Discharge of air through an orifice in scfm (standard cubic feet of free air per minute) at a standard atmospheric pressure of 14.7 psi (1 bar) and 70°F (21°C).

1-AVCW See-Thru Air Vent for Ozone Applications

For Pressures to 150 psig (10 bar) or Specific Gravity Down to 0.80

What Is Ozone?
Ozone is a gas that forms naturally during thunderstorms when lightning converts normal oxygen molecules (O_2) into ozone (O_3). The fresh, sweet smell in the air after a storm is the smell of ozone. The unstable ozone molecule reacts rapidly with most substances and is an extremely strong natural oxidant.

How Is Commercial Ozone Produced?
Ozone can be formed by exposing air to ultraviolet light; however, the most common method of generating ozone is by passing air through an electrical discharge. Because ozone has strong oxidizing properties, its production requires corrosion-resistant equipment.

How Is Ozone Used in Water Filtration and Purification?
Because ozone is such an effective oxidant, it kills viruses, bacteria, mold, mildew, fungus and germs. Passing ozone through water achieves high purification rates without any chemical residue. Oxygen is the only by-product.

Typical Customer Applications:
- Purifying standing ground water in Third World countries.
- Conditioning water for poultry and livestock.
- Purifying water in the bottled water industry.
- Filtering and purifying water for process applications.

A See-Thru Body Shows You It's Working
Now, you can literally see what you've been missing. The Armstrong 1-AVCW See-Thru Air Vent lets you easily check its operating condition. You won't have to waste time and money scheduling maintenance that isn't needed, and you can quickly react to a condition before it becomes a problem.

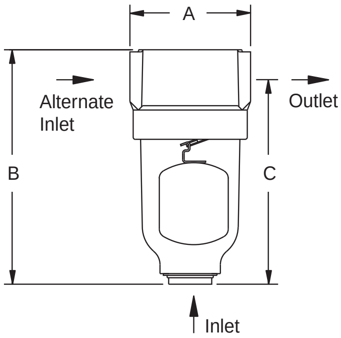
Efficient Operation
Simple ball-float mechanism doesn't need electricity to operate. The air vent automatically discharges only when air or gas is present. No liquid is lost, as with manual venting.

Positive Seating
Free-floating valve mechanism ensures positive seating and prevents liquid loss. There are no fixed pivots to wear or create friction. Wear points are heavily reinforced for long life.

Corrosion Resistance
Long-lasting PBT (polybutylene terephthalate) cap provides trouble-free operation. Stainless steel internal parts resist corrosion and reduce maintenance.

Compare–and Save the Difference
Seeing really is believing–especially when you compare the Armstrong 1-AVCW See-Thru Air Vent with manual venting. Measure the time and money you can save with a more efficient, easier-to-maintain system. For more information or technical assistance, contact your local Armstrong Representative.

NOTE: The Armstrong 1-AVCW should not be used in an environment where there are high levels of ketones or chlorinated or aromatic hydrocarbons.



1-AVCW

List of Materials	
Name of Part	**Material**
Cap	PBT (Polybutylene Terephthalate)
Body	Polysulfone*
O-Rings (Body Cap and Fitting)	Viton®
Float Lever and Screws	Stainless Steel
Valve & Seat	Stainless Steel
Fitting	PBT (Polybutylene Terephthalate)
Retainer Ring	Zinc Plated Steel

*UV sensitive

Physical Data	in	mm
Inlet Connection (In Body)	3/4	20
Inlet Connection (Alternate)	1/2	15
Outlet Connection	1/2	15
"A" Face-to-Face	3-1/2	89
"B" Height	6-13/16	172
"C" Bottom to ℄	6	152
Maximum Allowable Pressure (Vessel Design)	150 psig @ 150°F (10 bar @ 66°F)	
Maximum Operating Pressure	150 psi (10 bar)	
Specific Gravity Range	1.00 to 0.80	
Weight, lb (kg)	1 (.5)	

Model 1-AVCW Capacity

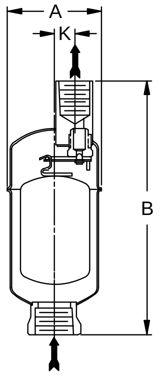
Differential Pressure		Orifice Size	scfm	m³/hr
psig	bar			
15	1.0	1/8"	4.3	7.3
30	2.0		6.5	11.0
50	3.5		9.5	16.1
75	5.0		13.1	22.2
100	7.0		16.9	28.7
125	8.5		20.5	34.8
150	10.5		24.2	41.3

NOTE: Discharge of air through an orifice in scfm (standard cubic feet of free air per minute) at a standard atmospheric pressure of 14.7 psi (1 bar) and 70°F (21°C).

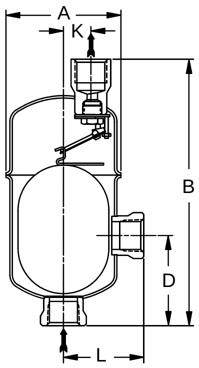
For a fully detailed certified drawing, refer to CD #1264.

Free Floating Lever Air/Gas Vents—All Stainless Steel

For Pressures to 600 psig (41 bar) or Specific Gravity Down to 0.50



Model 11-AV



Model 22-AV and 13-AV

The Armstrong all-stainless steel guided lever air vents have been developed to provide positive venting of air/gases under pressure.

The body and cap and all working parts of the No. 11-AV, 22-AV and 13-AV are made of high strength, corrosion resistant stainless steel. Body and caps are welded together to form a permanently sealed, tamperproof unit with no gaskets. Elliptical floats and high leverage provide up to 115 SCFM capacity for these compact air/gas vents. Lever action is guided to assure proper seating of the valve under all operating conditions.

11-AV, 22-AV and 13-AV—All stainless steel construction where exposure to either internal or external corrosion is a problem. These air/gas vents have the same proven free floating mechanisms used in other Armstrong steam traps. Pressures to 600 psi @ 100°F (41 bar @ 38°C).

For a fully detailed certified drawing, refer to list below:
11-AV CD #1066
13-AV and 22-AV CD #1086

Physical Data

Model No.	11-AV		22-AV		13-AV	
Pipe Connections	1/2, 3/4**	15, 20**	3/4	20	1	25
“A”	2-3/4	70	3-7/8	99	4-1/2	114
“B”	7-1/4	184	8-13/16	224	11-3/8	289
“D”	–	–	3-3/8	86	6-1/8	156
“K”	9/16	14	7/8	22	1-3/16	30
“L”	–	–	2-5/8	67	3-1/4	83
Weight, lb (kg)			5 (2.3)		7-1/2 (3.4)	
Max. Allow. Pressure (Vessel Design)	500 psig @ 100°F (34 bar @ 38°C) 440 psig @ 500°F (30 bar @ 260°C)		600 psig @ 100°F (41 bar @ 38°C) 475 psig @ 500°F (33 bar @ 260°C)		570 psig @ 100°F (39 bar @ 38°C) 490 psig @ 500°F (34 bar @ 260°C)	

** 1/2" (15 mm) outlet.

List of Materials

Model No.	Valve & Seat	Leverage System	Float	Body & Cap
11-AV	*440 Stainless Steel	303/304 Stainless Steel	304 Stainless Steel	Sealed Stainless Steel 304-L
22-AV				
13-AV				

*Type 316 SS valve and seat available. Consult factory.

Free Floating Lever Air/Gas Vents—All Stainless Steel

For Pressures to 600 psig (41 bar) or Specific Gravity Down to 0.50

Maximum Operating Pressures of free floating lever vents with weighted floats for different orifice sizes, and the specific gravities on which they can be used.

11-AV Maximum Operating Pressures

Minimum Specific Gravity	0.75		0.50	
Float wt., oz (g)	2.90 (82) Standard		2.08 (59) Special	
Orifice Size (in)	Maximum Operating Pressure			
	psi	bar	psi	bar
1/8	178	12	118	8
#38	267	18	177	12
5/64	400	28	311	21

22-AV Maximum Operating Pressure

Specific Gravity*	1.00		0.95		0.90		0.85		0.80		0.75		0.70		0.65		0.60		0.55		0.50	
Float wt., oz (g)	10.0 (282)		9.5 (268)		9.0 (254)		8.5 (240)		8.0 (226)		7.5 (212)		5.4 (152)		5.0 (141)		4.6 (130)		4.2 (119)		3.8 (109)	
Orifice Size (in)	Maximum Operating Pressure																					
	psi	bar	psi	bar	psi	bar	psi	bar	psi	bar	psi	bar	psi	bar	psi	bar	psi	bar	psi	bar	psi	bar
5/16	35	2.4	33	2.3	31	2.2	30	2.0	28	1.9	26	1.8	19	1.3	18	1.2	16	1.1	15	1.0	14	0.9
1/4	57	3.9	54	3.7	51	3.5	49	3.4	46	3.2	43	3.0	31	2.1	29	2.0	27	1.8	24	1.7	22	1.5
3/16	126	8.7	120	8.2	113	7.8	107	7.4	101	7.0	95	6.5	68	4.7	64	4.4	59	4.1	54	3.7	49	3.4
5/32	217	14.9	206	14.2	195	13.5	185	12.7	174	12.0	163	11.2	118	8.1	110	7.6	101	7.0	93	6.4	85	5.8
1/8	371	25.6	352	24.3	334	23.0	316	21.8	297	20.5	279	19.2	202	13.9	187	12.9	173	12.0	159	11.0	145	10.0
7/64	474	32.7	451	31.1	427	29.5	404	27.9	380	26.2	357	24.6	258	17.8	240	16.5	222	15.3	204	14.0	186	12.8
#38	590	40.7	561	38.7	532	36.7	503	34.7	473	32.7	444	30.6	321	22.1	298	20.6	276	19.0	253	17.5	231	15.9
5/64	600	41.4	600	41.4	600	41.4	600	41.4	600	41.4	600	41.4	473	32.6	440	30.3	407	28.1	374	25.8	341	23.5

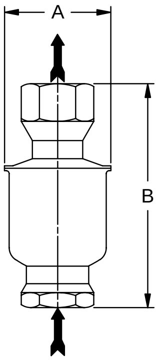
13-AV Maximum Operating Pressures

Specific Gravity*	1.00		0.95		0.90		0.85		0.80		0.75		0.70		0.65		0.60	
Float wt., oz (g)	14.9 (423)		14.2 (402)		13.4 (381)		12.7 (360)		12.0 (339)		11.2 (318)		10.5 (296)		9.7 (275)		9.0 (254)	
Orifice Size (in)	Maximum Operating Pressure																	
	psi	bar	psi	bar	psi	bar	psi	bar	psi	bar	psi	bar	psi	bar	psi	bar	psi	bar
1/2	21	1.5	20	1.4	19	1.3	18	1.3	17	1.2	16	1.1	15	1.0	14	1.0	13	0.9
3/8	45	3.1	43	3.0	41	2.8	38	2.7	36	2.5	34	2.3	32	2.2	30	2.0	27	1.9
5/16	72	5.0	69	4.7	65	4.5	61	4.2	58	4.0	54	3.8	51	3.5	47	3.3	44	3.0
9/32	96	6.6	91	6.3	87	6.0	82	5.6	77	5.3	72	5.0	68	4.7	63	4.3	58	4.0
1/4	144	9.9	137	9.4	130	8.9	123	8.5	116	8.0	109	7.5	102	7.0	94	6.5	87	6.0
7/32	206	14	196	13	186	13	176	12	165	11	155	10.7	145	10.0	135	9.3	125	8.6
3/16	309	21	294	20	279	19	264	18	249	17	234	16	218	15	203	14	188	13
5/32	484	33	460	32	437	30	413	28	389	27	365	25	342	24	318	22	294	20
1/8	570	39	570	39	570	39	570	39	570	39	570	39	570	39	570	39	570	39
7/64	570	39	570	39	570	39	570	39	570	39	570	39	570	39	570	39	570	39

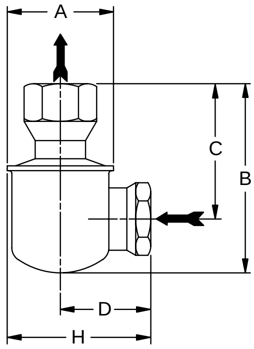
*If specific gravity falls between those shown, use next lowest: e.g., if actual gravity is 0.73, use 0.70 specific gravity data.

Armstrong Stainless Steel Thermostatic Air Vents

For Pressures to 300 psig (20 bar)…Capacities to 104 scfm



TTF-1
Straight-Thru



TTF-1R
Right Angle

Armstrong offers Thermostatic Air Vents for positive venting of air and other non-condensable gases from steam in chamber type heat transfer equipment. Typical applications include jacketed kettles, retorts, vulcanizers, jacketed sterilizers or other contained equipment where air could accumulate in remote areas of the steam chamber and reduce heat transfer capacity. These vents are balanced pressure air vents that respond to the pressure-temperature curve of steam. Air is automatically vented at slightly below steam temperature throughout the entire operating pressure range.

Features

- Suitable for pressures from 0 - 300 psig
- All 304-L stainless steel bodies—sealed, tamper-proof
- Balanced pressure thermostatic element vents air at slightly below steam temperature over the entire pressure range—no adjustments required
- Dependable, proven phosphor-bronze bellows caged in stainless steel with bronze valve and stainless steel seat
- Available in straight-thru or right-angle connections

Armstrong thermostatic air vents should be installed at the highest point on a steam chamber, with the air vent located above the chamber. This will minimize the possibility of any liquid carryover, and air can be vented at atmosphere without a drain line.

List of Materials

Name of Part	Material
Body	304-L Stainless steel
Connections	304 Stainless steel
Balanced Pressure Thermostatic Air Vent	Stainless steel and bronze with phosphor-bronze bellows, entire unit caged in stainless steel
Gasket	Copper clad non-asbestos

Optional: All stainless steel thermostatic air vent.

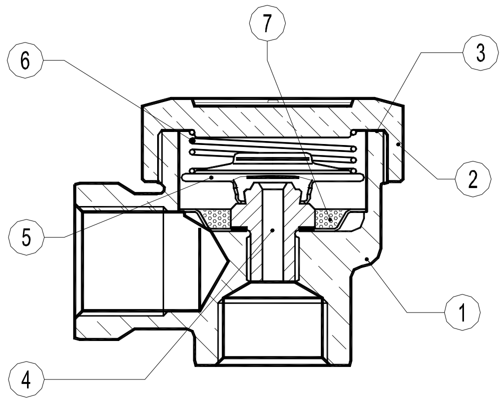
Physical Data

Model No.	Straight-Thru Connections TTF-1				Right-Angle Connections TTF-1R			
Pipe Connections	in 1/2	mm 15	in 3/4	mm 20	in 1/2	mm 15	in 3/4	mm 20
"A" Diameter	2-1/4	57	2-1/4	57	2-1/4	57	2-1/4	57
"B" Height	4-1/2	114	4-11/16	119	3-3/4	95	3-15/16	100
"C" ℄ inlet to face of outlet	–		–		2-5/8	67	2-13/16	71
"D" ℄ outlet to face of inlet	–		–		1-15/16	49	1-7/8	48
"H"	–		–		3-1/16	78	3	76
Weight, lb (kg)	3/4 (0.4)		1 (0.5)		3/4 (0.4)		1 (0.5)	
Maximum Allowable Pressure (Vessel Design)	300 psig @ 450°F (20 bar @ 232°C)							
Maximum Operating Pressure, psi (bar)	300 (20)							
Discharge Orifice Size	3/16"							

THERMOSTATIC STEAM TRAPS AND AIR ELIMINATORS - TH13A

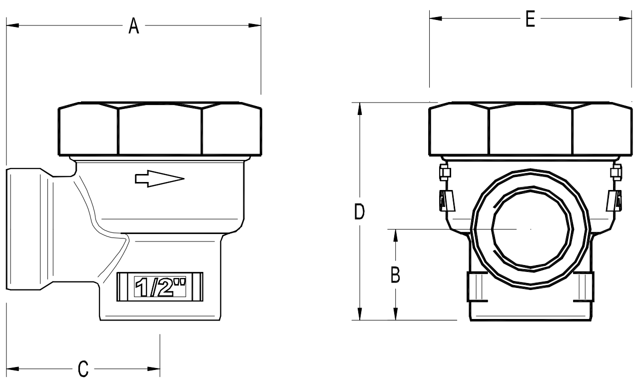
DESCRIPTION
The TH 13A series thermostatic steam traps and air eliminators are specifically designed for use on process equipment such as kettle cookers, sterilizers, food, chemical and laundry equipment. The small size makes it ideal for use with a wide variety of this equipment and specifically as air eliminator.
Connections are female screwed.

MAIN FEATURES
Modulating discharge.
Discharges condensate close to steam temperature.
Thermostats for different sub cooling (5ºK to 30ºK).
Excellent air discharge.
Simple and compact design.
Built-in strainer.



USE: Saturated steam.
AVAILABLE MODELS: TH13A
SIZES: DN ½”
CONNECTIONS: Female screwed ISO 7/1 Rp (BS21)
INSTALLATION: Vertical installation, angle connection.

PMA – Max. allowable pressure 16 bar
TMA – Max. allowable temperature 260 ºC
PMO – Max. operating pressure 13 bar
TMO – Max. operating temperature 200 ºC
How to order: i.e. TH13A DN ½” BSP



MATERIALS		
POS.Nr.	***DESIGNATION***	***MATERIAL***
1	Body	Brass EN12165 / CuZn39Pb2
2	Cover	Brass EN12165 / CuZn39Pb2
3	* Gasket	St.St./Graphite
4	* Valve seat	AISI304 / 1.4301
5	* Thermostat	Stainless steel
6	* Spring	AISI302 / 1.4300
7	* Strainer screen	AISI304 / 1.4301

* Available spare parts

DIMENSIONS (mm)-Screwed						
SIZE DN	***A***	***B***	***C***	***D***	***E***	***WGT. Kgs***
1/2"	63	22,5	38	54	50	0,5

FLOW RATE CAPACITY IN Kgs/h													
MODEL	***SIZE***	***DIFFERENTIAL PRESSURE (bar)***											
		0,2	***0,3***	***0,5***	***1***	***1,5***	***2***	***3***	***4***	***6***	***8***	***10***	***13***
TH13A	**1/2"**	45	55	70	95	125	135	180	200	270	315	330	360

Capacities shown refer to condensate at 10ºC below saturated steam temperature (standard type-S thermostat) .
Thermostats for 5º C type-H and 30º type-L, also available.
Capacities for cold condensate discharge at 20ºC are two to three times greater.

Liquid Drainers

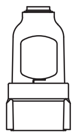
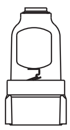
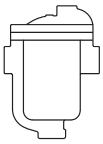
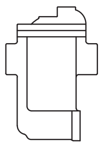
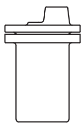
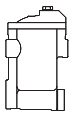
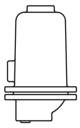
32-LD Forged Steel Free Floating
Guided Lever Drain Trap

1-LD Cast Iron Free Floating
Guided Lever Drain Trap

11-LD Stainless Steel Free Floating
Guided Lever Drain Trap

Liquid Drainers ID Charts

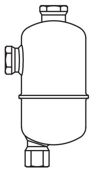
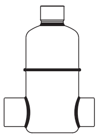
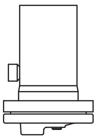
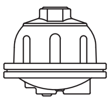
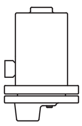
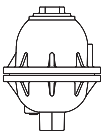
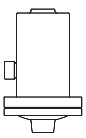
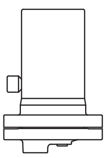
Armstrong Liquid Drainers

Illustration	Type	Flow Direction	Connection Type	Max. Allow. Press. psig	TMA °F	Body Material	Model	Max. Oper. Press. psig	Connection Size 1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	Located on Page
	**Series 1-LDC** See-Thru Free Floating Lever Drain Traps Capacities to **1,500** lb/hr	↓ →	Screwed	150	150	Nylon Cap Polysulfone Body	**1-LDC**	150	●	★★ ●					493
	**Series 1-LDCW** See-Thru Free Floating Lever Drain Traps for Ozone Applications	↓ →	Screwed	150	150	PBT Cap (Polybutylene Terephthalate) Polysulfone Body	**1-LDCW**		▲	★★ ●					495
	**Series 200 BVSW** Inverted Bucket Drain Traps Capacities to **7,000** lb/hr	↑	Screwed	250	450	ASTM A48 Class 30 Cast Iron	**211**	250	●						496
							212		●	●					
							213		●	●	●				
	**Series 800 BVSW** Inverted Bucket Drain Traps Capacities to **7,000** lb/hr	→	Screwed	250	450	ASTM A48 Class 30 Cast Iron	**800**	150	●	●					496
							811	250	●	●	●				
							812	250	●	●					
							813	250		●	●				
	**Series 880 BVSW** Inverted Bucket Drain Traps Capacities to **7,000** lb/hr	→	Screwed	250	450	ASTM A48 Class 30 Cast Iron	**800**	150	●	●					496
							881	250	●	●	●				
							882	250	●	●					
							883	250		●	●				
	**Series 300 BVSW** Inverted Bucket Drain Traps Capacities to **7,000** lb/hr	↑	Screwed Socketweld Flanged†	600	650	ASTM A105 Forged Steel	**312**	600	●	●	●				
				1,080	650		**313**		●	●	●				
	**Series 900 BVSW** Inverted Bucket Drain Traps Capacities to **7,000** lb/hr	→	Screwed Socketweld Flanged†	600	650	ASTM A216 WCB Cast Steel	**981**	300	●	●					
							983	600		●	●				
	**Series 1, 2, 3, 6** Free Floating Lever Drain Traps Capacities to **49,000** lb/hr	↓ →	Screwed	300	200	ASTM A48 Class 30 Cast Iron	**1-LD**	300	★ ●						499
				250	450		**2-LD**	250	●	●					
							3-LD			●	●				
							4-LD						●	●	

★ 1/4" outlet connection
★★ 1/2" outlet connection
† Flange selection may limit pressure and temperature rating.
†† Side connection not available.

Liquid Drainers ID Charts

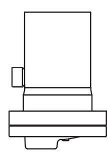
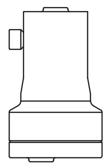
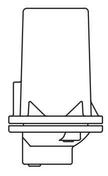
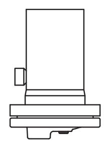
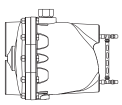
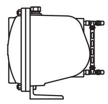
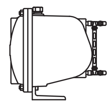
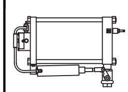
Armstrong Liquid Drainers

Illustration	Type	Flow Direction	Connection Type	Max. Allow. Press. psig	TMA °F	Body Material	Model	Max. Oper. Press. psig	Connection Size 1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	Located on Page
	**Series 11, 22, 13** Free Floating Lever Drain Traps Capacities to **9,500** lb/hr		Screwed Socketweld	500 or 440	100 or 500	304-L Stainless Steel	**11-LD††**	400	●	★★ ●					500
			Screwed Socketweld (22 and 13 Series Only)	600 or 475	100 or 500		**22-LD**	533		●					
				570 or 490	100 or 500		**13-LD**	570			●				
	**180-LD/181-LD** Free Floating Lever Drain Traps Capacities to **1,100** lb/hr		Screwed Socketweld	500 or 440	100 or 500	304L Stainless Steel	**180-LD**	229	●						502
							181-LD	350		●					
	**Series 30** Free Floating Lever Drain Traps Capacities to **42,000** lb/hr		Screwed Socketweld Flanged†	600 or 500	100 or 750	ASTM A105 Forged Steel	**32-LD**	600	●	●	●				501
				1,000 or 600	100 or 750		**33-LD**	900	●	●	●				
				1,000 or 600	100 or 750		**36-LD**	1,000					●	●	
	**Series 21** Fixed Pivot Drain Trap Capacities to **2,700** lb/hr		Screwed	250	450	ASTM A48 Class 30 Cast Iron	**21**	250	●	●					504
	**Series 21-312** Fixed Pivot Drain Traps Capacities to **3,900** lb/hr		Screwed Socketweld Flanged†	600 or 500	100 or 750	ASTM A105 Forged Steel	**21-312**	74	●	●					
							21-312V	600	●	●					
	**Series 71-A** Snap Action Drain Trap Capacities to **1,950** lb/hr		Screwed	250	450	ASTM A48 Class 30 Cast Iron	**71-A**	250		●	●				
	**Series 71-315** Snap Action Drain Trap Capacities to **1,950** lb/hr		Screwed Socketweld Flanged†	1,000 or 600	100 or 750	ASTM A105 Forged Steel	**71-315**	1,000		●	●	●			
	**Series 2300** High Leverage Spring-Loaded Float Type Drain Trap Capacities to **14,500** lb/hr		Screwed Socketweld Flanged†	1,000 or 600	100 or 750	ASTM A105 Forged Steel	**2313-HLS**	1,000	●	●	●				506
							2315-HLS				●	●	●		
							2316-HLS						●	●	

† Flange selection may limit pressure and temperature rating.

Liquid Drainers ID Charts

Armstrong Liquid Drainers

Illustration	Type	Flow Direction	Connection Type	Max. Allow. Press. psig	TMA °F	Body Material	Model	Max. Oper. Press. psig	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	3"	Located on Page
	**Series 2400** High Leverage Spring-Loaded Float Type Drain Traps Capacities to **16,250** lb/hr		Screwed Socketweld Flanged†	1,500 or 900	100 or 850	ASTM A182 Gr. F22 Forged Stee	**2413-HLS**	1,500	•	•	•					506
				1,800 or 900	100 or 900		**2415-HLS**	1,800			•	•	•			506
							2416-HLS	1,800					•	•		
	**Series 2500/2600** High Leverage Spring-Loaded Float Type Drain Traps Capacities to **11,000** lb/hr		Screwed Socketweld Flanged†	2,120 or 1,700	100 or 900	ASTM A182 Gr. F22 Forged Steel	**25133G HLS**	2,120		•	•	•				506
				2,520 or 2,000	100 or 900		**25155G HLS**	2,520			•	•	•			
				3,700 or 3,000	100 or 900		**26155G HLS**	3,700				•	•			
	**Series 2, 3, 6** Free Floating Lever Dual Gravity Drain Traps Capacities to **40,000** lb/hr		Screwed	250	450	ASTM A48 Class 30 Cast Iron	**2-DG**	190	•	•						508
							3-DG	250		•	•					
							6-DG	250				•	•			
	**Series 30** Free Floating Lever Dual Gravity Drain Traps Capacities to **40,000** lb/hr		Screwed Socketweld Flanged†	600 or 500	100 or 750	ASTM A105 Forged Steel	**32-DG**	325	•	•	•					
				1,000 or 600	100 or 750		**33-DG**	700		•	•					
				1,000 or 600	100 or 750		**36-DG**	1,000				•	•			
	**Series JD&KD** Ultra-Capacity Drain Traps Capacities to **302,000** lb/hr		Screwed	300	650	ASTM A395 Ductile Iron	**JD8**	300*					•			510
							KD8						•			
							KD10							•		
							KD12								•	
	**Series L&M** Ultra-Capacity Drain Traps Capacities to **700,000** lb/hr		Screwed	250	450	ASTM A48 Class 30 Cast Iron	**L8**	250*					•			
							L10							•		
							M12								•	
	**Series LS&MS** Ultra-Capacity Drain Traps Capacities to **700,000** lb/hr		Screwed Socketweld Flanged†	450	650	ASTM A216 WCB Cast Steel	**LS8**	450*					•			
							LS10							•		
							MS12								•	
	**ADP-1** Pneumatically Operated Liquid Drainer Capacities to 1.5 lb liquid per cycle		Screwed	180	150	Aluminum ASTM B221 6061-T6511	**ADP-1**	180		•						514

*For different specific gravities, see table LD-33 on page LD-49.
†Flange selection may limit pressure and temperature rating.

Free Floating Guided Lever Drain Traps

For Loads to 9,500 lb/hr (4,309 kg/hr)...Pressures to 570 psig (39 bar)

Armstrong's stainless steel, free-floating guided lever drain traps use the same bodies, caps, lever mechanisms, valves and seats of Armstrong inverted bucket steam traps that have been proven in years of service. Elliptical floats and high leverage make it possible to open large orifices to provide adequate capacity for drain trap size and weight.

The hemispherical valve, seat and leverage of the 11-LD, 22-LD and 13-LD stainless steel traps are identical in design, materials and workmanship to those for saturated steam service up to 570 psig (39 bar) with the exception of the addition of a guidepost to assure a positive, leaktight valve closing under all conditions.

List of Materials

Table LD-17.

Model No.	Valve & Seat	Leverage System	Float	Body & Cap	Gasket
11-LD 22-LD 13-LD	Stainless Steel			Sealed Stainless Steel, 304L	—

For information on special materials, consult the Armstrong Application Engineering Department.

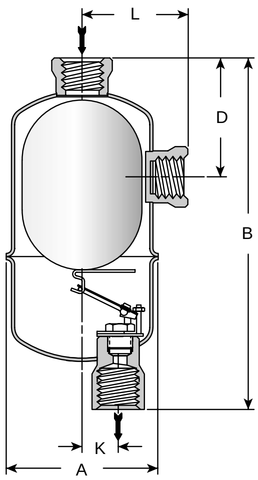


Figure LD-34.
No. 11-LD, 22-LD and 13-LD stainless steel guided lever liquid drain trap with sealed, tamperproof construction.

Physical Data

Table LD-18. Armstrong Guided Lever Liquid Drain Traps

Model No.	Stainless Steel					
	11-LD**		22-LD		13-LD	
Pipe Connections	in	mm	in	mm	in	mm
	3/4*	20*	3/4	20	1	25
"A"	2-3/4	70	3-15/16	100	4-1/2	114
"B"	7-1/4	184	8-13/16	224	11-3/8	289
"D"	—	—	3	76	6-1/8	156
"K"	9/16	14	7/8	22	1-3/16	30
"L"	—	—	2-5/8	67	3-9/32	83
Approx. Wt. lbs (kg)	1-3/4 (0.79)		3-1/4 (1.5)		7-1/2 (3.4)	
Max. Allowable Pressure (Vessel Design)	500 psig @ 100°F (35 bar @ 38°C) 440 psig @ 500°F (30 bar @ 260°C)		600 psig @ 100°F (41 bar @ 38°C) 475 psig @ 500°F (33 bar @ 260°C)		570 psig @ 100°F (39 bar @ 38°C) 490 psig @ 500°F (34 bar @ 260°C)	

Note: Vessel design pressure may exceed float collapse pressure in some cases.
Pipe size of vent connection is same as that of inlet and outlet connections.
*1/2" (15 mm) outlet. **No side connection.

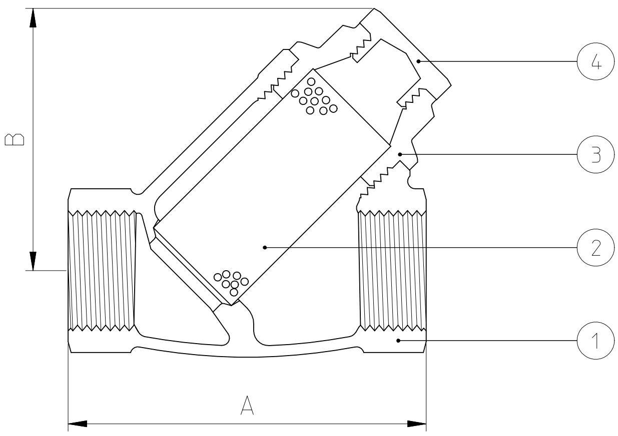
Pipeline Ancillaries

STY085

Y strainer.

Suitable for steam, water, air, gas and most non corrosive chemicals

- **Body & cap: Bronze B-62**
- **Strainer: 304 stainless steel, 0.5mm holes**
- **End Connections: Screwed BSP**
- **Maximum pressure rating 2,100 kpa cold**
- **Sizes: 15mm to 80mm**



HIDROSTATIC TEST	
BODY	450 PSI (31 BAR)

WORKING CONDITIONS		
SATURATED STEAM	150 PSI (10 BAR)	NON SHOCK
WATER, OIL	300 PSI (21 BAR)	

	1/4"	3/8"	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"
A	50	50	75	80	96	110	130	150	195	230
B	40	40	53	62	73	83	91	108	122	147

POS.	QUANT.	DENOMINATION	MATERIAL	ABNT SPECIFICATION	ASTM SPECIFICATION
4	01	CAP	BRONZE	NBR6314/C83600	B62/C83600
3	01	BONNET	BRONZE	NBR6314/C83600	B62/C83600
2	01	STRAINER	ST. STEEL	NBR5601/304	A276/304
1	01	BODY	BRONZE	NBR6314/C83600	B62/C83600

NOTE: THE DIMENSIONS ARE EXPRESSED IN MILLIMETERS.

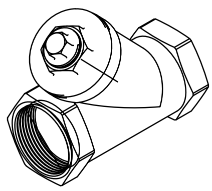
STYSD60B

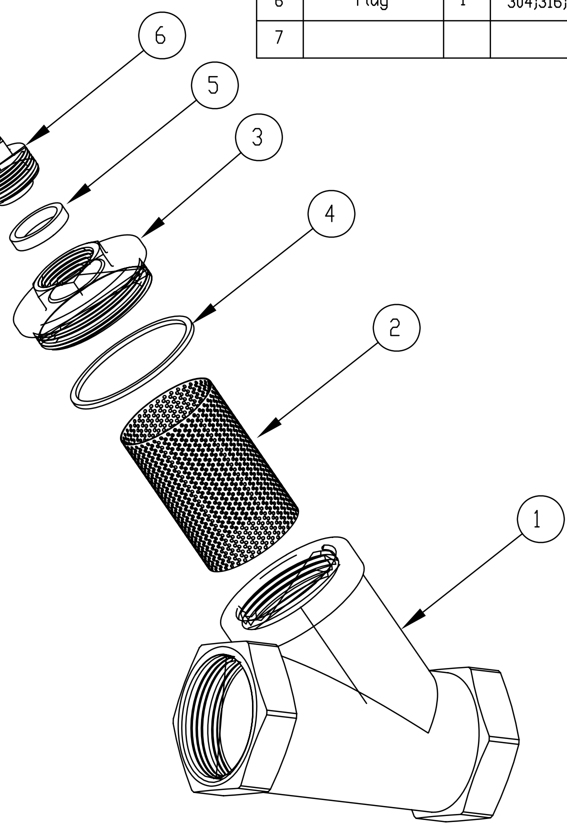
Y strainer.

Suitable for steam, water, air, gas and most chemicals

- **Body & cap: 316 stainless steel**
- **Strainer: 316 stainless steel**
- **End Connections: Screwed BSP**
- **Maximum pressure rating 4,135 kpa cold**
- **Sizes: 15mm to 80mm**

No	Part	Q'ty	Material	Note
1	Body	1	304;316;CF8M	
2	Screen	1	304;316;	
3	Cap	1	304;316;CF8M	
4	Gasket	1	Teflon	
5	Packing	1	Teflon	
6	Plug	1	304;316;CF8M	
7				





600 PSI Y-STRAINER DIMENSION

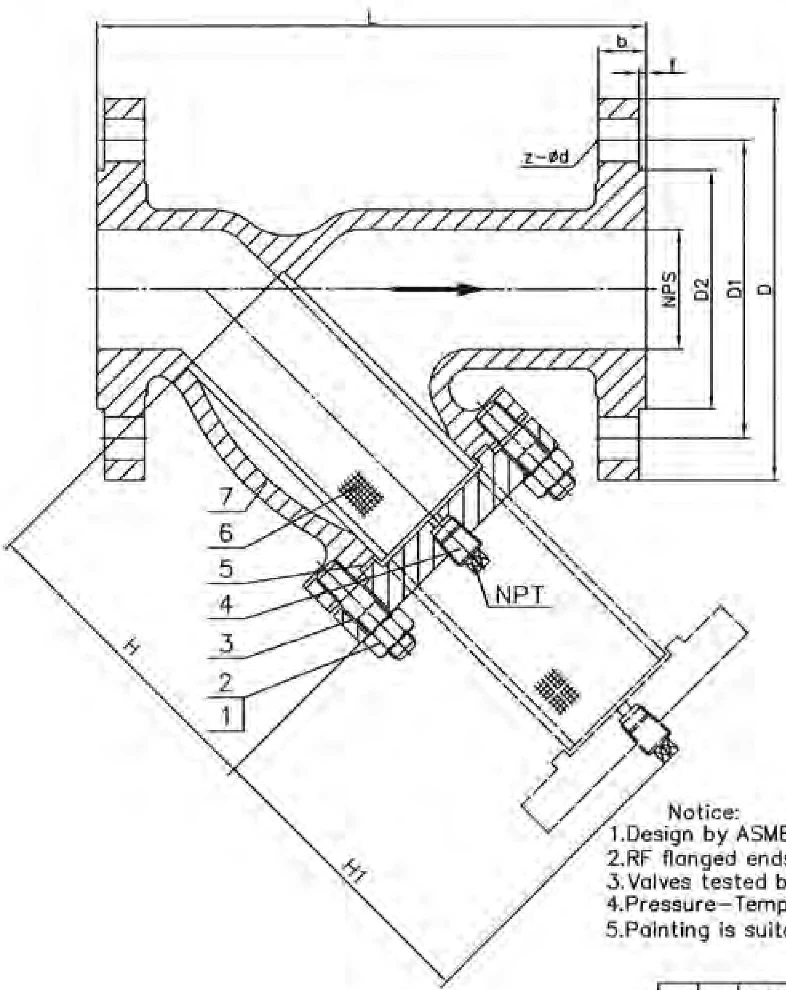
Valve Size	1/4	3/8	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3
L m/m	57.0		61.0	70.0	86.0	100.0	111.0	138.0	170.0	195.0
H m/m	32.0		37.0	41.0	47.0	54.0	62.0	76.0	110.0	130.0
D m/m	10.0		15.0	20.0	25.0	32.0	38.0	51.0	65.0	80.0
Weight/kgs	0.25		0.28	0.4	0.6	0.9	1.15	1.65	3.60	5.00

STYCS15R

Y strainer.

Suitable for steam, water, air, gas and most non corrosive chemicals

- **Body & cap: ASTM A216 Gr WCB**
- **Strainer: 304 stainless steel, 40 mesh**
- **Gasket: Flexible graphite**
- **End Connections: Flanged ANSI 150 RF**
- **Maximum pressure rating 1,964 kpa cold**
- **Sizes: 15mm to 300mm**



Performance Specification			
Class		150	
Test Pressure	Shell test	2.94	MPa
	Seal test	–	
	Back seal Test	–	
	Air Seal Test	–	

Notice:
1.Design by ASME B16.34
2.RF flanged ends by ASME B16.5
3.Valves tested by API 598
4.Pressure–Temperature Rating as per ASME B16.34
5.Painting is suitable for maximum temperature 200℃

7	Body	ASTM A216–WCB	
6	Filter Screen	SS304(40mesh)	
5	Gasket	FLEXIBLE GRAPHITE/304	
4	Plug Fitting	Carbon Steel	
3	Bonnet	ASTM A216–WCB	
2	Bonnet Bolt	ASTM A193 Gr.B7	
1	Bonnet Bolt Nut	ASTM A194 Gr.2H	
NO	PART NAME	MATERIAL	REMARKS

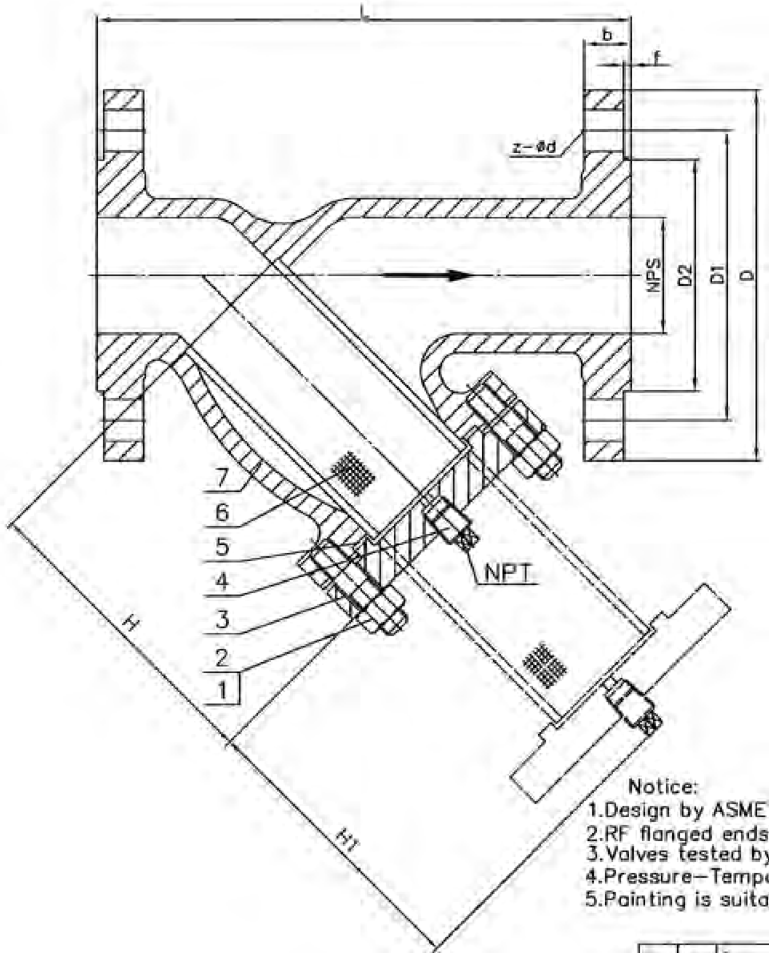
NPS	DN	Typical Dimensions				150Lb Flange Dimensions					
		L	NPT	H	H1	D	D1	D2	b	f	z–Ød
1¼	–	180	1/2	93	85	115	88.9	63.5	13.2	2	4–16
1½	–	200		122	110	125	98.4	73	14.7	2	4–16
2	–	203	3/4	128	115	150	120.7	92.1	16.3	2	4–19
2½	–	216		145	130	180	139.7	104.8	17.9	2	4–19
3	–	241		165	150	190	152.4	127	19.5	2	4–19
4	–	292		205	190	230	190.5	157.2	24.3	2	8–19
5	–	355		250	235	255	215.9	185.7	24.3	2	8–22
6	–	406		280	165	280	241.3	215.9	25.9	2	8–22
8	–	495		330	310	345	298.5	269.9	29	2	8–22
10	–	622		390	365	405	362	323.8	30.6	2	12–26
12	–	699		415	390	485	431.8	381	32.2	2	12–26

STYCS30R

Y strainer.

Suitable for steam, water, air, gas and most non corrosive chemicals

- **Body & cap: ASTM A216 Gr WCB**
- **Strainer: 304 stainless steel, 40 mesh**
- **Gasket: Flexible graphite**
- **End Connections: Flanged ANSI 300 RF**
- **Maximum pressure rating 5,100 kpa cold**
- **Sizes: 15mm to 300mm**



Performance Specification			
Class		300	
Test Pressure	Shell test	7.67	MPa
	Seal test	–	
	Back seal Test	–	
	Air Seal Test	–	

Notice:
1.Design by ASME B16.34
2.RF flanged ends by ASME B16.5
3.Valves tested by API 598
4.Pressure–Temperature Rating as per ASME B16.34
5.Painting is suitable for maximum temperature 200℃

NO	PART NAME	MATERIAL	REMARKS
7	Body	ASTM A216–WCB	
6	Filter Screen	SS304(40mesh)	
5	Gasket	FLEXIBLE GRAPHITE/304	
4	Plug Fitting	Carbon Steel	
3	Bonnet	ASTM A216–WCB	
2	Bonnet Bolt	ASTM A193 Gr.B7	
1	Bonnet Bolt Nut	ASTM A194 Gr.2H	

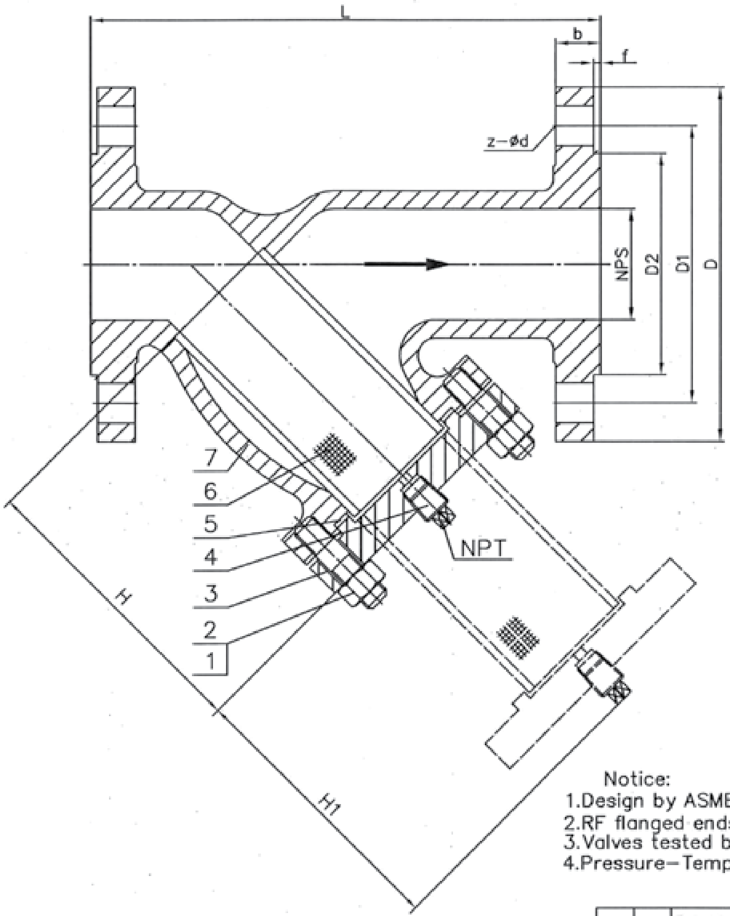
NPS	DN	Typical Dimensions				300Lb Flange Dimensions					
		L	–	H	H1	D	D1	D2	b	f	z–Ød
1¼	–	180	1/2	93	85	135	98.4	63.5	19.5	2	4–19
1½	–	200		122	110	155	114.3	73	21.1	2	4–22
2	–	267	3/4	145	130	165	127	92.1	22.7	2	8–19
2½	–	292		160	150	190	149.2	104.8	25.9	2	8–22
3	–	318		185	170	210	168.3	127	29	2	8–22
4	–	356		210	190	255	200	157.2	32.2	2	8–22
5	–	400		250	235	280	235	185.7	35.4	2	8–22
6	–	444		285	165	320	269.9	215.9	37	2	12–22
8	–	559		330	310	380	330.2	269.9	41.7	2	12–26
10	–	622		395	365	445	387.4	323.8	48.1	2	16–29
12	–	711		425	380	520	450.8	381	51.3	2	16–32

STYSS15R

Y strainer.

Suitable for steam, water, air, gas and most chemicals

- **Body & cap: ASTM A351 Gr CF8M (316 stainless steel)**
- **Strainer: 316 stainless steel, 40 mesh**
- **Gasket: Flexible graphite**
- **End Connections: Flanged ANSI 150 RF**
- **Maximum pressure rating 1,964 kpa cold**
- **Sizes: 15mm to 300mm**



Performance Specification			
Class		150	
Test Pressure	Shell test	2.85	MPa
	Seal test	−	
	BacK seal Test	−	
	Air Seal Test	−	

Notice:
1.Design by ASME B16.34
2.RF flanged ends by ASME B16.5
3.Valves tested by API 598
4.Pressure−Temperature Rating as per ASME B16.34

NO	PART NAME	MATERIAL	REMARKS
7	Body	ASTM A351−CF8M	
6	Filter Screen	SS316(40mesh)	
5	Gasket	FLEXIBLE GRAPHITE/316	
4	Plug Fitting	SS316	
3	Bonnet	ASTM A351−CF8M	
2	Bonnet Bolt	ASTM A193 Gr.B8	
1	Bonnet Bolt Nut	ASTM A194 Gr.8	

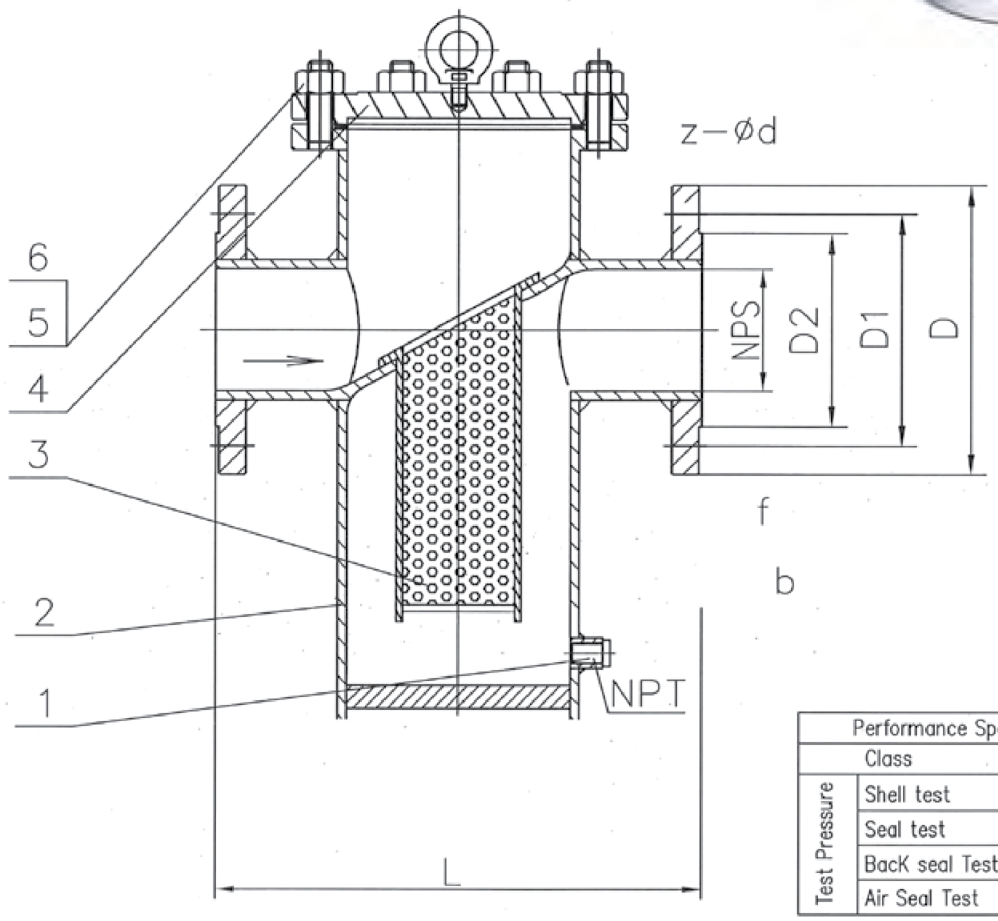
NPS	DN	Typical Dimensions				150Lb Flange Dimensions					
		L	NPT	H	H1	D	D1	D2	b	f	z−ød
1 1/4	−	180	1/2	93	85	115	88.9	63.5	13.2	2	4−16
1 1/2	−	200		122	110	125	98.4	73	14.7	2	4−16
2	−	203	3/4	128	115	150	120.7	92.1	16.3	2	4−19
2 1/2	−	216		145	130	180	139.7	104.8	17.9	2	4−19
3	−	241		165	150	190	152.4	127	19.5	2	4−19
4	−	292		205	190	230	190.5	157.2	24.3	2	8−19
5	−	355		250	235	255	215.9	185.7	24.3	2	8−22
6	−	406		280	165	280	241.3	215.9	25.9	2	8−22
8	−	495		330	310	345	298.5	269.9	29	2	8−22
10	−	622		390	365	405	362	323.8	30.6	2	12−26
12	−	699		415	390	485	431.8	381	32.2	2	12−26

STBCDS15R

Basket strainer.

Suitable for steam, water, air, gas and most non corrosive chemicals

- **Body & cap: ASTM A216 Gr WCB**
- **Strainer: 304 stainless steel, 40 mesh**
- **Gasket: Flexible graphite**
- **End Connections: Flanged ANSI 150 RF**
- **Maximum pressure rating 1,964 kpa cold**
- **Sizes: 15mm to 300mm**



Performance Specification			
Class		150	
Test Pressure	Shell test	3.0	MPa
	Seal test	–	
	BacK seal Test	–	
	Air Seal Test	–	

Notice:

1.RF flanged ends by ASME B16.5
2.Valves tested by API 598
3.Pressure–Temperature Rating as per ASME B16.34
4.Painting is suitable for maximum temperature 200℃

NO	PART NAME	MATERIAL	REMARKS
6	Bonnet Bolt	ASTM A193 Gr.B7	
5	Bonnet Bolt Nut	ASTM A194 Gr.2H	
4	Bonnet	Carbon Steel	
3	Filter Screen	SS304	
2	Body	ASTM A234–WPB	
1	Plug Fitting	Carbon Steel	

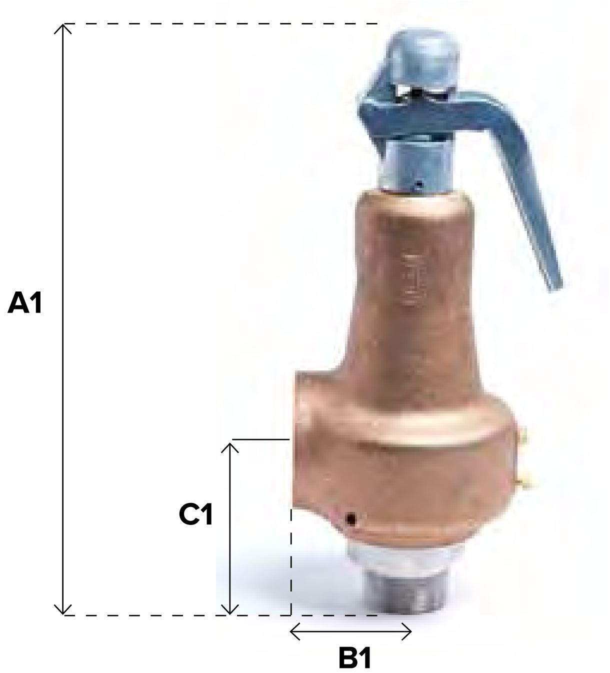
NPS	DN	Typical Dimensions			150Lb Flange Dimensions					
		L	NPT	–	D	D1	D2	b	f	z–Ød
2	–	270	1/2	–	150	120.7	92.1	16.3	2	4–19
2½	–	330	1/2	–	180	139.7	104.8	17.9	2	4–19
3	–	340	1/2	–	190	152.4	127	19.5	2	4–19
4	–	430	1/2	–	230	190.5	157.2	24.3	2	8–19
5	–	480	3/4	–	255	215.9	185.7	24.3	2	8–22
6	–	500	3/4	–	280	241.3	215.9	25.9	2	8–22
8	–	560	3/4	–	345	298.5	269.9	29	2	8–22
10	–	660	1	–	405	362	323.8	30.6	2	12–26

SPSS32

Safety Relief Valve.

Suitable for steam, air and gas applications such as down stream of pressure reducing valves to protect plant integrity. ASME Section 1 certified, in-house setting available.

- Body & cap: Bronze B62
- Seat & disc: 316 stainless steel
- Lever: Steel (plated)
- Soft seat available on request
- End Connections: Screwed BSP
- Maximum pressure rating 2,100 kpa cold
- Sizes: 15mm to 50mm



SPSS32 Dimensions (mm)

Inlet	Orifice	Outlet	A1	B1	C1	D	Weight (kg)
15	D	20	166.7	34.9	57.2	34.9	0.91
20	E	25	181	41.3	58.7	34.9	1.13
25	F	32	228.6	47.6	71.4	42.9	1.81
32	G	40	246.1	54	76.2	42.9	3.18
40	H	50	308	65.1	88.9	69.9	6.12
50	J	65	338.1	79.4	95.3	69.9	7.94

SPSS32 Capacity Chart

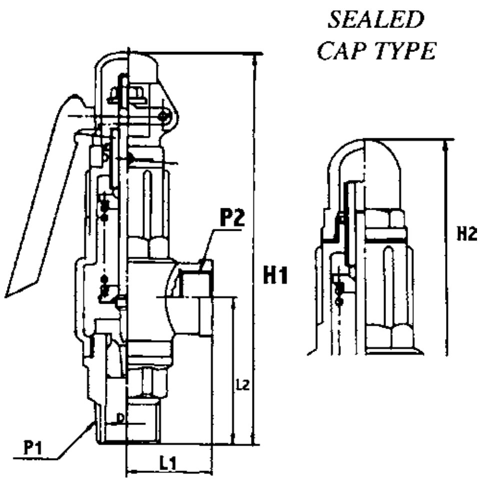
SPSS32 90% of Actual Capacity @ 3% Over Pressure						
Orifice	D	E	F	G	H	J
Valve Size	15 x 20	20 x 25	25 x 32	32 x 40	40 x 50	50 x 65
Set kpa	Flow in kg/hr Saturated Steam					
103	77	137	215	352	550	903
138	89	159	249	408	637	1045
172	102	180	283	463	724	1188
207	113	202	317	519	811	1330
241	126	224	351	574	898	1473
276	138	246	385	629	985	1615
310	150	267	419	685	1071	1757
345	162	289	453	741	1158	1900
379	175	311	487	796	1245	2042
414	186	332	521	852	1332	2185
448	199	354	555	907	1419	2327
483	211	376	590	964	1507	2472
517	224	398	624	1021	1596	2619
552	236	421	660	1078	1686	2766
586	249	443	695	1136	1775	2912
620	261	465	730	1193	1864	3059
655	274	488	765	1250	1954	3205
689	286	510	800	1307	2044	3352
724	299	532	834	1364	2133	3499
758	312	555	869	1421	2222	3654
793	324	577	905	1479	2312	3792
827	337	599	940	1536	2401	3939
862	349	621	975	1593	2490	4086
896	361	644	1010	1650	2580	4232
931	374	666	1044	1707	2669	4379
965	386	688	1079	1765	2759	4526
1000	399	711	1114	1822	2848	4672
1034	412	733	1150	1879	2937	4819
1069	424	756	1185	1936	3027	4966
1103	437	778	1220	1994	3116	5112
1138	449	800	1254	2051	3205	5259
1172	462	822	1289	2108	3295	5405
1206	474	844	1324	2165	3385	5552
1241	487	867	1359	2222	3474	5699
1275	499	889	1395	2279	3563	5846
1310	512	912	1429	2337	3653	5992
1344	524	934	1464	2394	3742	6139
1379	537	956	1499	2451	3831	6286
1413	549	979	1534	2508	3921	6432
1448	562	1001	1569	2566	4010	6579
1482	575	1023	1605	2623	4100	6726
1517	587	1045	1639	2680	4189	6873
1551	600	1068	1674	2737	4278	7019
1586	612	1090	1709	2794	4368	7166
1620	624	1112	1744	2851	4458	7312
1655	637	1135	1779	2908	4547	7459
1689	649	1157	1814	2966	4636	7606
1724	662	1179	1849	3023	4726	7752
1758	675	1202	1884	3080	4815	7899
1792	687	1224	1919	3137	4904	8046
1827	700	1246	1954	3195	4994	8192
1861	712	1268	1989	3252	5083	8339
1896	725	1291	2024	3309	5173	8486
1930	737	1313	2059	3366	5262	8633
1965	750	1336	2094	3423	5351	8779
1999	762	1358	2129	3481	5441	8926
2034	775	1380	2164	3538	5530	9073
2068	787	1402	2199	3595	5620	9218

FGX

Relief Valve.

All stainless steel construction, enclosed cap design, suitable for air and gas and liquid applications, in-house setting available.

- Body & cap: 316 stainless steel
- Seat: 316 stainless steel
- Disc seal: PTFE
- End Connections: Screwed BSP
- Maximum pressure rating 2,000 kpa cold
- Maximum temperature 185 deg C
- Sizes: 15mm to 50mm



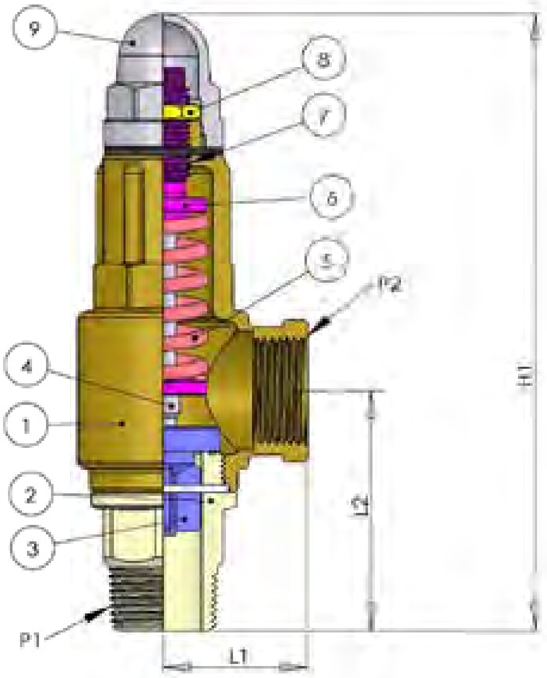
SIZE	P1	D	P2	LIFT	L1	L2	H1	H2	KG	PART NAME	MATERIAL
	BSP		BSP							BODY	A351-CF8M
15	1/2"	21	1"	2.5	40	66	201	180	1.3	SEAT	A351-CF8M
20	3/4"	21	1"	3.2	40	66	201	180	1.3	SPINDLE	A351-F16M
25	1"	21	1"	4.0	40	66	201	183	1.3	RETAINER	A351-CF8M
32	1-1/4"	32	2"	6.5	66	102	286	264	4.9	DISC	A351-CF8M
40	1-1/2"	38	2"	7.3	66	102	286	264	5.0	DISC SEAL	PTFE
50	2"	50	2"	8.0	66	105	289	267	5.3	CAP	A351-CF8M
										SPRING	A351-CF8

FGX Liquid Capacity							
Set Pressure		Litres / Min - Water @ 20 Deg C. 25% Pverpressure					
Kpa	Psi	15mm	20mm	25mm	32mm	40mm	50mm
100	15	21	33	60	97	141	234
200	29	29	46	85	138	199	331
300	44	36	57	104	169	244	405
400	59	42	66	120	195	282	468
500	73	47	74	134	218	315	523
600	87	51	81	147	239	345	573
700	100	55	87	159	258	373	619
800	116	59	93	170	276	398	662
900	130	63	99	180	293	423	702
1000	145	66	105	190	308	445	740
1100	160	70	111	200	323	463	778
1200	175	76	120	215	340	485	815
1300	190	82	129	230	365	512	835

JUR1068

Relief Valve.

- Suitable for water, air and gas, in-house setting available.
- Body & cap: Bronze
- Seat & disc: Bronze
- End Connections: Screwed BSP
- Maximum pressure rating 1,000 kpa cold
- Sizes: 15mm to 50mm



General Material

NO	NAME	MATERIAL	QTY	FLUID SYMBOL	
1	VALVE BODY	BRONZE	1	NONCORROSIVE GAS	NG
2	VALVE SEAT	BRASS	1	CORROSIVE GAS	CG
3	DISC	BRASS	1	STEAM	S
4	STEM	BRASS	1	SUPER STEAM	SS
5	SPRING	STEEL	1	HOT WATER	HW
6	SPRING SEAT	BRASS	1	NONCORROSIVELIQUID	NL
7	ADJUST THREAD	BRASS	1	CORROSICELIQUID	CL
8	ADJUST NUT	BRASS	1		
9	CAP	BRONZE	1		
WORK PRESSURE(Kg/cm²)			0.1 ~ 20Kg		
WORKING TEMP(C)			-45 C ~ 185C		
WORKING FLUID			NG CG SS S HW NL CL		

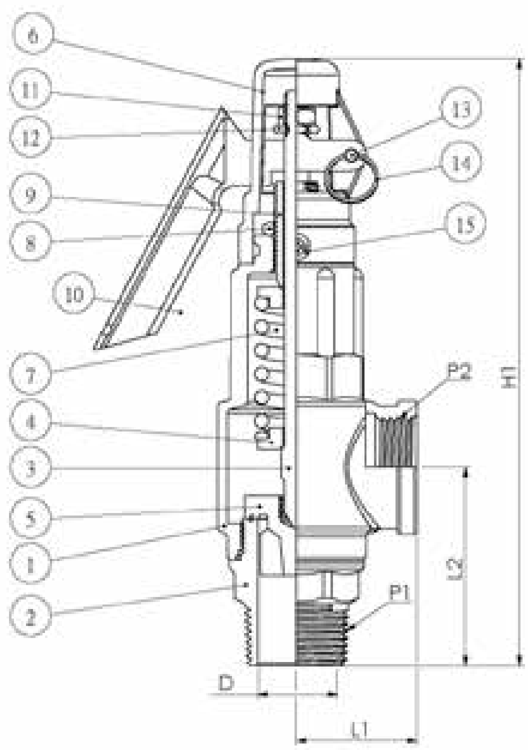
Lift Type Dimensions UNIT : mm

NOMINAL					LIFT	L1	L2	H1	WEIGHT (KG)
P1	*	DN	*	P2					
1/2	*	15	*	1/2	0.52	31.5	49	140	0.51
3/4	*	20	*	3/4	0.76	35	53	150	0.63
1	*	25	*	1	1	40	69.5	165	1.14
1 1/4	*	32	*	1-1/4	1.28	54	64	208	2.09
1 1/2	*	40	*	1 1/2	1.52	60	94	236	2.6
2	*	50	*	2	2	65	100	255	3.64

JUR1069

Safety Relief Valve.

- Suitable for low pressure steam, air and gas, in-house setting available.
- Body & cap: Bronze
- Seat & disc: Bronze
- End Connections: Screwed BSP
- Maximum pressure rating 1,000 kpa cold, 350 kpa steam
- Sizes: 15mm to 50mm



LIFT TYPE SAFETY VALVE

NO	NAME	MATERIAL	QTY	REMARK
1	VALVE BODY	CASTING-BRONZE	1	
2	VALVE SEAT	FORGING-BRASS	1	
3	SPINDEL	BRASS	1	
4	SPRING SEAT	BRASS	2	
5	DISC	FORGING-BRASS	1	
6	CAP	CASTING-BRONZE	1	
7	SPRING	STEEL	1	
8	ADJUST NUT	BRASS	1	
9	ADJUST THREAD-ROD	BRASS	1	
10	HANDEL	STEEL	1	
11	HEXGON NUT	STEEL	1	
12	STOPPER PIECE	BRASS	1	
13	INSERT PIN	STEEL	1	
14	CLIP	STEEL	1	
15	FIXTURE SCREW	STEEL	1	

LIFT TYPE SERIES DIMENSIONS UNIT:mm

NOMINAL SIZE P1 X D X P2	P1	P2	D	L1	L2	H1	
1/2 X13 X 1/2	1/2	1/2	13	32	52	162	
3/4 X 19 X 3/4	3/4	3/4	19	36	58	172	
1 X 25 X 1	1	1	25	40	71	204	
1-1/4 X 32 X 1-1/4	1-1/4	1-1/4	32	52	83	223	
1-1/2 X 38 X 1-1/2	1-1/2	1-1/2	38	58	86	243	
2 X 50 X 2	2	2	50	65	103	287	

1069					Unit : Kg/h	Steam
Size	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
D	13	19	25	32	38	50
Area	21.2	45.3	78.5	128.6	181.4	314.0
Pressure	Capacity (Kg/H)					
Kg/cm2	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
10	96	205	355	581	813	1420
2	26	56	96	157	233	384
3	35	74	128	210	305	514
4	43	93	161	263	378	643
5	52	112	193	316	450	773
6	61	130	225	369	523	902
7	70	149	258	422	595	1031
8	78	168	290	475	668	1161
9	87	186	323	528	741	1290
10	96	205	355	581	813	1420
11	105	224	387	634	886	1549
12	113	242	420	687	958	1678
13	122	261	452	740	1031	1808
14	131	280	484	793	1103	1937
15	140	298	517	846	1176	2067
16	148	317	549	899	1248	2196
17	157	336	581	952	1321	2325
18	166	354	614	1005	1394	2455
19	175	373	646	1058	1466	2584
20	183	392	678	1111	1539	2713
21	192	411	711	1164	1611	2843
22	201	429	743	1217	1684	2972
23	210	448	775	1270	1756	3102
24	218	467	808	1323	1829	3231
25	227	485	840	1376	1902	3360
26	236	504	872	1429	1974	3490
27	245	523	905	1482	2047	3619
28	253	541	937	1535	2119	3749
29	262	560	970	1588	2192	3878
30	271	579	1002	1641	2264	4007

1069					Unit : Kg/h	Air
Size	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
D	13	19	25	32	38	50
Area	21.2	45.3	78.5	128.6	181.4	314.0
Pressure	Capacity (Kg/H)					
Kg/cm2	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
17.6	466	1282	2220	3637	5129	8880
10.6	290	37094	64221	105220	148377	256885
3	5988	12791	22145	36283	51164	88581
4	7485	15989	27682	45354	63956	110726
5	8982	19187	33218	54424	76747	132872
6	10479	22384	38754	63495	89538	155017
7	11976	25582	44291	72566	102329	177162
8	13473	28780	49827	81636	115120	199308
9	14970	31978	55363	90707	127911	221453
10	16467	35176	60900	99778	140702	243598
11	17964	38373	66436	108849	153493	265744
12	19461	41571	71972	117919	166285	287889
13	20958	44769	77509	126990	179076	310034
14	22455	47967	83045	136061	191867	332179
15	23952	51164	88581	145131	204658	354325
16	25449	54362	94117	154202	217449	376470
17	26946	57560	99654	163273	230240	398615
18	28443	60758	105190	172344	243031	420761
19	29940	63956	110726	181414	255822	442906
20	31437	67153	116263	190485	268614	465051
21	32934	70351	121799	199556	281405	487196
22	34431	73549	127335	208626	294196	509342
23	35929	76747	132872	217697	306987	531487
24	37426	79945	138408	226768	319778	553632
25	38923	83142	143944	235838	332569	575778
26	40420	86340	149481	244909	345360	597923
27	41917	89538	155017	253980	358151	620068
28	43414	92736	160553	263051	370942	642213
29	44911	95933	166090	272121	383734	664359
30	46408	99131	171626	281192	396525	686504

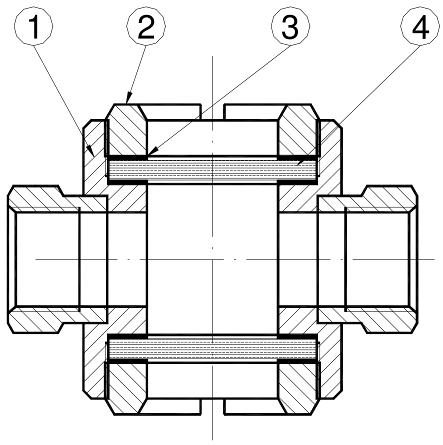
1069					Unit : Kg/h	Water
Size	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
D	13	19	25	32	38	50
Area	21.2	45.3	78.5	128.6	181.4	314.0
Pressure	Capacity (Kg/H)		44 BAR=44X 1.02 = 44.88 KG			
Kg/cm2	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
44.88	4326	9240	15998	26210	36961	63990
2	913	1951	3377	5533	7802	13508
3	1118	2389	4136	6777	9556	16544
4	1291	2759	4776	7825	11034	19104
5	1444	3084	5340	8749	12337	21359
6	1582	3379	5849	9584	13514	23397
7	1708	3649	6318	10351	14597	25272
8	1826	3901	6754	11066	15605	27017
9	1937	4138	7164	11737	16551	28656
10	2042	4362	7551	12372	17447	30206
11	2142	4575	7920	12976	18298	31680
12	2237	4778	8272	13553	19112	33089
13	2328	4973	8610	14107	19892	34440
14	2416	5161	8935	14639	20643	35740
15	2501	5342	9249	15153	21368	36994
16	2583	5517	9552	15650	22069	38208
17	2662	5687	9846	16131	22748	39383
18	2740	5852	10131	16599	23407	40525
19	2815	6012	10409	17054	24049	41636
20	2888	6168	10679	17497	24674	42717
21	2959	6321	10943	17929	25283	43772
22	3029	6469	11201	18351	25878	44802
23	3097	6615	11452	18763	26459	45809
24	3163	6757	11699	19167	27028	46794
25	3229	6896	11940	19562	27586	47759
26	3292	7033	12176	19950	28132	48705
27	3355	7167	12408	20330	28668	49633
28	3417	7299	12636	20703	29194	50544
29	3477	7428	12860	21069	29711	51438
30	3537	7555	13079	21429	30219	52318

DOUBLE WINDOW SIGHT GLASS

DW16SS (Stainless Steel)

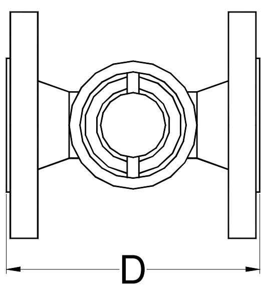
DESCRIPTION
For monitoring the right operation of a steam trap to avoid leakage of live steam and consequently big energy losses, a sight glass is recommended to be installed downstream the steam trap.
Double window DW sight glass, has been designed for this particular application.
Connections are female screwed or flanged.

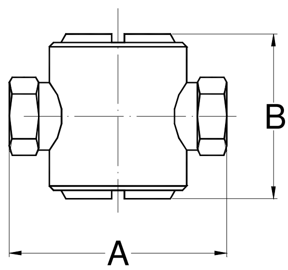
OPTIONS:	Different glasses and design on request.
USE:	Condensate pipes downstream steam traps.
AVAILABLE MODELS:	DW16SS - double window borosilicate glass.
SIZES:	½" to DN 1" - DN15 to DN25. 11/2" and 2" on request.
CONNECTIONS:	Female screwed ISO 7/1Rp(BS21). NPT (ANSI B1.20.1). Flanged EN 1092-1 or ANSI (welded flanges). Special flanges upon request.
INSTALLATION:	Horizontal or vertical installation. See IMI installation and maintenance instructions.



PMO – Max. operating pressure	12	bar
TMO –Max. operating temperature	280	ºC

How to order: i.e. DW16SS DN ½" BSP



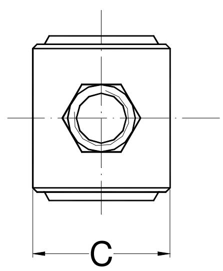


MATERIALS		
POS. Nr.	***DESIGNATION***	***MATERIAL***
1	Body	AISI316 / 1.4401
2	Cover	Brass (NickelPl.)
3	* Gasket	St.St./Graphite
4	* Glass	Borosilicate

* Available spare parts

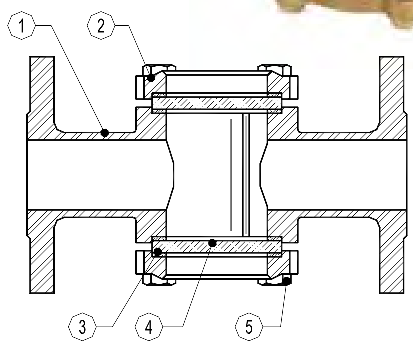
DIMENSIONS (mm)-Screwed					EN 1092-1 Flg.	
SIZE DN	***A***	***B***	***C***	***WGT. Kgs***	***D***	***WGT. Kgs***
1/2"	103	80	65	1,3	130	2,4
3/4"	103	80	65	1,3	130	3,4
1"	100	90	65	1,9	130	4,5

Different face-to-face dimensions on the flanged version,under request.



DOUBLE WINDOW SIGHT GLASS
DW12G – DW12SS

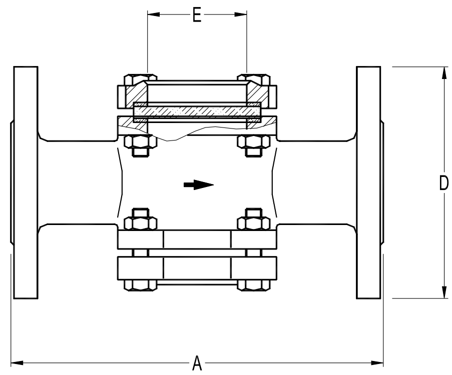
DESCRIPTION
For monitoring the right operation of a steam trap to avoid leakage of live steam and consequently big energy losses, a sight glass is recommended to be installed downstream the steam trap. Double window DW sight glass, has been designed for this particular application.
Connections are flanged.



OPTIONS: Tempered glass.
USE: Condensate pipes downstream steam traps.
AVAILABLE MODELS: DW12G – PN16 Cast iron
DW12SS – PN25 Stainless steel
SIZES: DN15 to DN150

CONNECTIONS: Flanged EN 1092-1/-2 PN16-PN25

INSTALLATION: Horizontal or vertical installation.
See IMI installation and maintenance instructions.



LIMITING CONDITIONS DW12G (Tempered glass)		LIMITING CONDITIONS DW12SS (Temp. glass)		LIMITING CONDITIONS DW12G (Borosilicate)		LIMITING CONDITIONS DW12SS (Borosilicate)	
ALLOWABLE PRESSURES	RELATED TEMP.	ALLOWABLE PRESSURES	RELATED TEMP.	ALLOWABLE PRESSURES	RELATED TEMP.	ALLOWABLE PRESSURES	RELATED TEMP.
16 bar	-10 /120º C	25 bar	-10 /37º C	16 bar	-10 /120º C	25 bar	-10 /37º C
/	/	18 bar	93 ºC	14,4 bar	150 ºC	18 bar	93 ºC
/	/	17 bar	120 ºC	12,8	200 ºC	16 bar	148 ºC
/	/	/	/	11,8	230 ºC	14 bar	204 ºC
/	/	/	/	10,5	280 ºC	11 bar	280 ºC

CE MARKING (PED-European Directive 97/23/EC)			
PN 16	Category	PN 25	Category
DN15 to DN50	SEP - art. 3, paragraph3	DN15 to DN40	SEP - art. 3, paragraph3
DN65 to DN150	1 (CE Marked)	DN50 to DN125	1 (CE Marked)
-	-	DN150	2 (CE Marked)

DIMENSIONS (mm)					
SIZE DN	*A*	*B*	*C*	*Weight (kgs)*	
				DW12G	*DW12SS*
15	130	95	44	3	3
20	150	105	44	3,5	4
25	160	115	44	4	5
32	180	140	50	6	6,5
40	200	150	50	6,5	7,3
50	230	165	60	9	10,5
65	290	185	90	17	17
80	310	200	90	18	20
100	350	220	110	23	26,5
125	400	250	142	50	52
150	480	285	160	63	68

MATERIALS			
POS.	*DESIGNATION*	*MATERIAL DW12G*	*MATERIAL DW12SS*
1	Body	GJL-250 / 0.6025	CF8M / 1.4408
2	Cover	GJL-250 / 0.6025	CF8M / 1.4408
3	* Gasket	Graphite	Graphite
4	* Window	Borosilicate glass	Borosilicate glass
		Tempered glass **	Tempered glass **
5	Bolts	Steel 8.8	A2-70

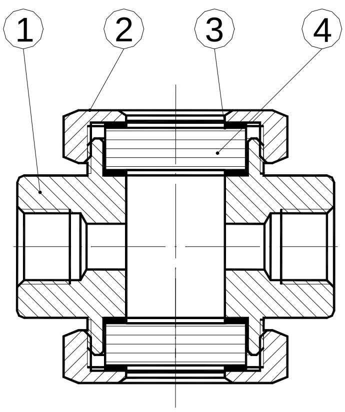
* Available spare parts.** Option

DOUBLE WINDOW SIGHT GLASS

DW40S (DN15 – DN25)

DESCRIPTION
For monitoring the right operation of a steam trap to avoid leakage of live steam and consequently big energy losses, a sight glass is recommended to be installed downstream of the steam trap.
Double window DW sight glass, has been designed for this particular application.
Connections are female screwed or flanged.

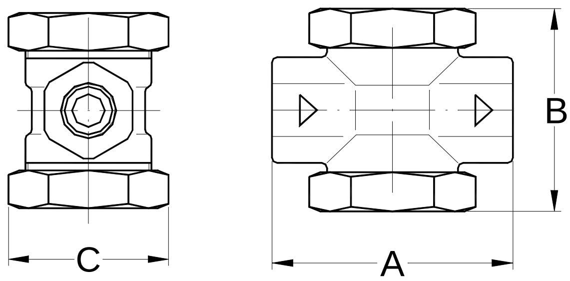
USE:	Condensate pipes downstream steam traps.
AVAILABLE MODELS:	DW 40 S
SIZES:	DN ½” to DN 1“; DN 15 to DN 25
CONNECTIONS:	Female screwed ISO 7/1Rp(BS21). NPT (ANSI B1.20.1) Flanged EN 1092-1 or ANSI
INSTALLATION:	Horizontal or vertical installation. See IMI, installation and maintenance instructions.



PMO – Max. operating pressure	40 bar
TMO – Max. operating temperature	280 ºC

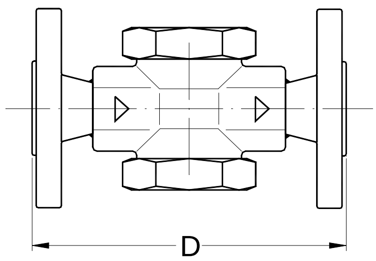
How to order: i.e. DW40 DN ½” BSP.

DIMENSIONS (mm)-Screwed					EN 1092-1 Flanges	
SIZE DN	*A*	*B*	*C*	*WGT. Kgs*	*D*	*WGT. Kgs*
15	90	80	60	1,25	150	2,8
20	90	80	60	1,25	150	3,4
25	100	87	65	2,1	160	4,7



MATERIALS		
POS.Nr.	*DESIGNATION*	*MATERIAL*
1	Body	P250GH / 1.0460
2	Glass nut	P250GH / 1.0460
3	* Gasket	St.Steel / Graphite
4	* Window glass	Borosilicate

*Available spare parts.

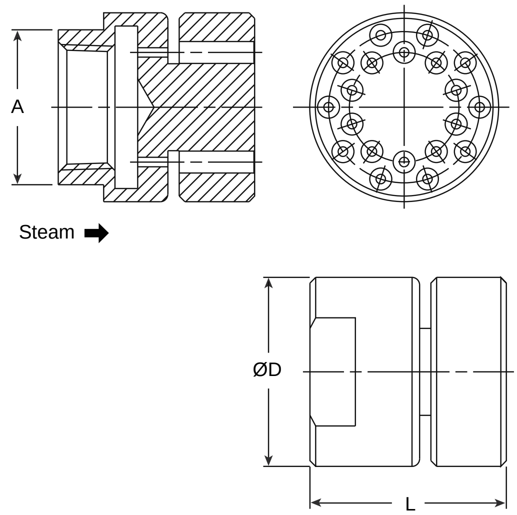


Armstrong MS-6 Noiseless Heater

The use of hot water is indispensable in food processing, cleaning, and plating operations. Although the simplest and most efficient way to provide the water is by direct steam sparging, such a format often results in vibration and noise caused by steam blowing into the water tank. These problems can be greatly reduced by mounting an MS-6 noiseless heater at the end of the pipe.

Features

- Stainless steel construction for greater durability
- Mounting is simple and economical
- Maintenance free



Formula for Calculating Steam Load
to Heat Water in Tank

$$\text{lbs/hr} = \frac{\text{Gal} \times \Delta T \times 8.3}{\text{Lat} \times T}$$

Gal = Gallons of water to be heated
ΔT = Temperature rise °F
Lat = Latent heat of steam (Btu/lb)
T = Time in hours

Specifications	
Fluid	Steam
Pressure Range	7 - 100 psi (0.5 - 7 bar)
Silencing Limit Temperature	190°F (90°C)
Material	304 Stainless Steel
Connection	NPT

Dimensions and Weights

Connection Size	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
	1/2	15	3/4	20	1	25	1-1/4	32	1-1/2	40	2	50
"L"	1-15/16	49	1-15/16	49	2-1/16	52	2-3/16	55	2-5/16	59	2-9/16	65
"D"	1-3/8	35	1-1/4	45	2	50	2-3/8	60	2-3/4	70	4-1/8	105
"A"	1-3/16	30	1-7/16	36	1-5/8	41	2	50	2-3/8	60	3-9/16	90
Weight, lb (kg)	0.55 (0.25)		0.88 (0.40)		1.15 (0.52)		1.70 (0.77)		2.54 (1.15)		6.59 (2.99)	

Capacities - Steam, lb/hr (kg/hr)

Inlet, psi (bar)	Connection Size											
	1/2"		3/4"		1"		1-1/4"		1-1/2		2	
	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr	lb/hr	kg/hr
7 (0.50)	54	25	129	58	157	71	190	86	291	132	362	164
10 (0.70)	65	30	147	67	179	81	222	101	323	147	413	187
15 (1.00)	84	38	177	80	214	97	276	125	376	171	498	226
20 (1.38)	103	46	208	94	250	113	330	150	430	195	582	264
30 (2.00)	140	63	269	122	321	146	439	199	536	243	751	341
40 (2.76)	177	80	330	149	392	178	547	248	643	292	921	418
50 (3.45)	214	97	390	177	463	210	655	297	749	340	1,090	494
60 (4.14)	251	114	451	205	534	242	764	346	856	388	1,259	571
70 (4.83)	289	131	512	232	605	275	872	395	963	437	1,428	648
80 (5.52)	326	148	573	260	676	307	980	445	1,069	485	1,597	725
90 (6.20)	363	165	634	288	748	339	1,088	494	1,176	533	1,767	801
100 (6.90)	400	181	695	315	819	371	1,197	543	1,282	582	1,936	878

EXHAUST HEADS - EH

DESCRIPTION

The EH Exhaust Head is designed to protect the personnel from injury and exterior of buildings from the harmful effects of steam ejection to atmosphere. The head is fitted to the end of a vertical exhaust pipe and thus breaks the beat and muffles the noise of escaping steam whilst effectively retaining the moisture for draining.
Connections are female screwed or flanged.

MAIN FEATURES
Stainless steel separating element.
Quite operation.
Reduces discharge velocity.

OPTIONS: Corrosion protection (metal abrasive blasted, metalized and painted).
Complete stainless steel construction.

USE: Opened vertical steam vent pipes in blowdown vessels, boiler feedtanks, etc.

CAUTION: Not recommended for safety valves outlets.

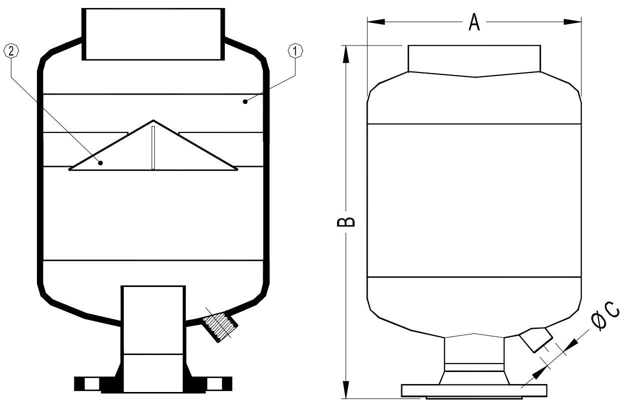
AVAILABLE MODELS:
EH/S - carbon steel body.
EH/SZ - metalized and painted.
EH/SS - stainless steel body.

SIZES: Screwed: DN1” to DN4”.
Flanged: DN25 to DN150.

CONNECTIONS: Female screwed ISO 7/1Rp(BS21)
Flanged EN 1092-1 PN16 or ANSI Class 150.

I
NSTALLATION: Vertical installation. The drain should be piped to a safe position.
The exhaust head should be selected so that it is the same nominal size as the vent pipe.

How to order: i.e.EH/S PN16 DN 65



DIMENSIONS (mm)				
FLANGED EN 1092-1				
SIZE DN	*A*	*B*	*C*	*WGT Kg*
25	168	345	1/2"	15
32	168	345	1/2"	16
40	168	400	1/2"	18
50	273	450	3/4"	26
65	273	450	3/4"	28
80	273	495	3/4"	29
100	273	495	1"	33
125	356	525	1"	42
150	356	525	1"	48
200	508	650	11/2"	95
250	508	650	11/2"	110

Note:
Dimensions are subject to change without notice.
Consult factory for certified dimensions.
Other sizes and designs can be supplied under request.

LIMITING CONDITIONS	
PS - Maximum Allow able Pressure	0,5 bar

Minimum operating temp.: -10ºC. Design code: AD-Merkblatt
Other conditions and CE marking on request.

MATERIALS	
DESIGNATION	*MATERIAL*
Body	Carbon steel P235GH / 1.0305
Separating element	Stainless steel AISI304 / 1.4301

HUMIDITY SEPARATORS - S16/S PN 16

DESCRIPTION
S-16 series centrifugal separators remove moisture from steam and compressed air pipelines. Steam and compressed air passing through the separator and as a result of centrifugal forces, impact and swirling effects, separate the particles with a heavier specific gravity, such as water and oil droplets, moisture in suspension, dirt and scale.
The condensate collected at the bottom of the separator, must be automatically drained by a suitable steam or compressed air trap.
Connections are threaded.

MAIN FEATURES
Several possibilities of installation.
No moving parts.

OPTIONS: Zinc plated (compressed air)
Condensate flanged connection.

USE: Steam, compressed air and other gases (Group 2).

AVAILABLE MODELS: S16/S - carbon steel body.

SIZES: DN ½” to DN 2”.

PIPE CONNECTIONS: Screwed BSP or NPT

INSTALLATION: Always with the condensate discharge pointing downwards.
See IMI, installation and maintenance instructions.

HOW TO SELECT: Generally, in an existing plant it is advisable to fit a separator of the same size of the pipe line. Pressure drop is normally negligible. For approximate pressure drop calculation please consult.

LIMITING CONDITIONS **		
Rating	Press. bar	Temp. ºC
PN16	16	50
	14	100
	13 *	195
	12	250

*PMO-Max.operating pressure for saturated steam. Minimum operating temp.: -10ºC. Design code: AD-Merkblatt
** Rating according to EN1092:2007.

CE MARKING - GROUP 2 GASES CAT.		
RATING	SIZE	CAT.
PN16	DN 1/2" to DN 1"	SEP
	DN 11/4" to DN 2"	1

CE Marking: This product have been designed for use on water steam, air and other gases which are in Group 2 of the PED-European Pressure Equipment Directive 97/23/EC and it comply with those requirements.
The product carries the CE mark when falling in category 1 and above.

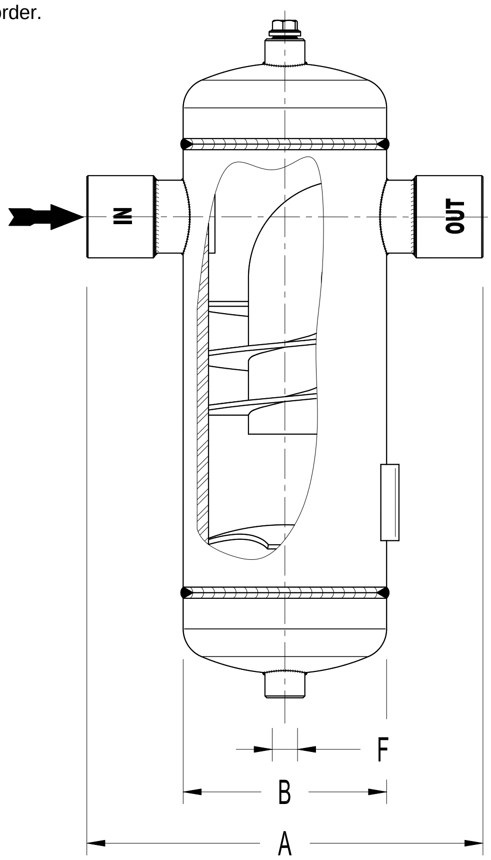
HUMIDITY SEPARATORS - S16/S PN 16

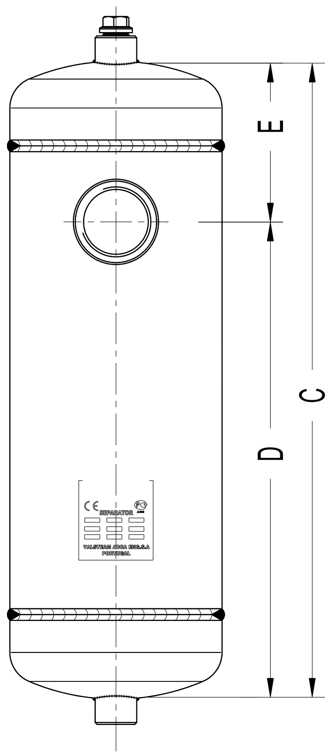
APPROXIMATE DIMENSIONS (mm)								
DN	*A*	*B*	*C*	*D*	*E*	*F* **	*VOL. dm3*	*WGT Kg*
1/2"	218	114	260	165	70	1/2"	2	5
3/4"	218	114	260	165	75	1/2"	2,5	6
1"	230	114	300	200	100	1/2"	3	7
11/4"	263	140	395	285	110	1/2"	5	12
11/2"	263	140	435	325	110	1/2"	5,7	13,8
2"	322	168	505	385	120	1/2"	10,5	19,5

Weight and dimensions to be confirmed in case of order
** F-screwed drain connection as standard.Alternatively can be supplied flanged EN1092-1 or ANSI on the same class of main dimensions.
Consult factory for certified dimensions. Dimensions subject to change without notice.
Note: the top of separator is supplied with a threaded connection with size not exceeding the size of drain one. This connection is always supplied closed with a threaded socket. It can be used for air vent or balancing pipe connection.

MATERIALS	
DESIGNATION	*MATERIAL*
Body	EN10216-2 / P235GH / 1.0325
Heads	EN10028-2 / P265GH / 1.0425
Inlet / Outlet pipes	EN10216-2 / P235GH / 1.0325
Sockets Inlet / Outlet	ASTM A105 / 1.0432
Sockets	ASTM A105 / 1.0432
Internals	EN10025-2 / S235JR / 1.0038

EN10204 3.1 certificate available if requested with the order.





HUMIDITY SEPARATORS - S25/S

PN16 – PN40

DESCRIPTION
S-25 series centrifugal separators remove moisture from steam and compressed air pipelines. Steam and compressed air passing through the separator and as a result of centrifugal forces, impact and swirling effects, separate the particles with a heavier specific gravity, such as water and oil droplets, moisture in suspension, dirt and scale.
The condensate collected at the bottom of the separator, must be automatically drained by a suitable steam or compressed air trap.
Connections are flanged.

MAIN FEATURES
Several possibilities of installation.
No moving parts.

OPTIONS:	Zinc plated (compressed air) Condensate flanged connection.
USE:	Steam, compressed air and other gases (Group 2).
AVAILABLE MODELS:	S25/S - carbon steel body. S25/SZ - zinc plated body
SIZES:	DN15 to DN300.
PIPE CONNECTIONS:	Flanged EN1092-1 PN16 and PN40 ANSI Class 150 lbs and Class 300 lbs Female screwed BSP or NPT on request.
INSTALLATION:	Always with the condensate discharge pointing downwards. See IMI, installation and maintenance instructions.
HOW TO SELECT:	Generally, in an existing plant it is advisable to fit a separator of the same size of the pipe line. Pressure drop is normally negligible. For approximate pressure drop calculation please consult.

HUMIDITY SEPARATORS - S25/S

PN16 – PN40

LIMITING CONDITIONS **											
Rating	Press. bar	Temp. ºC	Rating	Press. bar	Temp. ºC	Rating	Press. bar	Temp. ºC	Rating	Press. bar	Temp. ºC
PN16	16	50	ANSI Cl.150 lbs	16	50	PN25 ANSI CL.300lbs	25	50	PN40 ANSI CL.300lbs	40	50
	14	100		14	100		23	100		37	100
	13 *	195		13 *	195		20 *	216		31 *	239
	12	250		-	-		17	300		27	300

*PMO-Max.operating pressure for saturated steam. Minimum operating temp.: -10ºC. Design code: AD-Merkblatt

** Rating according to EN1092:2007.

CE MARKING - GROUP 2 GASES CATEGORIES								
RATING	SIZE	CAT.	RATING	SIZE	CAT.	RATING	SIZE	CAT.
PN16	DN15 to DN25	SEP	PN25	DN15	SEP	PN40	DN15 to DN32	1
	DN32 to DN50	1		DN20 to DN40	1		DN40 to DN80	2
	DN65 to DN125	2		DN50 to DN100	2		DN100 to DN150	3
	DN150 to DN200	3		DN125 to DN150	3		DN200 to DN300	4
	DN250 to DN300	4		DN200 to DN300	4		-	

CE Marking

This product have been designed for use on water steam, air and other gases which are in Group 2 of the PED-European Pressure Equipment Directive 97/23/EC and it comply with those requirements.

The product carries the CE mark when falling in category 1 and above.

APPROXIMATE DIMENSIONS (mm)																		
FLANGED EN1092-1 - ANSI																		
SIZE DN	*A PN16*	*A PN25*	*A PN40*	*A 150 lbs*	*A 300 lbs*	*B*	*C*	*D*	*E*	*J*	*L PN16*	*A PN25*	*L PN40*	*L 150 lbs*	*L 300 lbs*	*F*	*VOL. * dm3*	*WGT ** Kg*
15	230	230	230	250	259	114	260	185	75	115	144	144	144	135	130	1/2"	2	5
20	230	230	230	255	264	114	260	180	80	115	136	136	136	123	119	1/2"	2,5	6
25	230	230	230	262	274	114	300	215	85	135	142	142	142	126	120	1/2"	3	7
32	260	260	260	290	303	140	395	285	110	155	194	194	194	200	215	1/2"	5	12
40	260	260	260	294	307	140	435	325	110	165	243	243	243	226	220	1/2"	5,7	13,8
50	310	310	310	341	354	168	505	380	125	190	281	281	281	265	259	1/2"	10,5	19,5
65	380	394	394	430	442	219	550	410	140	240	275	268	268	250	244	3/4"	18,5	32
80	400	416	416	440	459	219	610	462	148	260	306	298	298	286	277	3/4"	25	38
100	470	490	490	520	530	273	715	528	187	330	326	313	313	302	293	3/4"	35,4	57
125	535	561	561	605	622	324	845	630	215	403	380	367	367	346	337	1"	50	81,5
150	565	605	605	633	652	356	960	690	270	457	428	408	408	394	385	1"	75	153
200	605	641	650	685	700	406	1170	880	290	545	485	467	459	446	436	1"	140	195
250	720	756	790	784	815	508	1540	1140	400	671	714	696	679	682	666	11/2"	280	321
300	840	868	914	913	944	610	1700	1172	528	800	662	648	625	626	597	11/2"	400	465

* Volume correspond to the class PN16 design.Classes PN25 and above may have slightly lower volumes.

** Weight correspond to the class PN16 design.

F-screwed drain connection as standard.Alternatively can be supplied flanged EN1092-1 or ANSI on the same class of main dimensions.

Consult factory for certified dimensions. Dimensions subject to change without notice.

Note: the top of separator is supplied with a threaded connection with size not exceding the size of drain one. This connection is always supplied closed with a threaded socket. It can be used for air vent or balancing pipe connection.

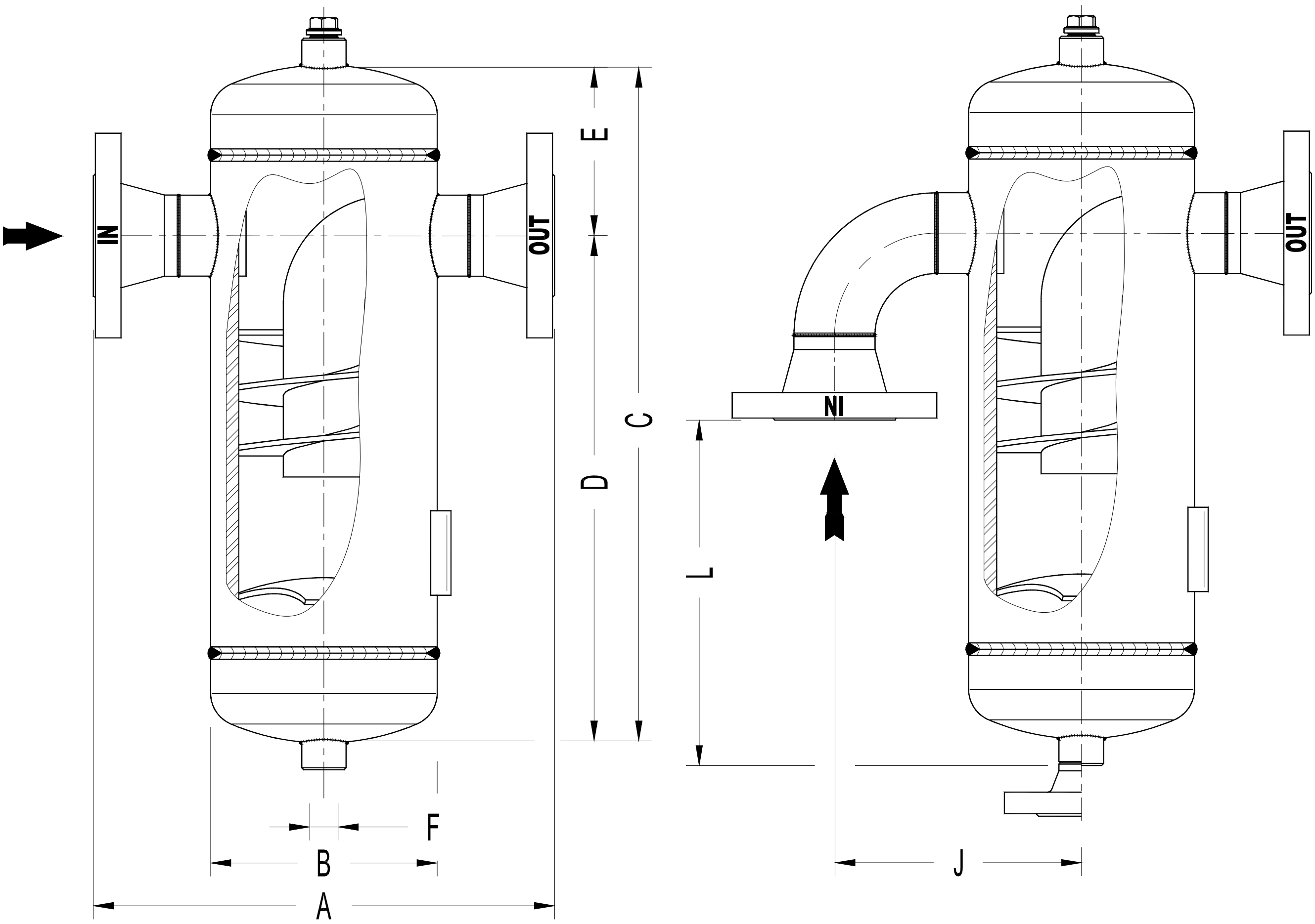
HUMIDITY SEPARATORS - S25/S
PN16 – PN40

MATERIALS	
DESIGNATION	***MATERIAL***
Body	EN10216-2 / P235GH / 1.0325
Heads	EN10028-2 / P265GH / 1.0425
Inlet / Outlet pipes	EN10216-2 / P235GH / 1.0325
EN flanges	EN10222-2 / P250GH / 1.0460
ANSI flanges	ASTM A105 / 1.0432
Sockets	ASTM A105 / 1.0432
Internals	EN10025-2 / S235JR / 1.0038

EN10204 3.1 certificate available if requested with the order.

FLANGE CONNECTIONS			
Rating	***Sep. SIZE***	***EN STD.***	***ANSI STD.***
PN16	* DN15 to DN50	EN1092-1 PN40	ANSI B16.5 Cl.150 lbs
PN16	DN65 to DN300	EN1092-1 PN16	ANSI B16.5 Cl.150 lbs
PN25	DN15 to DN150	EN1092-1 PN40	ANSI B16.5 Cl.300 lbs
PN25	DN200 to DN300	EN1092-1 PN25	ANSI B16.5 Cl.300 lbs
PN40	DN15 to DN300	EN1092-1 PN40	ANSI B16.5 Cl.300 lbs

* Flanges EN 1092-1 PN16 and PN40 from DN15 to DN50 has the same number and size of holes.



EVH-Elbow vertical inlet / horizontal outlet

HUMIDITY SEPARATORS - S25/SS (Stainless steel)

PN16 – PN40

DESCRIPTION
S-25SS series centrifugal separators remove moisture from steam and compressed air pipelines. Steam and compressed air passing through the separator and as a result of centrifugal forces, impact and swirling effects, separate the particles with a heavier specific gravity, such as water and oil droplets, moisture in suspension, dirt and scale.
The condensate collected at the bottom of the separator, must be automatically drained by a suitable steam or compressed air trap.
Connections are flanged.

MAIN FEATURES
Several possibilities of installation.
No moving parts.

OPTIONS:	Condensate flanged connection.
USE:	Steam, compressed air and other gases (Group 2).
AVAILABLE MODELS:	S25/SS - Stainless steel body.
SIZES:	DN15 to DN300.
PIPE CONNECTIONS:	Flanged EN1092-1 PN16 and PN40 ANSI Class 150 lbs and Class 300 lbs Female screwed BSP or NPT on request.
INSTALLATION:	Always with the condensate discharge pointing downwards. See IMI, installation and maintenance instructions.
HOW TO SELECT:	Generally, in an existing plant it is advisable to fit a separator of the same size of the pipe line. Pressure drop is normally negligible. For approximate pressure drop calculation please consult.

HUMIDITY SEPARATORS - S25/SS (Stainless steel)

PN16 – PN40

LIMITING CONDITIONS **											
Rating	Press. bar	Temp. ºC	Rating	Press. bar	Temp. ºC	Rating	Press. bar	Temp. ºC	Rating	Press. bar	Temp. ºC
PN16	16	50	ANSI Cl.150 lbs	16	50	PN25 ANSI CL.300lbs	25	50	PN40 ANSI CL.300lbs	40	50
	16	100		16	100		25	100		40	100
	13 *	195		13 *	195		21 *	217		32 *	240
	12	250		-	-		18	300		30	300

*PMO-Max.operating pressure for saturated steam. Minimum operating temp.: -10ºC. Design code: AD-Merkblatt

** Rating according to EN1092:2007.

CE MARKING - GROUP 2 GASES CATEGORIES								
RATING	SIZE	CAT.	RATING	SIZE	CAT.	RATING	SIZE	CAT.
PN16	DN15 to DN25	SEP	PN25	DN15	SEP	PN40	DN15 to DN32	1
	DN32 to DN50	1		DN20 to DN40	1		DN40 to DN80	2
	DN65 to DN125	2		DN50 to DN100	2		DN100 to DN150	3
	DN150 to DN200	3		DN125 to DN150	3		DN200 to DN300	4
	DN250 to DN300	4		DN200 to DN300	4		-	

CE Marking

This product have been designed for use on water steam, air and other gases which are in Group 2 of the PED-European Pressure Equipment Directive 97/23/EC and it comply with those requirements.

The product carries the CE mark when falling in category 1 and above.

APPROXIMATE DIMENSIONS (mm)												
FLANGED EN1092-1 - ANSI												
SIZE DN	A PN16	A PN25	A PN40	A 150lbs	A 300lbs	B	C	D	E	F	VOL. * dm3	WGT ** Kg
15	230	230	230	250	259	114	260	185	75	1/2"	2	5
20	230	230	230	255	264	114	260	185	75	1/2"	2,5	6
25	230	230	230	262	274	114	300	200	100	1/2"	3	7
32	260	260	260	290	306	140	395	285	110	1/2"	5	12
40	260	260	260	294	307	140	435	320	115	1/2"	5,7	13,8
50	310	310	310	341	354	168	505	385	120	1/2"	10,5	19,5
65	380	394	394	430	442	219	550	410	140	3/4"	18,5	32
80	400	416	416	440	459	219	610	462	148	3/4"	25	38
100	485	511	511	533	553	273	715	528	187	3/4"	35,4	57
125	535	561	561	605	622	324	845	630	215	1"	50	81,5
150	585	605	605	635	652	356	962	692	270	1"	75	153
200	605	641	657	685	703	406	1170	880	290	1"	140	195
250	720	756	790	784	815	508	1540	1140	400	11/2"	280	321
300	840	868	914	913	944	610	1700	1172	528	11/2"	400	465

* Volume correspond to the class PN16 design.Classes PN25 and above may have slightly lower volumes.

** Weight correspond to the class PN16 design.

F-screwed drain connection as standard.Alternatively can be supplied flanged EN1092-1 or ANSI on the same class of main dimensions.

Consult factory for certified dimensions. Dimensions subject to change without notice.

Note: the top of separator is supplied with a threaded connection with size not exceding the size of drain one. This connection is always supplied closed with a threaded socket. It can be used for air vent or balancing pipe connection.

HUMIDITY SEPARATORS - S25/SS (Stainless steel)

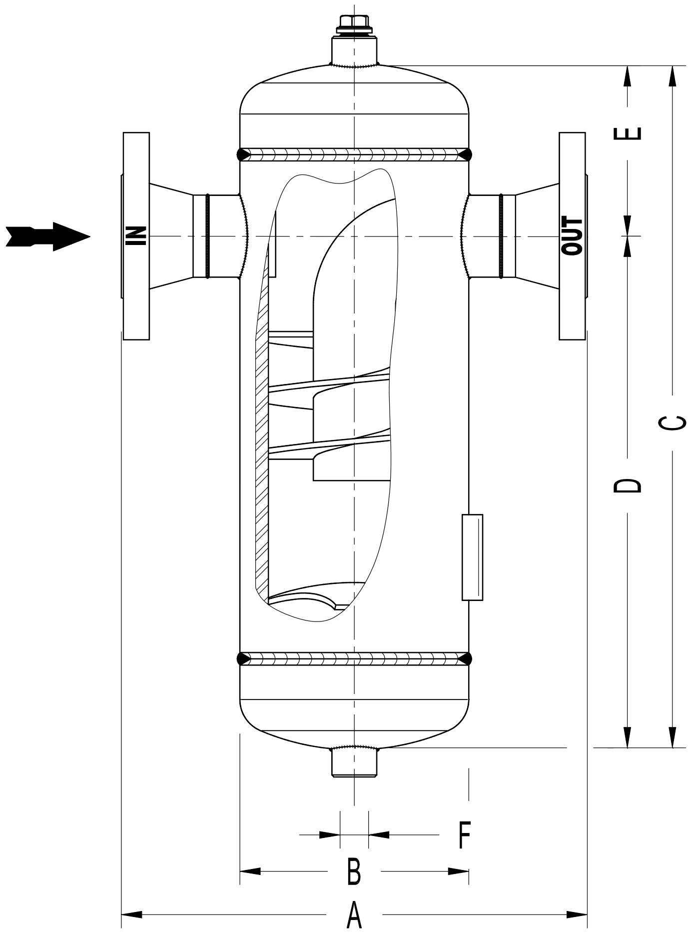
PN16 – PN40

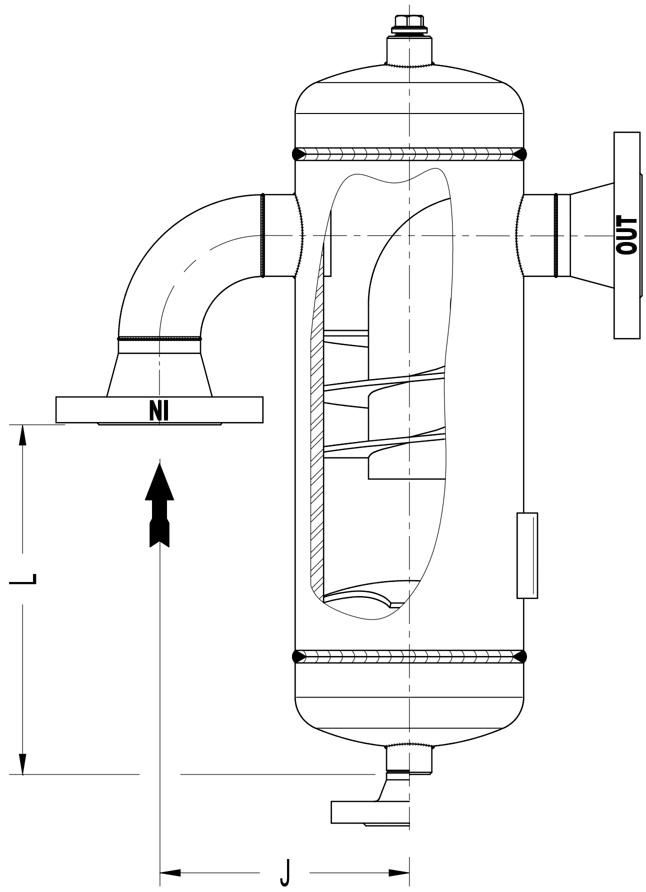
MATERIALS	
DESIGNATION	*MATERIAL*
Body	EN10216-5 / ASTM A312TP316L
Heads	EN10028-7 / ASTM A403 WP316L
Inlet / Outlet pipes	EN10216-5 / ASTM A312TP316L
EN flanges	EN10222-5 / ASTM A182 F316/316L
ANSI flanges	ASTM A182 F316/316L
Sockets	AISI 304 (1.4301) / AISI316 (1.4401)
Internals	EN10272 / ASTM A479/A276-316/316L

EN10204 3.1 certificate available if requested with the order.

FLANGE CONNECTIONS			
Rating	*Sep. SIZE*	*EN STD.*	*ANSI STD.*
PN16	* DN15 to DN50	EN1092-1 PN40	ANSI B16.5 Cl.150 lbs
PN16	DN65 to DN300	EN1092-1 PN16	ANSI B16.5 Cl.150 lbs
PN25	DN15 to DN150	EN1092-1 PN40	ANSI B16.5 Cl.300 lbs
PN25	DN200 to DN300	EN1092-1 PN25	ANSI B16.5 Cl.300 lbs
PN40	DN15 to DN300	EN1092-1 PN40	ANSI B16.5 Cl.300 lbs

* Flanges EN 1092-1 PN16 and PN40 from DN15 to DN50 has the same number and size of holes.





EVH-Elbow vertical inlet / horizontal outlet

SAMPLE COOLERS

SC32 – SC132

DESCRIPTION

ADCA sample coolers are specially designed to cool samples of boiler water or steam for analysis.
Sample coolers prevent steam flashing-off from hot pressurised liquid samples, which can be dangerous and will result in an incorrect water sample.
This device may be used for boiler water analysis and other sampling or cooling applications compatible with construction materials.

MAIN FEATURES

Corrosion-resistant body and internals.
Self draining sample (inlet top, outlet bottom).

OPTIONS: Sample inlet valve.
Cooling water inlet valve.
Temperature indicator
Bolted top plate.
Different connection sizes and materials under request against extra price.
Double coil high pressure design for larger capacities

USE: Steam boilers and hot water systems.

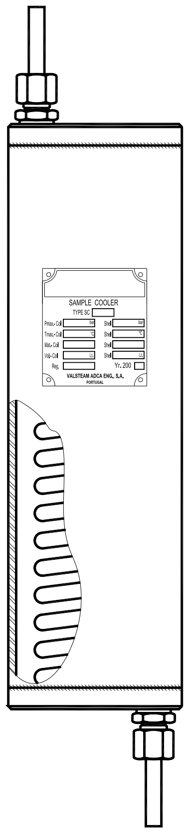
AVAILABLE MODELS: SC32/SS - SC132/SS - stainless steel body and coil.

SIZES AND CONNECTIONS : SC32 – SC132
Cooling water inlet/outlet : 1/2” on body (BSP or NPT)
Sample tube inlet/outlet : 8 mm O/D

INSTALLATION: Vertical installation.

OPERATION: Cooling water must be in its maximum flow before open or close the sample inlet valve, in order to avoid the risk of scalding.
The sample valve must also be closed before the cooling water valve.

PERFORMANCE: 30 to 60 kg/hr of sample water at ≈ 30ºC with 1m3/h -15ºC inlet cooling water (boilers up to 20 bar-220ºC), for other pressures, temperatures and /or certified figures please consult.



LIMITING CONDITIONS				
	BODY		COIL	
Model	Pressure bar	Related Temp. ºC	Pressure bar	Related Temp. ºC
SC32 - SC132	20	120	110	400
			90	450

Minimum operating temperature : -10ºC
Design code : AD - Merkblatt

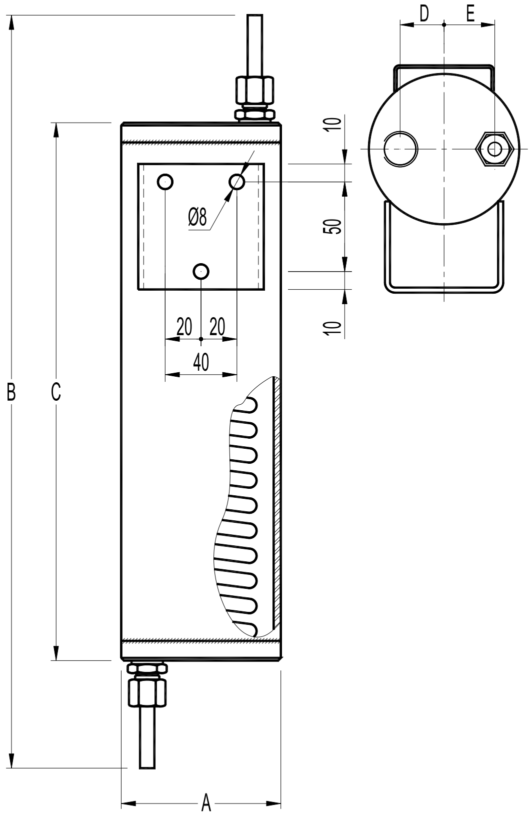
SAMPLE COOLERS

SC32 – SC132

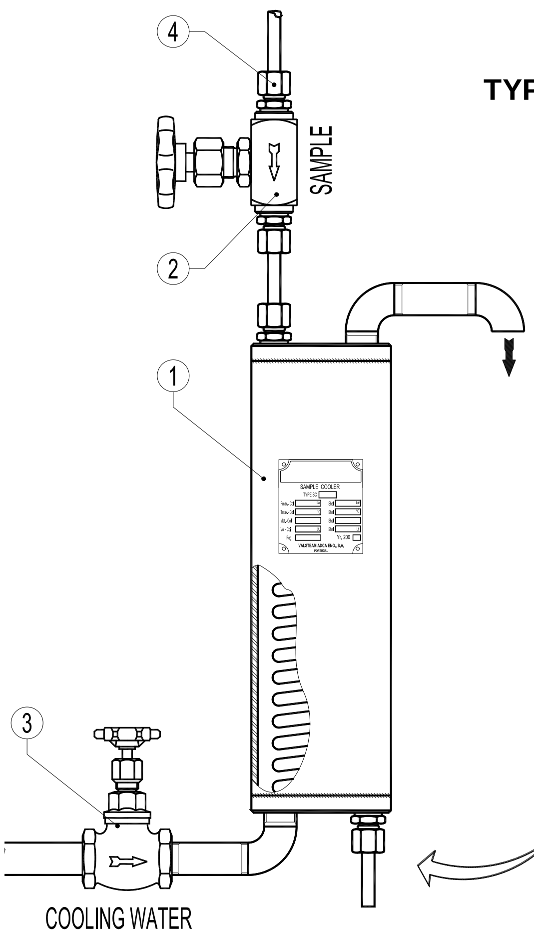
DIMENSIONS (mm)						
MODEL	***A***	***B***	***C***	***D***	***E***	***WGT Kg***
SC 32	90	420	300	26	30	3,9
SC 132	90	520	400	26	30	4,8

MATERIALS	
DESIGNATION	***MATERIAL***
	SC32 - SC132
Body	AISI 304 / 1.4301
Covers	AISI 304 / 1.4301
Coil	AISI 316L / 1.4404
Compression fittings *	Fe / Zn 12 - ISO 2081 - Cl. L
Discharge tube	ASI 316L / 1.4404
Thermometer connector	AISI 316 / 1.4401

EN10204 3.1 certificate available if requested with the order.
* Stainless steel available against extra price

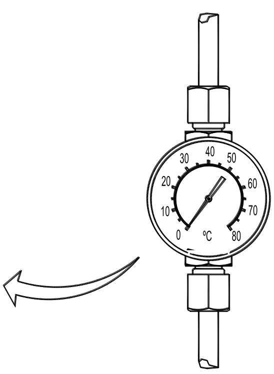


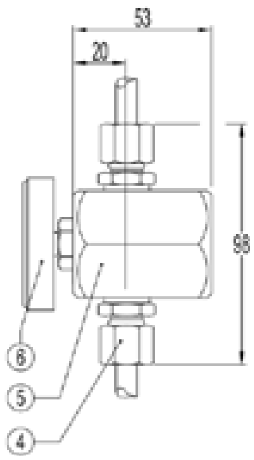
TYPICAL INSTALLATION



Pos.	Designation
1	Sample Cooler
2	* Sample inlet valve NV-400
3	Cooling water inlet valve ADCA GV32B
4	**Comp. fitting DN1/4"x 8 (2) Fe/Zn - ISO 2081 - Cl.L
4 ***	**Comp. fitting DN1/4"x 8 (2) Cl. S (316Ti / 1.4571)
5	Thermometer connector
6	Bimetal thermometer

*Check operating conditions, see catalogue
Limited to max. 400 °C ; * Option, against extra price.





SAMPLE COOLERS

SC332 – SC432 – SC532

DESCRIPTION
ADCA sample coolers are specially designed to cool samples of boiler water or steam for analysis.
Sample coolers prevent steam flashing-off from hot pressurised liquid samples, which can be dangerous and will result in an incorrect water sample.
This device may be used for boiler water analysis and other sampling or cooling applications compatible with construction materials.

MAIN FEATURES
Corrosion-resistant body and internals.
Counter-current flow for better performance

OPTIONS: Sample inlet valve.
Cooling water inlet valve.
Temperature indicator
Bolted top plate.
Different connection sizes and materials under request against extra price.

USE: Steam boilers and hot water systems.

AVAILABLE MODELS: SC332/SS – SC432/SS – SC532/SS - stainless steel body and coil.

SIZES AND CONNECTIONS : SC332 and SC332H
Cooling water inlet/outlet : 1/2" (BSP or NPT)
Sample tube inlet/outlet : 10 mm O/D
SC432 and SC532 ; SC432H and SC532H
Cooling water inlet/outlet : 3/4" (BSP or NPT)
Sample tube inlet/outlet : 10 mm O/D

INSTALLATION: Vertical installation.

OPERATION: Cooling water must be in its maximum flow before open or close the sample inlet valve, in order to avoid the risk of scalding.
The sample valve must also be closed before the cooling water valve.

PERFORMANCE: 30 to 60 kg/hr of sample water at ≈ 30ºC with 15ºC inlet cooling water, for certified figures please consult.

LIMITING CONDITIONS							
SC332 - SC432 - SC532				SC332H - SC432H - SC532H			
BODY		COIL		BODY		COIL	
Pressure bar	Related Temp. ºC	Pressure bar	Related Temp. ºC	Pressure bar	Related Temp. ºC	Pressure bar	Related Temp. ºC
20	120	130	300	20	120	280	300
		120	400			268	400
		110	450			260	450
		100	500			245	550

Minimum operating temperature : -10ºC

SAMPLE COOLERS

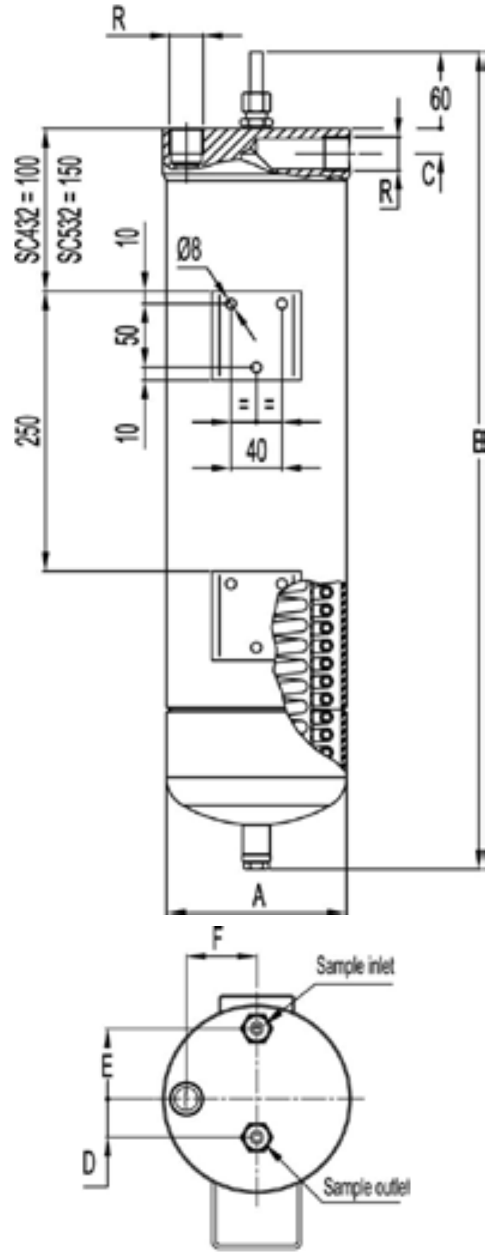
SC332 – SC432 – SC532

DIMENSIONS (mm)							
MODEL	***A***	***B***	***C***	***D***	***E***	***F***	***WGT Kg***
SC332	90	610	15	18	35	35	9
SC432	140	585	20	30	55	55	18,3
SC532	140	685	20	30	55	55	22,3

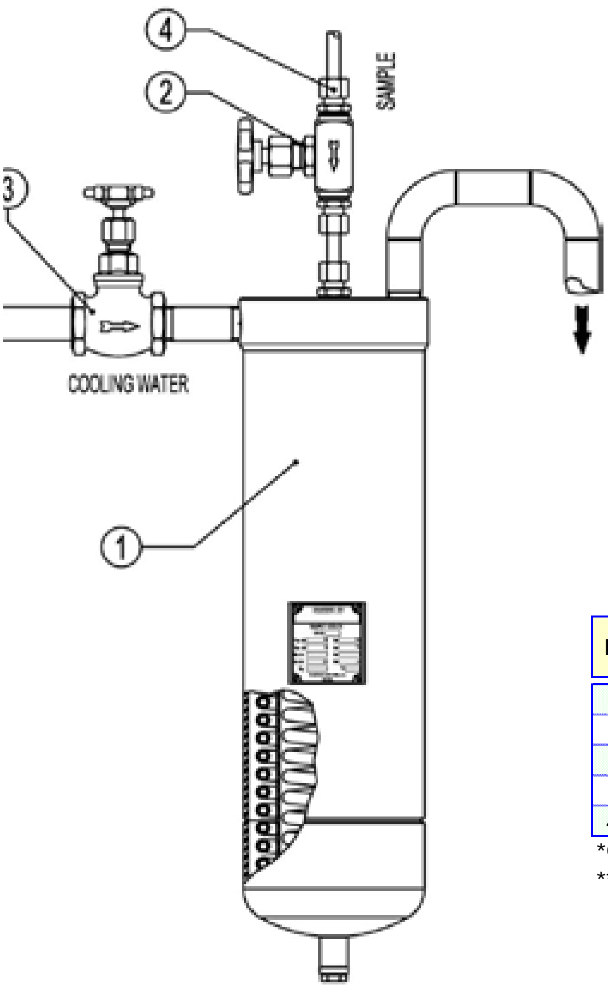
Note: same dimensions for the version "H" (higher temperatre)

MATERIALS	
DESIGNATION	***MATERIAL SC332 - SC432 - SC532***
Body	AISI 304 / 1.4301 or AISI 316 / 1.401
Cover	AISI 304 / 1.4301 or AISI 316 / 1.401
Coil	AISI 316Ti / 1.4571
Compression fittings *	Fe / Zn 12 - ISO 2081 - Cl. L
Discharge tube	AISI 316Ti / 1.4571

EN10204 3.1 certificate available if requested with the order.
Same materials for the version"H", except the coil thickness.
* Stainless steel available against extra price



TYPICAL INSTALLATION



Pos.	Designation
1	Sample Cooler
2	* Sample inlet valve NV-400
3	Cooling water inlet valve ADCA GV32B
4	**Comp. fitting DN1/4"x 10 (2) Fe/Zn - ISO 2081 - Cl.L
4 ***	**Comp. fitting DN1/4"x 10 (2) Cl. S (316Ti / 1.4571)

*Check operating conditions, see catalogue
Limited to max. 400 ºC ; * Option, against extra price.

VACUUM BREAKER - VB 21

DESCRIPTION
The VB21 vacuum breakers are simple and reliable devices that automatically relieve or “break” an unwanted vacuum condition, restoring the atmospheric pressure.
This device is particularly suitable for steam heated units of small and medium volume as heat exchangers, heating coils, calorifiers, jacketed kettles, steam boilers, etc.
Connections are female screwed.

USE: Saturated and superheated steam

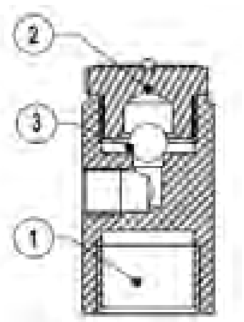
AVAILABLE MODELS: VB21; VB21M

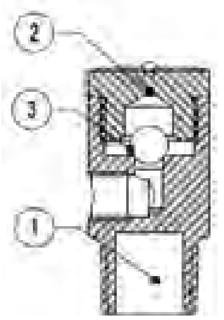
SIZES: ½” x 1/8”

CONNECTIONS: Inlet ½” vertical
Outlet 1/8” horizontal
VB21-Female screwed ISO 7-1 Rp (BS21)
VB21M-Male screwed ISO 7-1 R (BS21)

INSTALLATION: Vertical installation angled connection.
See IMI, installation and maintenance instructions.

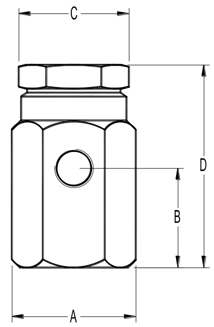
LIMITING CONDITIONS: 13 bar at 400 ºC
21 bar at 220 ºC

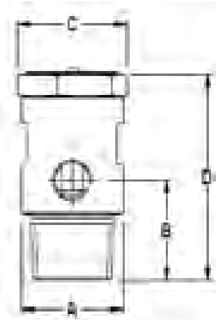




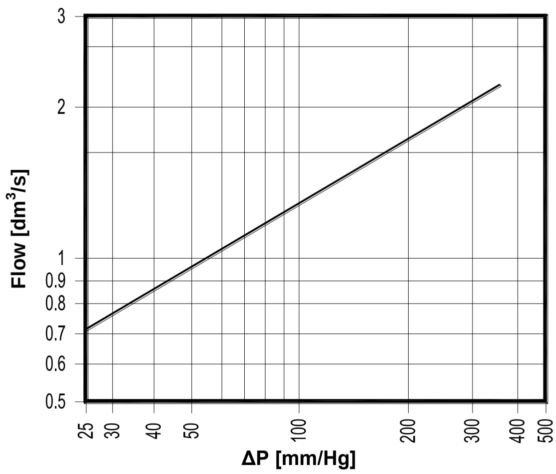
MATERIALS		
POS.Nr.	***DESIGNATION***	***MATERIAL***
1	Body	AISI304 / 1.4301
2	Cover	AISI304 / 1.4301
3	* Ball valve	Stainless steel

*Available spare parts.





CAPACITY CHART



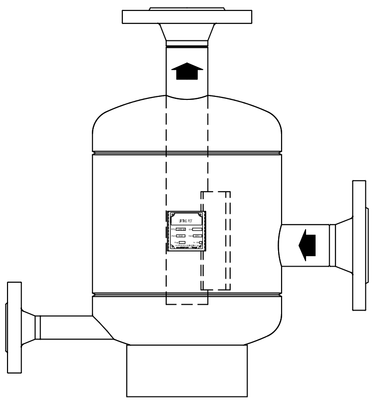
ΔP required to open vacuum breaker: 4,6mm/Hg.

DIMENSIONS (mm)					
MODEL	***A***	***B***	***C***	***D***	***WGT. Kgs***
VB21	32	25	27	50	0,17
VB21M	25	25	27	50	0,13

LIFTING POTS - LIPO

DESCRIPTION AND OPERATION

LIPO condensate lifting pots are used for rising condensate pipes eliminating steam and water hammering.
When the condensate is elevated to the condensate main in a higher level, the flash steam formed at a steam trap's outlet condenses in contact with colder condensate and steam bubbles implode, reducing its volume while passing to the liquid state. Vacuum is then suddenly formed and when filled again with the incoming condensate, it causes water hammer.
The air and flash steam cushion formed in the upper part of the lifting pot absorbs any shock while, in the bottom the condensate operates as a sealing liquid.



OPTIONS:	Stainless steel construction.
USE:	Condensate lines where condensate has to be lifted.
SIZES:	DN 15 to DN100
CONNECTIONS:	Flanged EN1092-1 or ANSI. Different connections on request.
CONSTRUCTION:	Carbon steel or stainless steel under request.
INSTALLATION:	Vertical installation (inlet/outlet angle connections) The differential pressure must be enough to overcome the pressure head and pipe friction.

LIMITING CONDITIONS		
	Flanged PN16	Flanged PN40
PS - Maximum Allowable Pressure	12 bar	18 bar
TS - Maximum Allowable Temperature	250ºC	250ºC

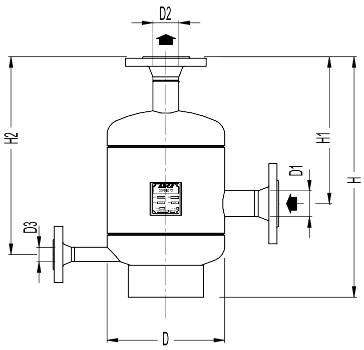
Minimum operating temp.: -10ºC. Design code: AD-Merkblatt
Other conditions on request.

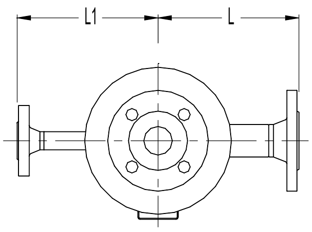
CE MARKING (PED - European Directive 97/23/EC)		
12 bar	18 bar	Category
DN 15 to 50	DN 15 to 50	1 (CE Marked)
DN 65 to 100	DN 65 to 100	2 (CE Marked)

LIFTING POTS - LIPO

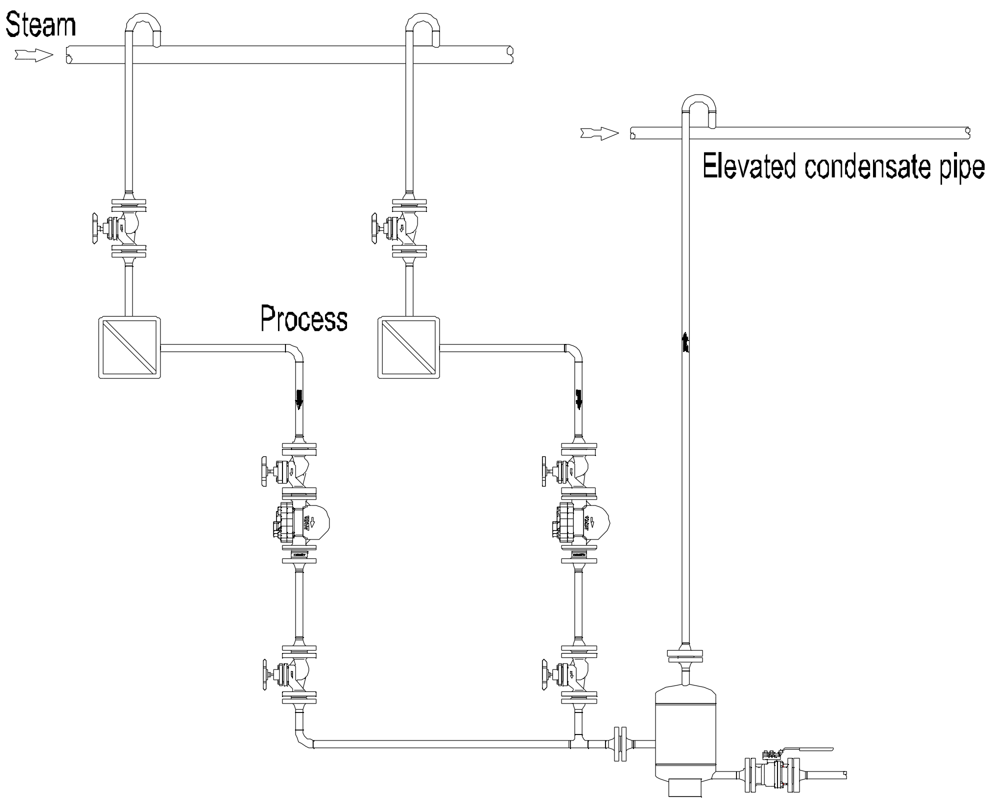
DIMENSIONS (mm)										
DN	H	H1	H2	L	L1	D	D1	D2	D3	WEIGHT *
15	384	240	325	180	180	170	DN15	DN15	DN15	9
20	384	240	325	180	180	170	DN20	DN20	DN15	10
25	384	240	325	180	180	170	DN25	DN25	DN15	11
32	450	275	370	210	210	220	DN32	DN32	DN20	18,5
40	450	275	370	210	210	220	DN40	DN40	DN20	19
50	450	275	370	210	210	220	DN50	DN50	DN20	21
65	630	425	540	240	240	275	DN65	DN65	DN20	35
80	630	400	540	240	240	275	DN80	DN80	DN20	38
100	660	400	545	350	350	400	DN100	DN100	DN20	72

* Weight in kgs to be confirmed .





TYPICAL INSTALLATION



Armstrong Simplifies Your Tracing Line Systems

Designed to simplify and supply all the components (steam traps, manifolds, valves, etc.) necessary for your drip and tracer line applications, Armstrong's new Steam Distribution and Condensate Collection Manifolds bring all components together to reduce installation costs and provide a compact, easily accessible, centrally located assembly.

Armstrong's manifold series includes four different configurations, a Steam Distribution (MSD/SMSD), and a Condensate Collection Assembly (CCA/CCAF). As an option, the condensate manifolds can offer freeze protection.

In either case, you will save the expensive headaches of trying to fabricate in-house. What's more, your manifold will be backed by the famous Armstrong quality—and a standard three-year limited warranty.

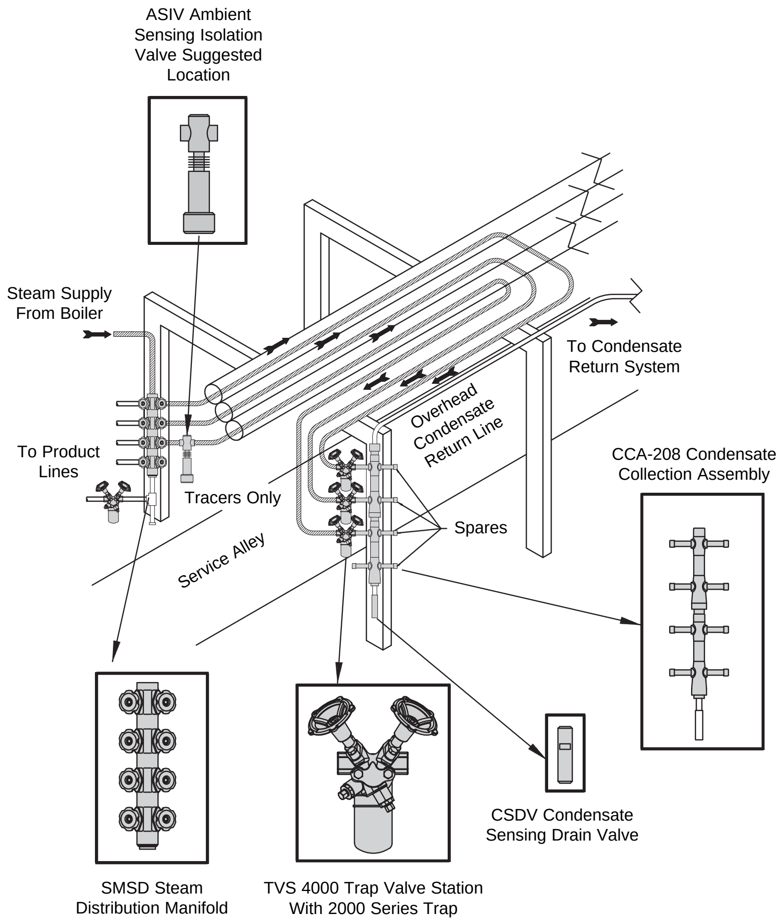
Steam Distribution Manifolds

As a Steam Distribution Assembly (MSD/SMSD), the manifold places all steam supply valves in one location. Standardizing components and centralizing their location simplifies installation, cutting costs from the beginning. You also save because routine maintenance is faster.

Condensate Collection Manifolds

To make industry's trapping and valving more efficient, Armstrong combines its stainless steel steam trap valve stations with manifolds into a package called the Condensate Collection Assembly (CCA). This prepackaged assembly offers many great benefits—cost savings in installation, design flexibility, and reduced purchasing time. CCAF would also include syphon tube freeze protection.

Whatever your condensate collection or steam distribution needs, Armstrong has the manifold for savings over the long term.



Shown are typical locations for Armstrong manifolds. The many manifolds in chemical/petrochemical plants consume valuable floor space and often block movement among the units. Operating costs are high, and installation requires expensive custom fabrication on site. Clearly, a prefabricated manifold permitting standardization of components offers substantial savings over conventional units. Shaded products are available from Armstrong. Call or consult your Armstrong Representative if additional product details are required.

The Proof Is in the Piston

Many of Armstrong's manifolds utilize the piston valve because of its years of excellent performance in steam systems all over the world. The proof of Armstrong's long service life for manifolds…is in the piston.

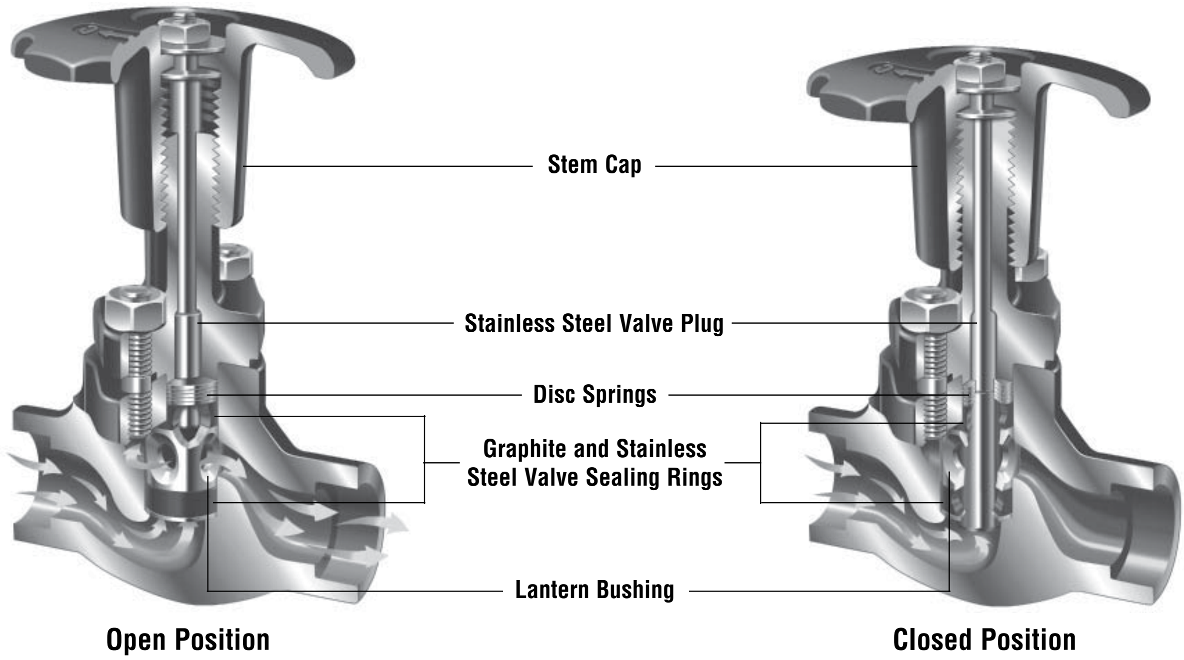
All types of valves—plug valves, gate valves, piston valves and even ball valves—have been summoned for duty in steam service. Due to its excellent sealing characteristics in steam service, and because it has no gland packing, the piston valve is frequently selected for steam systems.

People who have used it over the past 90 years can testify that leakage to atmosphere is extremely rare, even without any maintenance. The elastic contact between piston and valve sealing rings provides a perfect tightness, both in-line and to atmosphere.

Steam system valves, whatever their design, are used to isolate steam and condensate lines or when a faulty steam trap needs to be removed from the line. This means the valves stay in the open position for long periods and are nearly always in contact with the atmosphere. It is not surprising, therefore, that when the valves need to be closed, they can often prove difficult to operate. Our experience and the demands from end users for energy efficiency have led us to a sealing system designed especially for steam service.

The Piston Valve

Armstrong Steam Distribution Manifolds (MSD/SMSD) and TVS 4000 Trap Valve Stations incorporate advanced piston sealing technology for safer, longer lasting steam isolation service.



- **Dual sealing action.** The piston valve is a seatless valve that includes two graphite and stainless steel valve sealing rings that seal the stem and function as a seat. This combination provides long-term protection against leaks to the atmosphere and downstream piping.

- **Self-cleaning action.** Stainless steel piston slides without rotating between the two valve sealing rings, preventing dirt from damaging the surfaces.

- **Sealing integrity.** Flexible disc springs automatically provide leak tightness by exerting pressure, which keeps the upper and lower valve sealing rings compressed at all times. Sealing tightness is ensured by the compression of the sealing rings against the piston and valve body. This combination of disc springs and dual valve seal rings protects against expansion and contraction due to heating and cooling. This ensures dependable operation, even after years of service.

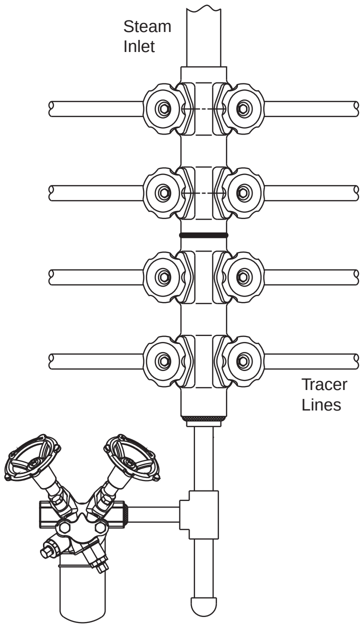
- **Protected valve stem.** The valve stem and sealing surfaces are completely protected from dirt and corrosion by the stem cap, whether in an open or closed position.

- **In-line repairability.** All sealing valve components may be easily replaced in-line.

- **Long-term operation.** Piston valve design ensures actuation even after many years without operation.

Steam Distribution Manifold (MSD/SMSD)

As Steam Distribution Assemblies (MSD/SMSD), the manifolds place all steam supply valves in one location. Standardizing components and centralizing their location simplifies installation while providing cost savings. You also save because routine maintenance is faster. Insulation can also be provided…and can be a major savings in most installations.



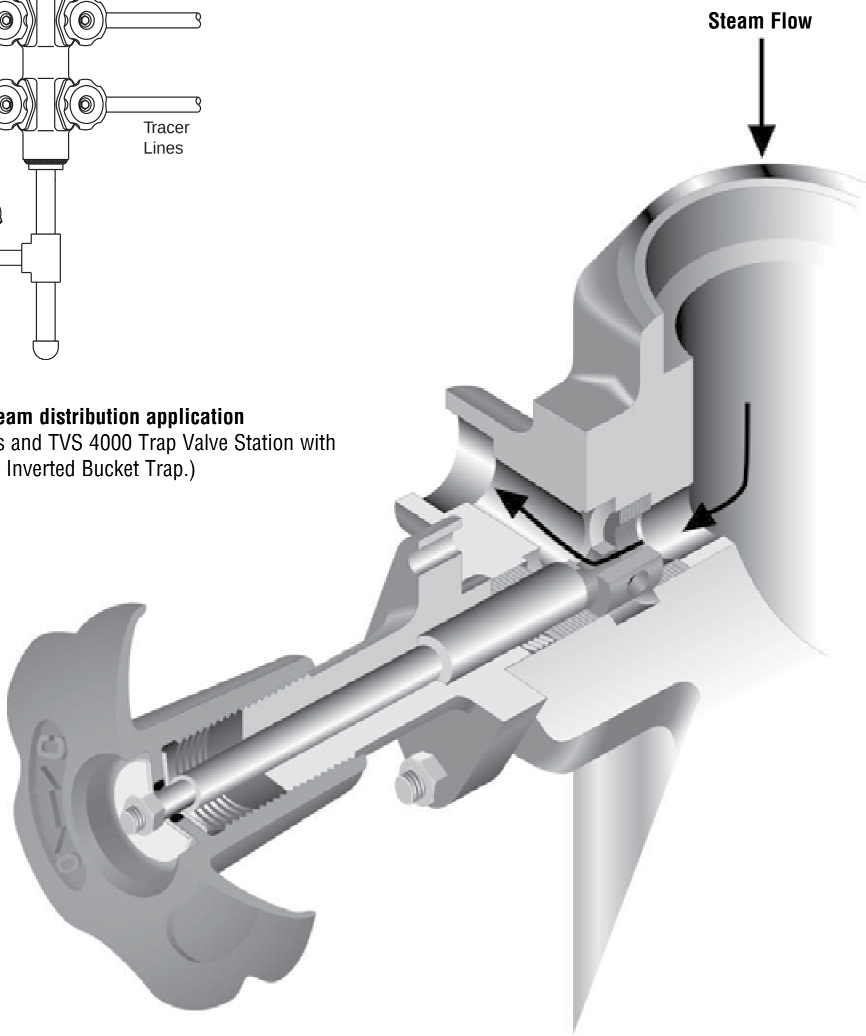
Typical SMSD steam distribution application
(shown with optional nipples and TVS 4000 Trap Valve Station with 2000 Series Inverted Bucket Trap.)

Cost Savings

- Reduced design specification costs
- Prefabrication vs. field assembly for easy installation
- Reduced shipping and field handling costs
- Lower long-term maintenance and operating costs
- 3-year guarantee

Design Flexibility

- Dimensional consistency
- Space savings
- Insulation package available
  SMSD may also be used on systems utilizing glycol, Dowtherm and other heat transfer liquids.



Steam Distribution Manifold (MSD/SMSD)

Physical Data

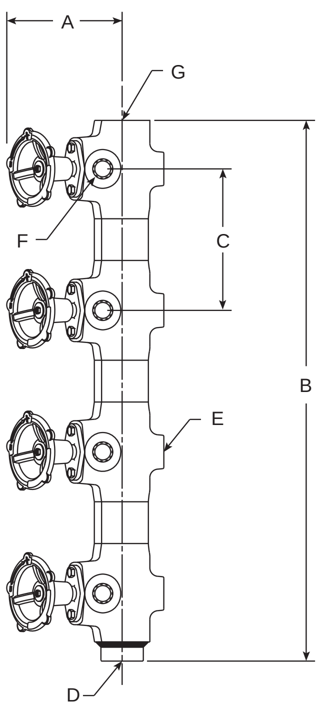
Model	MSD Series						SMSD Series					
	MSD-04		MSD-08		MSD-12		SMSD-04		SMSD-08		SMSD-12	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
"A" Position (Option)	8	203	8	203	8	203	8	203	8	203	8	203
"B" Height	11-1/2	292	24-1/4	615	37-1/8	243	10-1/4	260	19-3/4	501	29-1/4	743
"C" ℄ to ℄	6-3/8	162	6-3/8	162	6-3/8	162	4-3/4	120	4-3/4	120	4-3/4	120
"D" Blowdown Connection	3/4 SW	20	3/4 SW	20	3/4 SW	20	3/4 SW	20	3/4 SW	20	3/4 SW	20
"E" Number of Holes for Mounting (M14)	2	2	4	4	6	6	2	2	4	4	6	6
"G" Inlet	1-1/2 SW	40	1-1/2 SW	40	1-1/2 SW	40	1-1/2 SW	40	1-1/2 SW	40	1-1/2 SW	40
"F" Outlet*	1/2	15	1/2	15	1/2	15	1/2	15	1/2	15	1/2	15
Weight, lb (kg)	21 (10)		46 (21)		67 (30)		20 (9)		40 (18)		59 (27)	
Maximum Operating Pressure	464 psi (32 bar) @ 752°F (400°C)											

*3/4" (20 mm) available – contact factory.

List of Materials

Name	Material
Manifold Body	ASTM A105 forged steel
Handwheel	Ductile iron
Bonnet	ASTM A351 Gr. CF8M
Spring Washer	Stainless steel
Bonnet, Bolts	DIN 933, Gr. 8.8 per DIN 267
Piston & Stem	17% Chrome stainless steel
Valve Sealing Rings	Expanded graphite & stainless steel

For a fully detailed certified drawing, refer to CD #1097.



Steam Distribution Manifold

Steam Distribution Manifold
With TVS 4000, Inverted Bucket Drip Trap and Optional Stand

Pre-Assembled...Condensate Collection Assembly (CCA)

Armstrong combines its Trap Valve Stations (TVS) with manifolds into a package called the Condensate Collection Assembly (CCA). This prepackaged assembly offers many great benefits—cost savings in assembly, design flexibility and reduced purchasing and design time. The CCA with TVS 4000 Trap Valve Station and 2000 Series Inverted Bucket Traps is guaranteed for 3 years.

Cost Savings

This preassembled concept offers tremendous savings by reducing multiple component purchases that cause additional purchase order monitoring and shipping costs. Other savings include far less labor time required for field assembly.

This modular forged steel body design provides quick assembly/delivery, reducing overall project costs.

- Minimal welding vs complete manifold fabrication
- Eliminates multiple component purchases
- Reduced design specification costs
- Prefabrication vs. field assembly for easy installation
- Reduced shipping and field handling costs
- Lower long-term maintenance and operating costs
- 3-year guarantee

Design Flexibility

Armstrong can meet virtually any design parameter, including dimensional consistency, with your choice of socketweld or threaded connections. Armstrong inverted bucket, thermostatic, thermostatic wafer, bimetallic or disc steam traps can be provided or any other manufacturer's two-bolt steam trap can be used. If you require a specific piping arrangement, Armstrong can offer the flexibility to meet your specifications.

Materials

Manifold body: ASTM A105 forged steel

Removable Insulation Package

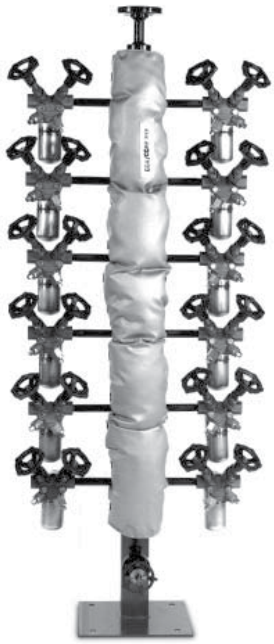
A removable insulation package is available for all steam and condensate manifolds.

- Inexpensive
- Quick to install
- Removable for maintenance
- Reusable after maintenance
- Weatherproof
- Formed to cover all manifold elements
- Strong, durable cover
- Available to fit all manifold sizes

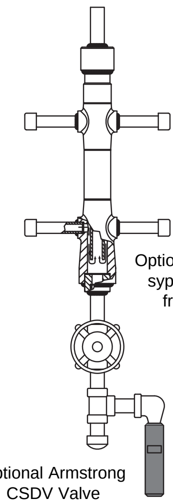
Freeze Protection Package (CCAF)–Optional

A manifold assembly for more efficient condensate return has another benefit—freeze protection. Armstrong's innovative manifold design actually serves as a heat station, heating one or more traps if the steam supply is interrupted or shut off to the traps. The protection is accomplished as long as one trap continues to discharge into the manifold. The manifold's internal syphon tube creates a water seal, which contains the flash steam from the discharge of the live trap. This allows radiant heat to protect shut-off traps from freezing.

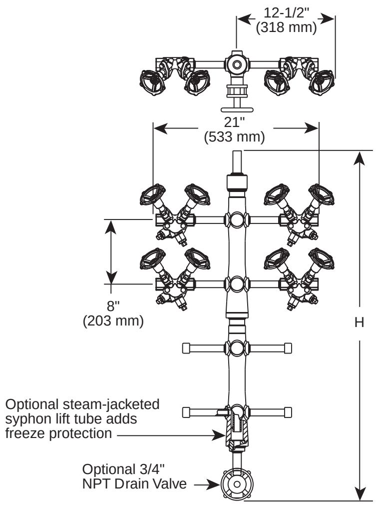
An optional freeze protection valve package senses condensate temperature. When this device opens, it drains condensate from the manifold assembly, thus providing further freeze protection.



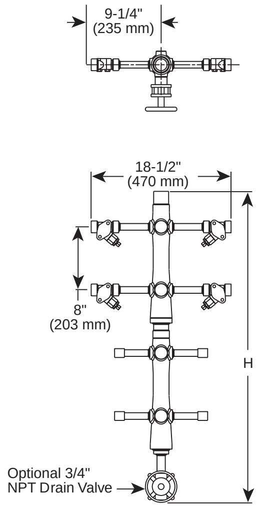
CCAF 212 Condensate Collection Assembly
(Shown with TVS 4000 Trap Valve Station with 2000 Series Inverted Bucket all stainless steel steam traps with optional removable insulation package including nipples, drain valve and stand.)



Pre-Assembled...Condensate Collection Assembly (CCA)



CCAF Condensate Collection Assembly with TVS 4000 Trap Valve Station, Optional Freeze Protection and Drain Valve.
Available with Armstrong's inverted bucket, disc, thermostatic, thermostatic wafer or bimetallic steam traps. Any manufacturer's 2-bolt steam trap can also be applied to Armstrong's trap connectors.



CCA Condensate Collection Assembly With IS-2 Connectors with Strainer, Blowdown Valve and Optional Drain Valve
Available with Armstrong's inverted bucket, disc, thermostatic, thermostatic wafer or bimetallic steam traps. Any manufacturer's 2-bolt steam trap can also be applied to Armstrong's trap connectors.

Physical Data

Model	CCA-204		CCA-206		CCA-208		CCA-210		CCA-212	
"H"	in	mm	in	mm	in	mm	in	mm	in	mm
	23-1/8	587	31-1/8	790	39-1/8	994	47-1/8	1,197	55-1/8	1,400
Maximum Allowable Pressure	604 psi @ 800°F (42 bar @ 427°C)									

Physical Data

Model	CCAF-204		CCAF-206		CCAF-208		CCAF-210		CCAF-212	
"H"	in	mm	in	mm	in	mm	in	mm	in	mm
	27-5/16	694	35-5/16	897	43-5/16	1,100	51-5/16	1,303	59-5/16	1,506
Maximum Allowable Pressure	604 psi @ 800°F (42 bar @ 427°C)									

How to Order Manifold Packages

CCA	208	2NPT	6PE	3DVN	TVS 4000 SCH80
Manifold Model	**Number of Take-offs Per Manifold**	**Connection Size Take-offs, NPS in (mm)**	**Connection Size Top, NPS in (mm)**	**Connection Bottom, NPS in (mm)**	**Trap Valve Station**
MSD Steam Distribution Manifold	04 08 12	2NPT = 1/2 (15) NPTF[1] 2SW = 1/2 (15) SW[1] 3NPT = 3/4 (20) NPTF 3SW = 3/4 (20) Socketweld	6SW = 1-1/2 (40) SW[1] 6FW150 = 1-1/2 (40) 150# RF Flange 6FW300 = 1-1/2 (40) 300# RF Flange 8FW150 = 2 (50) 150# RF Flange 8FW300 = 2 (50) 300# RF Flange	3SW = 3/4 (20) SW[1] 3NPT = 3/4 (20) NPTF 3WD = 3/4 (20) Welded Dripleg[2] 3TD = 3/4 (20) Threaded Dripleg[2]	TVS 4000 IS2 with BD IS2 Standard None
SMSD Small Steam Distribution Manifold					
CCA Condensate Collection Assembly	204 206 208 210 212		6PE = 1-1/2 (40) Plain End[1] 6FW150 = 1-1/2 (40) 150# RF Flange	3NPT = 3/4 (20) NPTM[1] 3DVN = 3/4 (20) Drain Valve NPTM/NPTM 3DVS = 3/4 (20) Drain Valve SW/NPTM	
CCAF Condensate Collection Assembly Freeze Protection			3PE = 3/4 (20) Plain end[1] 3NPT = 3/4 (20) NPTM 3FW150 = 3/4 (20) 150# Flange		

1. Armstrong stocks manifold cores (less nipples, drain valves and trap stations) in these connections.
2. Must pick this bottom connection to use trap station (TVS 4000 only choice) and trap on MSD and SMSD.
3. Nipples connecting manifold to trap station can be Schedule 80 (standard) or schedule 160 (optional).

ALL STAINLESS STEEL FILLED PRESSURE GAUGES



APPLICATIONS

For corrosive atmospheres and fiuids, resistant to high dynamic pressure loads and vibrations.
Well suited for the process industry applications inluding: Petrochemical, Chemical plants, and energy etc.

SPECIFICATIONS	CONTENTS
DIMENSIONS	100mm
ACCURACY	Class ± 1.0 %
PRESSURE RANGES	-1/0 to -1/+20 kg/cm^2 (bar) 0/1 to 0/1500 kg/cm^2 (bar)
TEMPERATURE	Working temperature 100˚C max. Ambient temperature around: -20˚C~60˚C
CONNECTIONS	AISI 316, LM or LBM/CBM Size : 22mm 3/8", PT, NPT, PF, BSP 1/2", PT, NPT, PF, BSP
SENSING ELEMENT	Bourdon Tube, AISI 316 DIN 50049 (AISI 316 Ti) <70 kg/cm^2 (bar) Coil ≧70 kg/cm^2 (bar) Helicoil
MOVEMENT	AISI 316
DIAL	White aluminium, black lettering
POINTER	Black aluminium
CASE	AISI 304
UPPER RING	AISI 304
FILLING	Glycerine (99.5%)
WINDOW	Normal glass, Laminated safety glass Acrylic
ORDER OPTIONS	Filling fluids optional Flange Red mark pointer U-shape clamp

BI-METAL THERMOMETERS

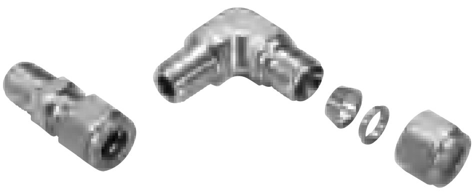
APPLICATIONS

Transformer dyeing, drier, food processing, boiler, air conditioning equipment, and other industrial machines

SPECIFICATIONS	CONTENTS
DIMENSION	26.5mm, 35mm, 50.6mm, 65mm, 80.5mm, 118mm, 130mm, 160mm
CASE	AISI 304
SENSOR STEM MATERIAL	AISI 304 or AISI 316
DIAL	White aluminium, black lettering
TEMPERATURE	-50~+600℃
O.D. OF SENSOR STEM	Standard: ø6.5mm, range 4~12mm
LENGTH OF SENSOR STEM	2"~25"
ACCURACY	± 1.0%

PRESSURE GAUGE ACCESSORIES

PIPE SEPARATOR



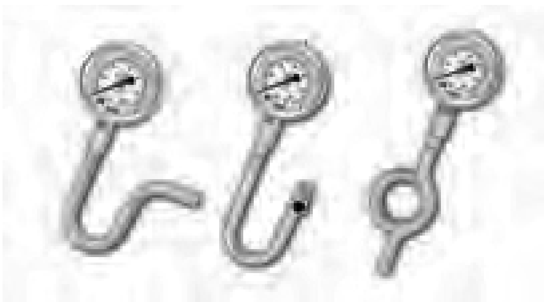
FEATURES

Connective thread includes four parts-cap nut, front ring, rear metal ring, divert connector. Applications include chemical fluid industry, manufacturing control, petroleum, equipment testing etc. Except for highly corrosive fluid, most of other fluids are safe to use this divert connector without leakage.

SPECIFICATIONS	CONTENTS
SPECIFICATIONS	Direct connector, L-shape connector, three-way connector
MATERIAL	AISI 316
DIMENSION	Female thread inner diameter: 6mm~25mm Male thread length: 1/8"~1"

*Customised designs available

SIPHON

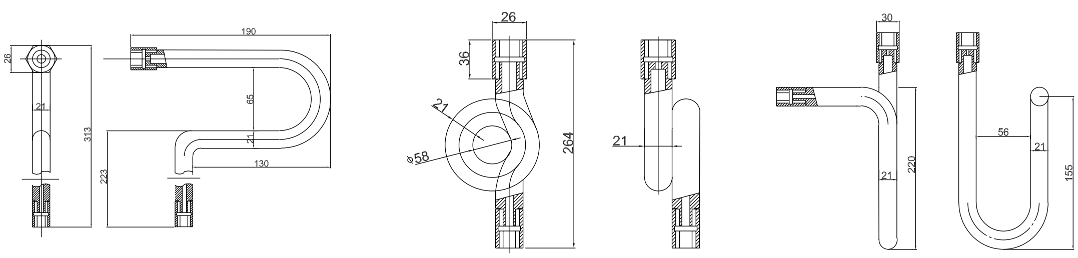


APPLICATIONS

Widely used in vapourised high temperature equipments or the vaporisation from percolated & saturated fluid.

SPECIFICATIONS	CONTENTS
CONNECTION	1/4"、3/8"、1/2" PT, NPT, PF, BSP F/M
PRESSURE RANGE	Carbon steel (150 bar 430˚C max.) AISI 316 stainless steel (135 bar 450˚C max.)

*Customised designs available



ARMSTRONG
FLOW CONTROL

System Monitoring

The New Standard for Steam Trap Management

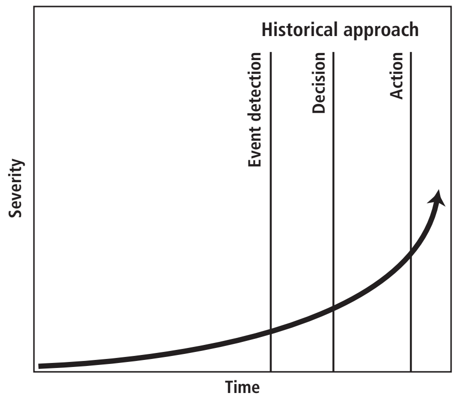
According to the Alliance to Save Energy, facilities have saved as much as 17% of fuel use when implementing energy-saving processes. Establishing a consistent, long-term steam trap management process is one way to achieve savings.

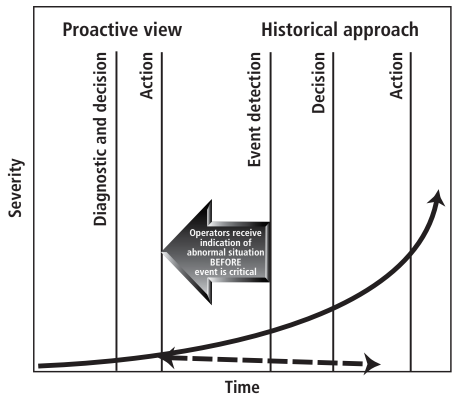
Historical Approach to Steam Trap Program*

Trap inspections are typically performed one time per year. The problem with this approach is that steam traps fail every day. These undetected failures lead to system irregularities, which, when left undetected long enough, can result in severe problems and equate to many dollars lost.

Proactive Approach to Best Practice Steam Trap Management*

Early detection means being able to act on a trap failure before the associated problem becomes severe. Therefore, immediate evaluation of the situation and measurement of the results are critical for continued best practice process improvement, yearly steam loss reductions and sustained monetary savings.





*Schavey, L. and Stout, J., "Achieving Operational Excellence in Gas Plants," Hydrocarbon Processing, January 2005.

Wireless, Labor-free, Instant Notification of Steam Trap Failure!

If you were to describe your vision for steam trap best practice, what would it look like?

Awareness
- The ability to constantly monitor the steam trap population without labor allocation
- Instant notification of steam trap failure

Action
- Quick diagnosis and action on best trap replacement based on return on investment (ROI)

Accountability
- A reporting system that provides tracking, measurement, ROI analysis and easy company-wide communication

SteamEye® and SteamStar® bring steam savings through instant notification of steam trap failure.

SteamEye® is the tool to reduce labor and energy costs by constantly monitoring the steam trap population. SteamStar® is the measurement software that will create company-wide awareness for a a whole new level of steam savings. When working together, SteamEye® will feed the moment-to-moment steam trap data into SteamStar®. SteamStar® will instantly report this information through Web-based software that allows easy access for company personnel to make timely, money-saving decisions.

SteamEye®
Best Practice Steam Trap Monitoring

Instant notification of steam trap failure and a sustained (24/7) monitoring process.

SteamStar™
Best Practice Steam System Measurement

Company-wide awareness and measurement of steam trap performance for ROI decision making.

SteamStar®
Easy-to-use and Very Affordable Steam Trap Database

SteamStar® is the first Web-based software for recording, monitoring and managing steam trap information.

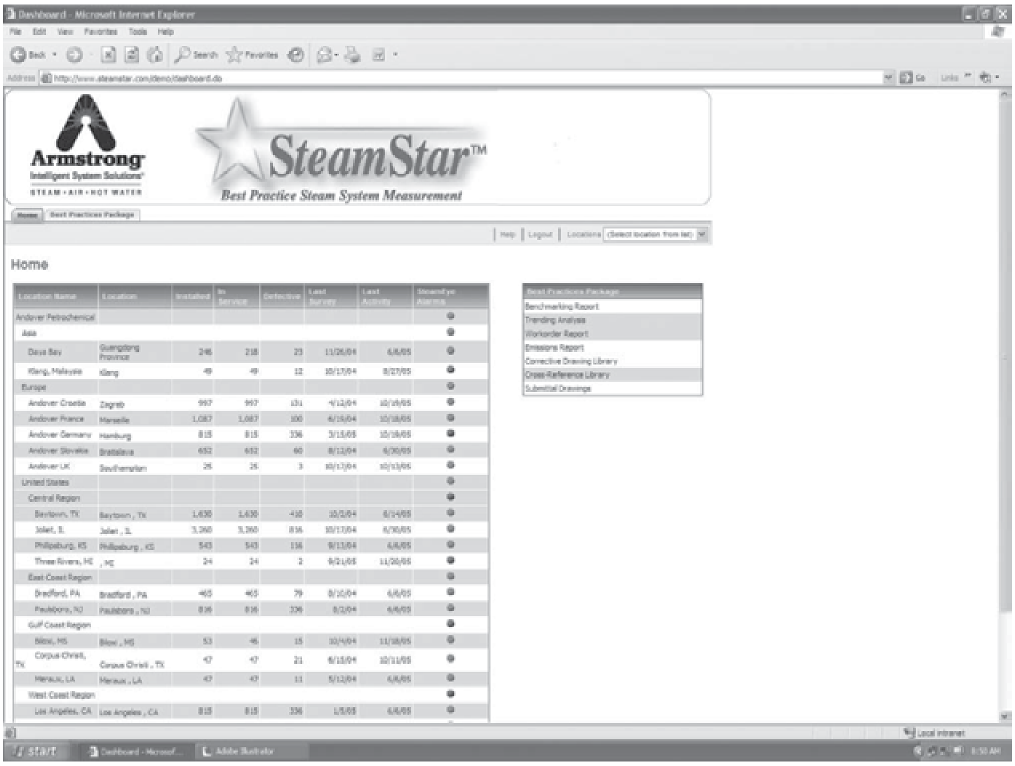
Improve steam system efficiency.
Steam system efficiency can be directly linked to how well the system is managed. SteamStar® provides diagnostic reporting at various levels of organizational responsibility. The reports permit the evaluation of current conditions and provide the knowledge necessary to make money-saving decisions.

Achieve best practice energy management goals.
History has shown that companies maximize sustainable cost savings when energy goals are measured, monitored, and managed on a consistent basis. SteamStar® is the Web-based tool that will bring data together by site, by region and by company to help achieve best practice energy management goals.

Save valuable time.
Typically steam trap data are presented from multiple sites in different software formats and with different qualifying terminology. These variables make managing steam system information difficult and time-consuming. SteamStar® offers a platform for company-wide steam data to be viewed and analyzed without wasted time.

Eliminate costs associated with software
licensing agreements. Licensing agreements can cost tens of thousands of dollars for initial software purchase. For the software to facilitate multiple users, additional capital outlay is required. The Web-based platform of SteamStar® eliminates licensing fees and dramatically reduces the required investment. A one month return on investment!

Improve company-wide communication.
Users at the plant level can perform evaluations to determine root causes of steam system issues. Using the same platform, the global energy manager has the ability to analyze data for sites around the world. This level of communication promotes understanding of steam system efficiency.



Screen shot of SteamStar® home page.

SteamStar®
Easy-to-use and Very Affordable Steam Trap Database

SteamStar® Web-based software will evaluate steam system data.

Continuous Steam Trap Monitoring captures real time steam trap operation from SteamEye®. SteamEye® is the automated steam trap monitoring tool that provides accurate and constant information from each steam trap. This information is translated by SteamStar® into actionable reports. All of the reports available in SteamStar® are designed for best practice measurement.

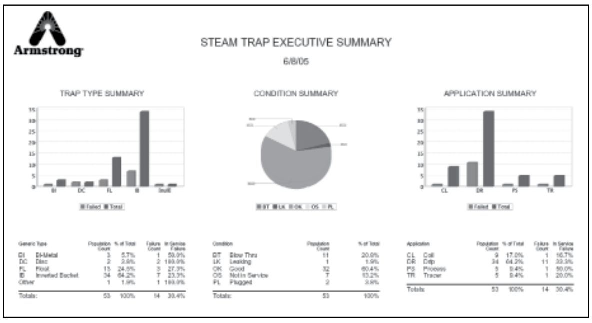
- Executive Summary
- Steam and Monetary Loss
- Defective Trap Report
- Manufacturer Summary
- Trap Evaluation by Application

Company Benchmarking
This premium report establishes a comparison to sister sites and industry peer best practices. The user has a choice of which sites to benchmark and which factors to compare. Steam losses and monetary losses can be compared by site, by type of application, by type of trap, and more. This report will offer management a wide analysis of which sites are working to reduce steam losses and which lag behind. It will also highlight any areas of concern in terms of high steam trap failure rate compared to total monetary losses. This report is a valuable tool for facility managers and global energy managers alike.

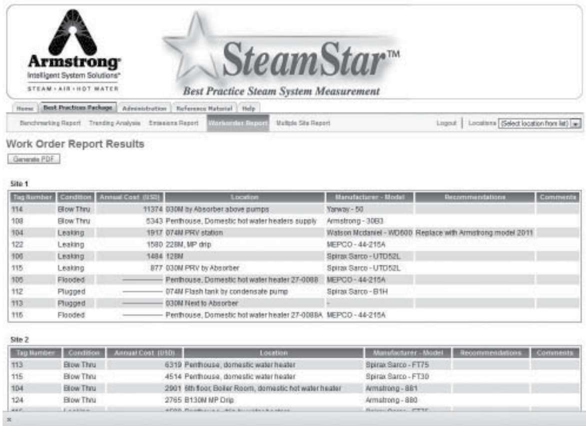
Prioritized Work Orders
The work order report is a premium report that was designed for optimum facility payback on labor and material while keeping energy losses to a minimum. This report is available at the site or unit level and will create a work order for steam trap repairs based on payback.

Trend History
The premium trend analysis report will assist a manager with the comparison of multiple years of data. The data available for comparison are steam loss, monetary loss, fuel consumed, and emissions created. Like the other premium reports, the trend analysis report can be compared by site and/or region. It will also track emissions—CO_2, SOx, NOx—and highlight the progress made toward steam system efficiency and dollars saved.

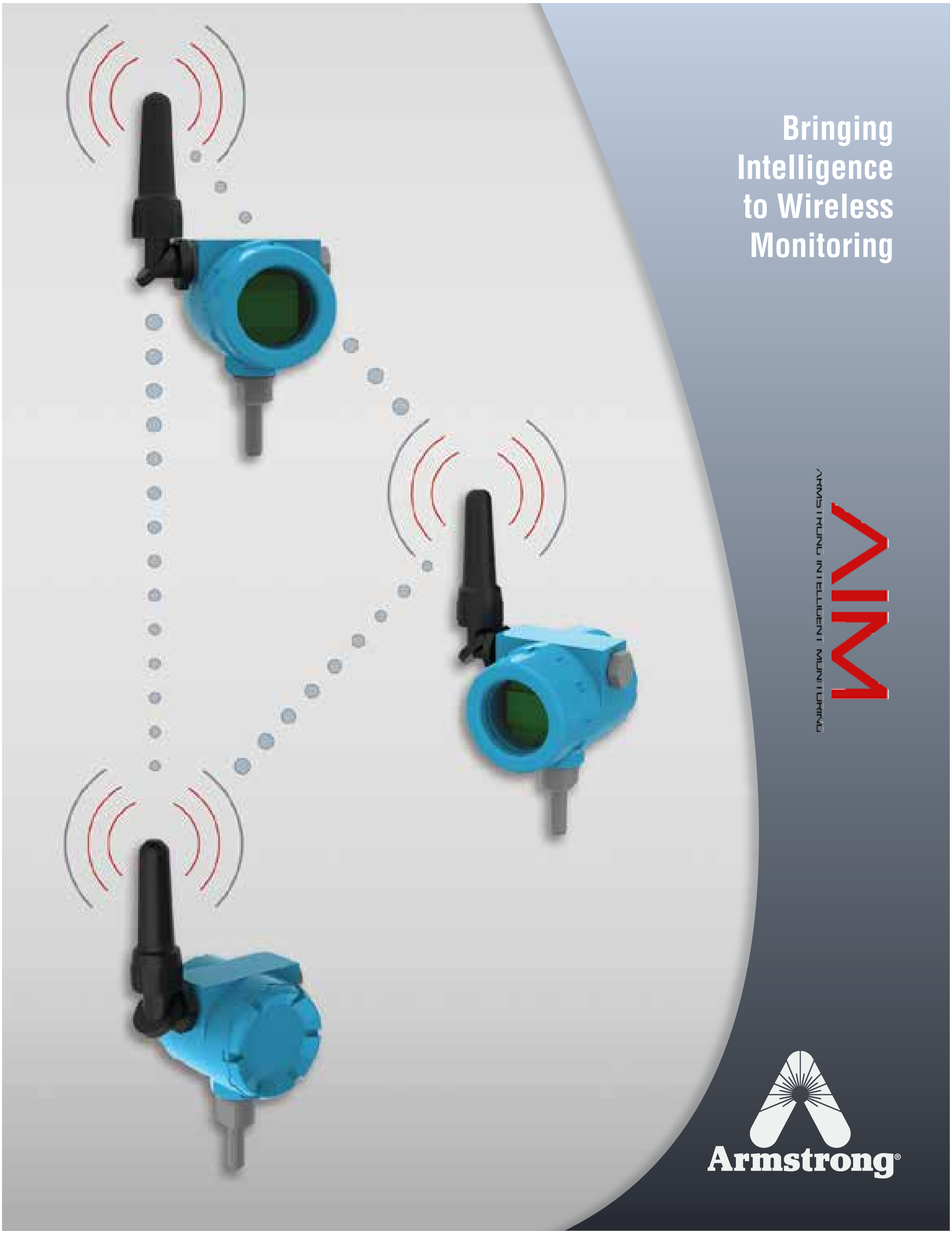
Emissions Summary
The premium emissions report is valuable for its ability to focus on the quantifiable emissions of CO_2, SOx, and NOx in one summarized view. Steam system efficiency is not only viewed as important in terms of energy losses but also in terms of environmental impact. The emissions report is especially beneficial to users that are penalized by world governments for high emission factors.



Screen shot of executive summary.



Screen shot of prioritized work order.


Bringing
Intelligence
to Wireless
Monitoring
AIM
ARMSTRONG INTELLIGENT MONITORING
Armstrong®

Cut The Cord

Is your plant monitoring system held back by outdated technology or devices that can't think for themselves? It's time to cut the cord and enter the world of intelligent wireless monitoring from Armstrong International.

AIM™ brings intelligence to wireless technology by applying smart thinking devices to monitor critical plant applications in real time.

Three Challenges - One System Solution

Three constant challenges that plant managers and maintenance personnel face in the operation of any system include:

- Identifying a failure - ability to immediately pinpoint what has failed, when it failed and where it failed.
- Evaluating the scope - comprehending the magnitude of the failure especially in terms of energy lost and emissions discharged to the atmosphere.
- Measuring the impact - accurately calculate the costs including wasted energy, process disruptions and plant shut downs, safety hazards and fines levied.

AIM™ enables your team to tackle all three challenges with one system solution that combines a mix of methods including acoustic and temperature monitoring with integrated software through a smart wireless gateway to deliver:

- Immediate failure notification of devices such as steam traps
- Immediate notification of release to flare for emissions mitigation
- Pinpoint accuracy of failure location for fast resource deployment
- Detection of “sizzling” relief valves for proactive maintenance scheduling
- Preemptive warning of hazardous vapor release to improve worker safety

Ready, AIM™, Fire

ARMSTRONG INTELLIGENT MONITORING

Problem

- Identifying condition of critical steam traps that are difficult to access.
- Condensate backing up into turbine caused by plugged steam trap.
- Significant energy loss due to failed steam traps on high pressure steam lines.
- Reboiler not draining properly due to plugged steam trap.

Solution

ST5700
Steam Trap Monitoring

Result

- A safe and reliable methodology for testing inaccessible steam traps for immediate failure notification.
- Significant cost avoidance from potential turbine blade damage.
- Significant energy savings due to reduced consumption.
- Immediate identification of root cause problem to reduce potential production loss.

Problem

- Excessive use of flare due to safety relief valve lift.
- Leaking isolation and bypass valves for critical process.
- Gas pressure regulator failure.

Solution

AD5000
Acoustic Monitoring

Result

- Reduced hydrocarbon emissions to the environment and significant cost avoidance from potential environmental fines.
- Material loss reduction due to immediate location identification.
- Reduced process loss due to immediate identification and location of the root cause; Reduced safety issues.

Problem

- High viscosity in bulk storage tanks causing potential pumping issues due to inadequate temperature.
- Potential solidification in sulfur/asphalt transfer lines due to inadequate temperature.
- Pump trap failure (Flooded).
- Electric pump cavatation/seal failure.

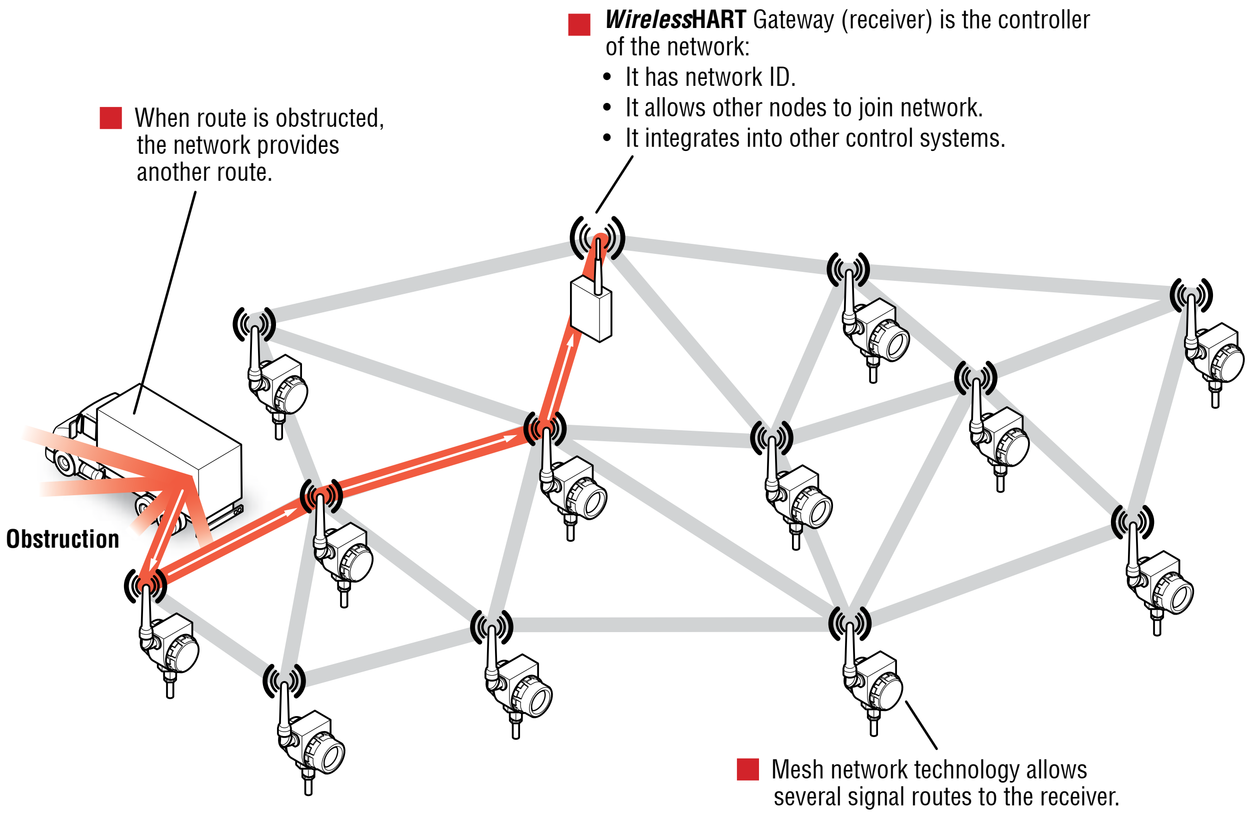
Solution

TD5100
Temperature Monitoring

Result

- Immediate low temperature indication and location on the storage tank to prevent transfer/tank loading problems due to high viscous material.
- Immediate low temperature indication and location on sulfur line to prevent material solidification.
- Early detection of reduced inlet condensate temperature to pump trap.
- Early detection of high temperature condensate into electric pump receiver.

Smart Mesh Technology



Self Organizing.

- Devices automatically establish routes for efficient and reliable communication.
- Expansion is simple… additional devices seamlessly integrate into existing networks.
- Mesh topology allows for easy network reconfiguration.

Self Healing.

- If obstructions are introduced within an existing network, the system will automatically adjust communication paths for continuous and reliable data flow.

Industry Standard IEEE 802.15.4.

- 2.4 GHz 16 band.
- Continuously hops across 16 channels to reduce potential interference.

No Blind Spots.

- Utilizing industry standard *Wireless*HART™, an open mesh networking design, AIM™ communicates through and around stacks, silos, cranes and other obstructions.

Harsh Environments? No Worries.

- AIM™ is designed to withstand extreme ambient temperature conditions (-40°F - 194°F) (-40°C - 90°C).

No Plant Disruptions.

- Installing AIM™ won't disrupt plant processes. There's no shutdown required to perform an installation and AIM is non-intrusive to valves, pipes and system equipment.

*Wireless*HART

AIM ARMSTRONG INTELLIGENT MONITORING

The HART Communication Protocol has served as the world's leading process communication technology for smart instruments since 1989. Today, more than 30 million HART devices are installed and in service worldwide.

Industry suppliers are manufacturing and shipping HART products in record numbers—75% of the smart devices installed are HART-enabled.

More HART products are installed in more plants around the world than any other. No other communication protocol comes close.

Wireless technology allows users to access the vast amount of unused information stranded in these installed HART smart devices— 85% of the installed HART devices. It also provides a cost-effective, simple and reliable way to deploy new points of measurement and control without the wiring costs.

Simple

- Reduced installation and wiring costs
- Always on security
- Adjusts as new instruments are added and to changes in plant infrastructure

Reliable

- "Hops" across channels
- Co-existence with other wireless networks
- Optimizes bandwidth and radio time
- Mesh network and multiple access points

Secure

- Protects valuable information with multi-layered security
- Robust multi-tiered always on security
- Protects wireless network with channel hopping
- Reports message integrity failures and authentication failures

Item	Description
Based on Industrial Standards	HART - IEC 61158 *Wireless*HART - IEC/PAS 62591Ed.1 EDDL - IEC 61804-3 Radio & MAC - IEEE 802.15.4(TM)-2006 IEC/PA
Radio Standard	IEEE 802.15.4-2006 @ 250kbps
Frequency Band	2.4GHz
Frequency Management	Channel hopping on a per packet basis
Distance	Up to 250 m (820 ft) line-of-sight between devices
Power	Battery
Topologies	*Wireless*HART Mesh

Transmitted Information

• The following information is sent from the nodes.

Information	Device ID	HART Tag	Primary Variable (PV)	Secondary Variable (SV)	Tertiary Variable (TV)	Quaternary Variable (QV)
Acoustic Model AD5000	☑	☑	Counts (0-255)	Current temperature reading (ºF or ºC)	Alarm Setting (default 0)	Estimated Battery Life (Days)
Steam Trap Model ST5700	☑	☑	Trap Condition • 1 – OK = no alarm; steam trap is functioning properly. • 2 – CD = alarm; steam trap plugged/locked or steam supply valve off. • 3 – BT = alarm; steam trap failed open, experiencing steam loss.	Current temperature reading (ºF or ºC)	Temperature Setting*	Estimated Battery Life (Days)
Temperature Model TD5100	☑	☑	Temperature (ºF or ºC)	Status Bit • 1 – Temp. above setting • 2 – Temp. below setting	Temperature Setting	Estimated Battery Life (Days)

Work Smarter - Not Harder

AIM™ helps you work smarter by anticipating your needs and taking the guess work out of system troubleshooting enabling you to address problems before they spiral out of control. Here's how.

Smart Thinking is in the Box

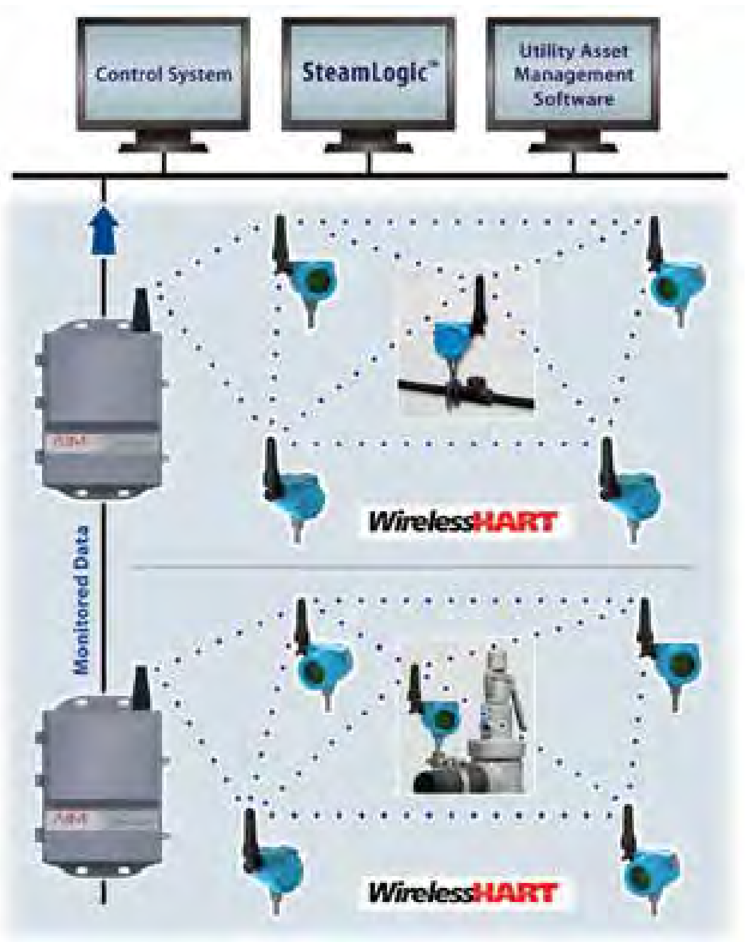
AIM™ works through a centrally located wireless gateway that enables real time, 24/7 monitoring.

The AIM™ Wireless Gateway easily connects and organizes WirelessHART devices to your host system while providing industry-leading security, scalability, and data reliability. The Gateway interface is easily viewed in a web browser.

Wireless Gateway Specifications

- Burst rate: User Selectable 4, 8, 16, 32 second or 1 to 60 minutes
- Network Size: Up to 100 devices
- Output: Ethernet, Modbus (485 or TCP), OPC, HART IP
- Approvals: FM, CSA, ATEX, IECEx

Wireless Architecture



AIM™ Wireless Gateway Web Browser Interface

SteamLogic™ Program Interface

Other Interfaces:

- Data historian connectivity for trending and analysis (Note: Data historian not included with AIM™ Wireless Gateway).

Ready, AIM™, Fire

AIM
ARMSTRONG INTELLIGENT MONITORING

Adjustable

Extreme Weather

Factory Mutual (FM) Approval	
United States	Intrinsic Safe for Class I/II/III, Division 1, Groups A, B, C, D, E, F, and G Zone Rating: Zone 0, AEx ia IIC Temperature Code: T3 Ambient Temperature Range: T_{amb} -40°C to 90°C (-40°F to 194°F) For use with TADIRAN model TLH-5920 lithium ion battery only Standards used for Certification: FM3600, FM3610, FM3810, ANSI/ISA 60079-0, ANSI/ISA 60079-11
Canada	Intrinsic Safe for Class I/II/III, Division 1, Groups A, B, C, D, E, F, and G Zone Rating: Zone 0, Ex ia IIC Temperature Code: T3 Ambient Temperature Range: T_{amb} -40°C to 90°C (-40°F to 194°F) For use with TADIRAN model TLH-5920 lithium ion battery only Standards used for Certification: CSA 1010.1, CSAC22.2No.157, CSAC22.2No.25,CAN/CSAE60079-0, CAN/CSA60079-11
European Certification	ATEX Intrinsic Safety Ex ia IIC T3 Ambient Temperature Range: T_{amb} -40°C to 90°C (-40°F to 194°F) For use with TADIRAN model TLH-5920 lithium ion battery only Standards used for Certification: EN60079-0,EN60079-11, EN 60079-26
IECEx Certification	Equipment Protection Level: Ga Gas/Vapour: EX ia IIC T3 Ambient Temperature Range: T_{amb} -40°C to 90°C (-40°F to 194°F) For use with TADIRAN model TLH-5920 lithium ion battery only Standards used for Certification: IEC 60079-0, IEC 60079-11, IEC 60079-26

Output	*Wireless*HART 2.4 GHz
Local Display (if applicable)	Liquid Crystal Display Viewing Area: 1.34" x 0.55" (34 mm x 14 mm)
Temperature Operating Range	With display: -30°C to 80°C (-22°F to 176°F) Without display: -40°C to 90°C (-40°F to 194°F)
Materials of Construction	Housing – Aluminum Paint – Powder Coat O-ring – Nitrile Stem – 304 SS Antenna – Nylon 6,6 Nampelate – 304 SS
Battery Type	Tadiran Lithium Ion Model – TLH-5920
Weight	2.2 lbs (1 Kg)

ST5700 Note:
For proper operation, node must be installed on a steam trap operating at no less than 15 psig (1 bar).

Steam System Survey

History
Industries use approximately 42% of the total energy consumed annually in the United States. Of this, about half (or 21% of total U.S. energy consumption) is used to generate steam in more than 54,000 large industrial-sized boilers.

Unfortunately, much of that steam is lost through leaks in the distribution system, including piping, valves and steam traps. Lost steam must be replaced, which can only be done in a boiler that consumes fuel.

The cost of replacing wasted steam can be enormous in terms of system efficiency, lost production, fuel consumption, makeup water treatment cost, and maintenance. These additional costs must be factored into the bottom line of every organization.

Environmental Considerations
Inadequate trapping on steam mains not only results in economic losses, it also creates environmental concerns as additional fuel is burned to replace lost steam. For example, assume the steam-main pressure is 150 psig and the leak size is 5/64"—about the thickness of a penny. In this instance, approximately 27 lb of steam will be wasted per hour—escaping from the system or blowing through a trap and into the return line.

Twenty-seven pounds per hour may not sound significant, but over one year (8,400 hours), that small leak will waste the following equivalent amounts for fuel:
- 1.9 tons of bituminous coal at a value of $679 (coal cost $57/ton)
- 2,385 gal of residual oil at a value of $978 (oil cost $0.41/gal)
- 3,141 ccf of natural gas at a value of $1,272 (gas cost $4.05/mcf)

Pulverized bituminous coal in a dry bottom-firing boiler will generate the following pollutants per year:
- 727 lb of particulate matter
- 465 lb of sulfur oxides
- 250 lb of nitrogen oxides
- 7.2 lb of carbon monoxide
- 9.7 tons of total carbon

These figures represent a case in which just one trap has blown through—typical failure mode of many steam traps. Compound the figures by the number of potential failed traps and you can begin to understand the value of trap maintenance, both in terms of energy and the extra load placed on your environmental cleanup systems.

Evaluation = Efficiency = Dividend
Reliable evaluation of steam trap operation is necessary for traps to work at peak efficiency. Trap testing is a key element in a complete energy management program, and an essential skill for protecting your investment.

Accurately evaluating steam trap operation can pay dividends in energy conservation, save countless maintenance hours, and reduce unscheduled downtime caused by trap failure.

Steam-Trap Survey
To ensure that your steam traps are maximizing the return on your product investment, your first steps should be to conduct a steam-trap audit or trap survey, then implement a comprehensive trap-maintenance program. Proper trap maintenance requires someone who knows how each type of trap functions and can determine if each trap is operating as required.

Armstrong has the ability and trained personnel to conduct steam system energy audits for any facilities in the world. Our factory-trained technicians have decades of experience and have tested tens of millions of steam traps worldwide.

Test and Replace Just the Failed Traps
The sooner a trap is identified as an energy waster, the sooner it can be replaced. Since newer testing methods require minimal labor, traps can be tested more frequently and failed traps can quickly be identified. In addition, perfectly good traps that may be misdiagnosed as failed by less reliable testing techniques will no longer be routinely replaced, thus saving the expense of a new trap and related labor costs.

Armstrong continues to lead the industry with innovative testing and tracking tools such as SteamStar®, SteamEye® and TrapAlert™.

By using SteamEye® technology, you can better spend your maintenance time repairing only defective traps and not evaluating traps that have been misdiagnosed as failed. In conjunction with SteamStar®, the system becomes the premier steam trap management package for maintaining a healthy steam system.

Maintaining the Boiler Plant
Boiler plant reliability and efficiency depend on the stability and success of each component of the steam generation, distribution and condensate return system. Maintaining a boiler plant means paying close attention to components including flanges, elbows, valves, unions and steam traps, since each component has the potential to waste steam.

We can help with proper system evaluations, as well as piping recommendations, replacement-trap sizing and troubleshooting.

ARMSTRONG
FLOW CONTROL

Training

"Knowledge Not Shared is Energy Wasted"

Armstrong Flow Control runs a comprehensive range of training seminars covering everything from basic steam / hot water system layout to the responsibilities under the latest Workplace Health and Safety Standards. These seminars can be conducted in-house or off site and range from 1.5 hours to a full day course. All seminars are conducted by professional trainers and all participants receive a certificate on completion.

(A) Steam Systems

Topics to be covered:-

- Steam fundamentals
- Boilers
- Steam distribution
- Steam trapping and common applications
- Air venting
- Pressure reduction
- Control valve sizing
- Condensate return
- Waste Heat recovery
- Safety

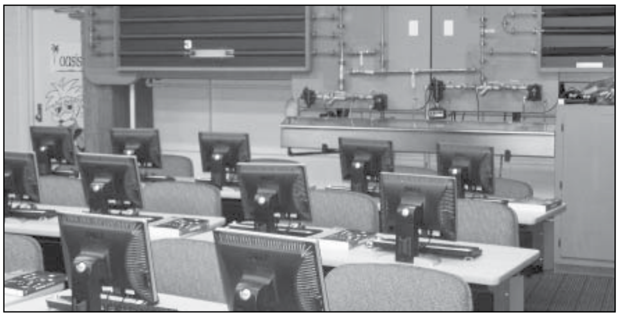
(B) National Workplace Health and Safety Certification 1010 Standard

Topics to be covered:-

- Boiler design
- Boiler safety valves
- Boiler operation
- Boiler inspection and maintenance
- Gas compliance and installation
- Boiler registration
- Boiler TDS control and blowdown
- Boiler water carryover
- Feedwater tanks
- Steam tables
- Heat load formula
- Steam pipe sizing
- Steam distribution
- Steam trapping
- Temperature and pressure control
- Condensate return
- Waste heat recovery
- Safety

Armstrong also provides a vast array of training aids including video's / CD's, booklets, pamphlets, cut-away samples and the world recognised Armstrong University online training course. One of Armstrong's key mottos is "Knowledge Not Shared is Energy Wasted".

Armstrong University Energy Seminar



Knowledge Not Shared Is Energy Wasted®

Since Armstrong designed and manufactured its first steam trap in 1911, we've solved virtually every imaginable problem in steam trapping and steam humidification. In the process we've accumulated a substantial body of information. It's practical know-how, not just theory. And for years we've shared this knowledge with anyone interested. We go to great lengths to share what we know because we're convinced that this kind of interaction is the best way to solve problems, meet individual needs and maximize the return on your energy investment.

Steam Energy Seminars are held at Armstrong's manufacturing headquarters in Three Rivers, Michigan. Armstrong also operates seminar facilities in Liege, Belgium, and Beijing, China.

All three facilities are fully equipped training centers. With the help of sophisticated sound and projection equipment and an elaborate working model of a steam system with live steam and glass piping, you'll see how different types of steam traps perform under various conditions.

Starting With the Basics

At an Armstrong University Energy Seminar, you'll learn how to cash in on long-term labor, material and energy savings. Starting with the basics, you'll review the fundamentals of steam.

Your Armstrong instructors have both the technical background and the field experience to make information relevant. Understandable. With their help, you'll walk step-by-step through the installation, operating/energy characteristics and maintenance of all kinds of steam traps.

Sessions are informal, with plenty of chances to participate and ask pointed, specific questions. (If you desire, a presentation can be tailored to your specific needs.) You'll also be able to listen to the questions and problems of others in the industry and discuss how their solutions may benefit your steam system.

At Armstrong University, there's no pressure selling. Basic information is presented honestly. And the demonstrations speak for themselves.

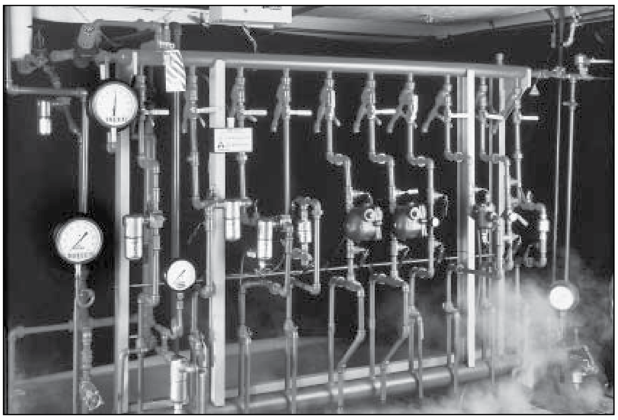
Applying Know-How

When you come to Armstrong University, you'll see firsthand the importance of trap selection and sizing—and why savings begin with proper installation and integration of steam system components.

You will also examine how steam trap selection, sizing and installation bear on energy consumption, downtime and maintenance. What's more, you'll review the guidelines for trapping steam distribution systems, tracer lines and various types of heating, process and heat exchange equipment.

In short, you'll learn about savings. Not as some loosely defined goal, but as hard, no-nonsense gains you can measure on a year-end chart.

Topics such as corrosion, water hammer and thermal stress will be discussed. And because each seminar can be tailored to your specific interests, special topics of individual concern may also be covered. Tell us what you want to know, and we'll emphasize it for you.



Reference Guide to Armstrong's Training Aids

Classroom Training Aids

Training for Energy Conservation

In a survey of plant engineers, plant managers and key maintenance engineers, 89% said that there will be a greater need for training in the years ahead. One of the primary areas of training will be in the arena of steam system maintenance because of the great potential to save energy and money.

Since building its first steam trap in 1911, Armstrong has been committed to sharing information and technical knowledge on steam energy conservation. Armstrong not only shares this information with its Representatives, but for years it has conducted seminars for its customers. Seminars have been conducted in our facilities as well as in customers' plants.

To extend its training program further, Armstrong assists many companies in developing their own in-house training activities. This guide is published to inform these trainers of the educational resources available from Armstrong. Many of the training aids are available at no charge. Other resource materials are available at a nominal charge. These items are marked with a dollar sign ($). For prices, contact Armstrong's Marketing Department.

Armstrong offers an extensive list of handbooks, catalogs and bulletins covering a wide range of topics. Some of these publications provide valuable resource material for classroom instruction.

Armstrong also provides many other training aids to help trainers conduct programs on various aspects of steam system operation and maintenance. Following are some of the materials for planning and implementing an effective steam system maintenance program.

Line Card 320 with Catalog CD-ROM: Line Card 320 includes a CD-ROM of Armstrong's catalog, Solution Source for Steam, Air and Hot Water Systems. The CD also features "Steam Conservation Guidelines for Condensate Drainage," which is recognized as one of the most authoritative discussions on steam, steam traps and steam energy conservation available today.

Sectional Models: Being able to see inside steam traps has been effective in helping people who work with traps to understand how they operate. Armstrong offers more than a dozen different sectional models of its steam traps and related products. Also available are glass traps, which allow students to view the operation of various steam trap types.

Videotapes: While Armstrong has more than a dozen different videotapes available, three have been found most useful in training situations.

- **Let's Talk Steam Traps/Update** is a two-part, 32-minute videotape that discusses the operating principles of mechanical, thermostatic and thermodynamic steam traps. Designed to be used in conjunction with the Conservation Guidelines section of this catalog, the tape discusses 10 steam system operating conditions that must be considered in evaluating steam trap performance.

- **Guidelines for Steam System Efficiency** is a 15-minute educational program covering basic considerations in the design, piping and trapping of steam systems. Topics covered in the tape include correct sizing and installation of steam supply and condensate return lines, steam velocities in the system, the use of air vents, vacuum breakers and safety drains, and much more. This videotape stresses how low energy, maintenance and operational costs in your system can be achieved by proper design, installation and maintenance.

- **Guidelines for the Prevention of Water Hammer** is a 16-minute videotape explaining three types of conditions that cause water hammer. The damaging effects of water hammer to steam system components also are described. Recommendations are made in the videotape on the proper trapping and piping to reduce the potential for water hammer. The results of reducing or eliminating water hammer are a safer work environment, lower maintenance costs and reduced system downtime.

Steam-A-ware™ Sizing and Selection Software: Proper sizing and specifying of steam traps, pressure reducing valves and water heaters is critical in order to save energy and extend equipment life. For users, this has continued to be a confusing and complex process. Now the easy-to-use Armstrong Steam-A-ware software program for sizing and selecting steam traps, pressure reducing valves and water heaters can be downloaded from Armstrong's Web site, **armstrong**international.com.

Reference Guide to Armstrong's Training Aids

Training for the Trainer

Armstrong recognizes the need to train the people who will be teaching others about the value of steam. In-house trainers are encouraged to avail themselves of the resources offered by Armstrong to make training programs effective and productive.

Seminars: One of the most effective means for trainers to learn about steam energy conservation is to attend and participate in Armstrong's steam energy seminars. Thousands of people have participated in these seminars, held monthly at Armstrong's demonstration laboratories in Three Rivers, Michigan; Liege, Belgium; and Beijing, China. These multi-media seminars provide practical experience for trainers, engineers, maintenance personnel and energy managers.

Representatives

In-house trainers are encouraged to call their Armstrong Representatives as a valuable resource in planning and implementing programs. The Representative can serve as a catalyst in moving your program forward, and virtually all the training aids outlined in this bulletin are available through your Armstrong Representative.

Often, training items may be borrowed from your Representative. He or she may be called on for advice and counsel and may serve as an authoritative resource speaker for your employees.

Continuing Education Aids

"Knowledge not shared is energy wasted®" is a philosophy of Armstrong, and the company is dedicated to the premise of sharing knowledge on a continuing basis. Furthermore, knowledge not applied is knowledge wasted. For example, a person may learn the techniques of testing steam traps in a classroom setting, but if it is not applied, the skill is quickly lost. Following are some training aids involving hands-on experience that are useful on a day-to-day basis.

Reprints: Sharpen Trap Testing Skills to Save Maintenance Hours and Conserve Energy is a reprint from **POWER** Magazine. It was authored by Armstrong's technical staff, including engineers and research staff members. It stresses the importance of individual training and plenty of practical experience. The article also includes a copy of the steam trap testing flow chart.

Flow Chart: The flow chart poster can help guide a person through logical steps of diagnosing a trap's performance. It lists a number of conditions to look for and identifies steam system conditions that impact on troubleshooting steam traps, regardless of the type.

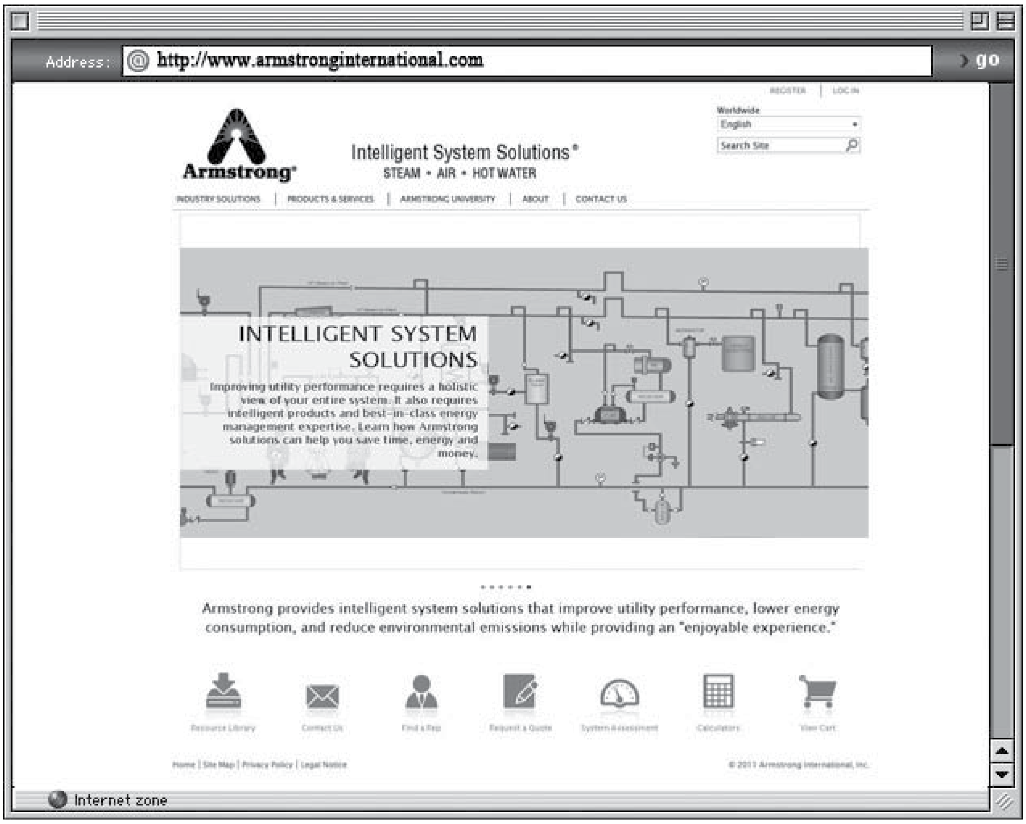
Bulletin No. 310: Steam Trap Testing Guide for Energy Conservation is a small, shirt-pocket guide loaded with tips for effectively testing all types of steam traps. This step-by-step testing guide gives helpful hints on how to test traps by the sound method.

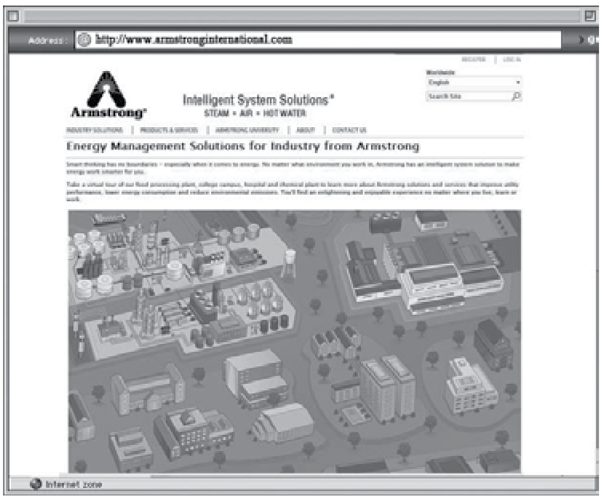
Bulletin No. 301: Service Guide is a 36-page handbook and fits easily into a pocket for on-the-job reference relating to inverted bucket steam traps. It contains valuable information ranging from installing traps to inspecting/testing, troubleshooting and a wide range of other helpful tips.

armstronginternational.com

Armstrong's new and improved Website offers a user-friendly navigational interface to encourage all visitors to find product and service information with a few less clicks of a mouse. Completely reorganized and expanded, the site makes it possible to review every Armstrong product, service and system solution by industry or application.

Product literature and technical specifications are available as downloads, as are CAD drawings. Requests for quotes are also available for more than 20 product families. Stop by today to learn more about Armstrong's intelligent system solutions!





Interactive Plant and Facility Tours
Take Armstrong's interactive tour to get an overview of how utility systems function in realistic settings. Navigate through a typical food plant, a pharmaceutical facility, many institutional buildings, and a hydrocarbon and chemical processing refinery to learn how solutions and products are applied in each atmosphere.

Learn about Intelligent System Solutions at armstronginternational.com

- **System Solutions.** Armstrong System Solutions are more than the sum of their parts. At Armstrong, it is the system that solves—and saves.
- **Product Solutions.** Every system solution begins with a smart, practical product that solves a problem. Hard-working products are at the heart of every Armstrong solution in steam, air or hot water.
- **Service Solutions.** Finally, the talent, personnel and financing to affordably optimize your utility operation—Armstrong will work with you to assess your system and identify your needs.
- **Industry Solutions.** The power of world-class energy expertise zeroes in on industry-specific targets. A longtime player in key global businesses, Armstrong understands the specific challenges of individual industries.

Armstrong University

At Armstrong, “Knowledge Not Shared Is Energy Wasted®” has been a theme and a way of life for years. For us, it’s how we go about our business, how we build relationships with customers and solve problems—both inside and outside the company.

For you, it’s a promise. It’s our pledge to use what we know to make your business more efficient, more profitable and more rewarding. In many ways, Armstrong University is the capstone for a tradition of knowledge-sharing.

It is certainly the most ambitious and comprehensive effort we’ve ever undertaken. That’s why we’re using “Knowledge Not Shared Is Energy Wasted” as both a motto and a statement of purpose for Armstrong University.

Whether you prefer to learn online or by participating in a seminar at one of our worldwide, fully equipped global learning centers, you’re encouraged to enroll today.

Earn CEUs once you've completed Armstrong University!

- The Continuing Education Unit (CEU) is a nationally recognized standard for assessing the time spent in educational, professional development, or training activities.
- Armstrong in partnership with Kalamazoo Valley Community College's Michigan Technical Education Center (M-TEC) is proud to advise you that Armstrong University courses deliver training that carries CEUs from an accredited institution of higher education.

Check out what else you can do on the AU Campus:

- Enroll in “Undergraduate” and “Graduate” courses that lead you through theory and system operation, installation, and maintenance. Pay close attention; there is a quiz after each course!
- Access and learn via our vast library of video, animation and technical information.
- Explore Armstrong’s unparalleled information library using our search engine.
- Use online calculators to determine steam loss, flash steam and annual savings by returning condensate.

Armstrong Videotapes/DVDs

What Is Steam?
15:07 Minutes
This is the basics-of-steam primer… the "Steam 101" short course on the principles of steam that leads to a thorough understanding of the concepts outlined in the many Armstrong training tapes and materials. Both live action video and clear, simple animation are used to illustrate steam properties and behavior. Everyday demonstrations and a straight-forward style help make this an informative and entertaining tape, whether used as an introduction or as a refresher.

Guidelines for Steam System Efficiency
15:17 Minutes
This educational program covers basic considerations in the design, piping and trapping of steam systems. Topics include correct sizing and installation of steam supply and condensate return lines; steam velocities in the system; proper steam trap installation; trap safety factors; the use of air vents, vacuum breakers and safety drains; and how non-condensables affect the performance and service life of heat exchanger equipment.

Guidelines for the Prevention of Water Hammer
16:15 Minutes
The purpose of this educational tool is to help customers understand the nature and severity of the water hammer problem.

Using live action video and computer animation, this program identifies the most likely causes of water hammer and provides solutions that can be implemented to prevent its occurrence. With a better understanding of the problem, more preventive measures and equipment can be designed into new or existing installations. The results will be safety for personnel, lower maintenance costs and reduced system downtime.

Let's Talk Steam Traps/Update
32:00 Minutes
Part one uses animation techniques to help viewers see and understand the operating principles of the three types of traps: mechanical, thermostatic and thermodynamic. In addition, the tape helps steam trap users understand the internal operation of inverted bucket steam traps, differential condensate controllers, float and thermostatic traps, thermostatic traps, and disc traps.

The second part of this 32-minute videotape discusses 10 steam system operating conditions that must be considered in evaluating steam trap performance. The five types of traps are then rated on how they respond to these 10 different operating conditions.

Guidelines for Steam Trap Troubleshooting and Testing
18:40 Minutes
Just as properly functioning steam traps contribute to the efficient operation of a steam system, those that are malfunctioning can result in lost steam, lost heat and, especially, lost dollars. Guidelines for Steam Trap Troubleshooting and Testing not only outlines the need for establishing a preventive maintenance program, but details what to look and listen for in your testing.

This videotape recommends a step-by-step approach plant energy technicians can take to steam trap testing and problem solving. It emphasizes use of the faculties of both sight and hearing in gathering information, then applying training and experience to properly evaluate the results.

The Anatomy of the I.B.
15:00 Minutes
The Anatomy of the I.B. uses production techniques to look inside the inverted bucket steam trap. This videotape uses both cell animation and an operating glass-bodied model of an inverted bucket steam trap to show its components and observe its performance.

Guidelines for Unit Heater Efficiency
9:44 Minutes
Every winter industry relies on unit heaters to provide a comfortable environment for workers. The heating season is no time for the nuisance and discomfort of unit heater repair or replacement.

This video program discusses how correct selection, installation, and maintenance of steam supplied unit heaters ensures longer service life and reduces unnecessary repair and replacement costs.

Guidelines for Freeze Prevention
10:52 Minutes
Freezing in outdoor steam systems is a costly maintenance and production problem. Certain guidelines can be followed to minimize damage and process interruptions due to freezing. In addition to highlighting these piping and trapping guidelines, the tape covers an often overlooked problem that can prevent total drainage of the system.

Graphics and glass piping illustrate why condensate remains in or upstream of various types of traps after steam systems are shut down. The tape discusses what can be done to get rid of remaining condensate by the use of temperature and pressure actuated safety drains.

Armstrong Videotapes/DVDs

It's the Humidity
Part 1—24:58 Minutes
Part 2—20:57 Minutes
Part one is a video documentary covering the essentials of humidity and outlining the primary reasons for humidity control. What is humidity? Relative humidity? What is dew point? Enthalpy? How does evaporation affect comfort? How does humidity conserve energy? All of these questions are answered in practical and entertaining demonstrations.

Part two is a look at the four basic methods of large scale humidification. Through animation, the tape discusses the operation of evaporative pan, wetted element, water spray and steam humidifiers, and rates their ability to meet efficiency, maintenance, controllability, sanitation and cost requirements.

Guidelines for Steam Trap Repair
20:41 Minutes
This tape begins by outlining a plan for identifying faulty traps and returning them to effective operation. The first part of the tape provides guidelines for the inspection and repair of any trap.

The second part addresses specific trap types—inverted bucket, float and thermostatic, disc, and thermostatic. Each trap requires individual considerations, and attention is given to the differences as well as the common concerns.

The Armstrong Differential Condensate Controller
18:36 Minutes
To the paper, textile and boxboard industries, proper condensate drainage from steam heated cylinder dryers is necessary to optimize production and conserve heat energy.

This videotape discusses the standard steam trap drainage method and the blow-through method of condensate removal.

The Armstrong differential condensate controller, the tape points out, combines features of both methods, and overcomes the drawbacks of both. The result is efficient removal of condensate and air, minimum steam loss, and higher and more uniform temperatures across the dryer surface.

Let's Talk PRVs
30:00 Minutes
Pressure reducing valves, or PRVs, are important to the efficient use of fluids and gases in industry.

Let's Talk PRVs is an in-depth look at the reasons for, configurations of, and means of evaluating pressure reducing valves.

Through animation, the viewer looks inside several different types of PRVs to gain an understanding of their operating principles. This understanding will help the viewer select the right PRV for a particular application.

Guidelines for Steam/Air Coil System Design
13:12 Minutes
This educational video program explains the major causes of frozen steam coils, and the steps that can be taken to prevent the problems. The program uses the air handling system assembled in the Armstrong demonstration lab to illustrate problems and solutions. Glass piping and glass-bodied traps allow viewers to see the flow of condensate and to witness adverse effects of improper system design, as well as the benefits of corrective measures.

Guidelines for Ultra Capacity Steam Trap Repair
23:00 Minutes
This tape begins by outlining a plan to return individual faulty traps to effective operation. The first part of the tape provides guidelines to be followed in the inspection and repair of any trap.

In the second part, Armstrong's ultra capacity F&Ts (Models J, K, L and M) are disassembled, repaired and returned to service. Both single orifice and dual orifice variations are covered.

Technical References

Dry Saturated Steam Tables

Pressure		Temperature	Specific enthalpy			Specific volume steam
			Water (hf)	Evaporation (hfg)	Steam (hg)	
bar	kPa	°C	kJ/kg	kJ/kg	kJ/kg	m3/kg
0.30	30	69.1	289.33	2 335.28	2 624.61	5.230
0.50	50	81.3	340.58	2 304.77	2 645.35	3.241
0.75	75	91.8	384.47	2 278.10	2 662.57	2.218
0.95	95	98.2	411.52	2 261.38	2 672.91	1.778
1.00	100	99.6	417.55	2 257.63	2 675.18	1.694
1.013 25	101.325	100.0	419.10	2 256.66	2 675.76	1.674
0	0	100.0	419.10	2 256.66	2 675.76	1.674
0.1	10	102.7	430.33	2 249.62	2 679.95	1.533
0.2	20	105.1	440.76	2 243.05	2 683.81	1.414
0.3	30	107.4	450.51	2 236.86	2 687.37	1.313
0.4	40	109.6	459.68	2 231.02	2 690.69	1.226
0.5	50	111.6	468.33	2 225.47	2 693.80	1.150
0.6	60	113.6	476.53	2 220.19	2 696.72	1.083
0.7	70	115.4	484.34	2 215.13	2 699.47	1.024
0.8	80	117.2	491.78	2 210.29	2 702.07	0.971
0.9	90	118.8	498.90	2 205.64	2 704.54	0.923
1.0	100	120.4	505.73	2 201.16	2 706.88	0.880
1.1	110	122.0	512.28	2 196.83	2 709.12	0.841
1.2	120	123.5	518.60	2 192.65	2 711.25	0.806
1.3	130	124.9	524.69	2 188.60	2 713.29	0.773
1.4	140	126.3	530.57	2 184.67	2 715.25	0.743
1.5	150	127.6	536.27	2 180.86	2 717.13	0.715
1.6	160	128.9	541.78	2 177.15	2 718.93	0.690
1.7	170	130.2	547.13	2 173.54	2 720.67	0.666
1.8	180	131.4	552.32	2 170.02	2 722.34	0.644
1.9	190	132.6	557.37	2 166.58	2 723.96	0.623
2.0	200	133.7	562.29	2 163.23	2 725.52	0.603
2.2	220	135.9	571.74	2 156.74	2 728.48	0.568
2.4	240	138.0	580.74	2 150.53	2 731.27	0.537
2.6	260	140.0	589.33	2 144.55	2 733.89	0.509
2.8	280	141.9	597.56	2 138.80	2 736.36	0.484
3.0	300	143.8	605.45	2 133.24	2 738.70	0.461
3.2	320	145.5	613.04	2 127.87	2 740.92	0.440
3.4	340	147.2	620.36	2 122.67	2 743.02	0.422
3.6	360	148.9	627.42	2 117.61	2 745.03	0.404
3.8	380	150.4	634.24	2 112.70	2 746.94	0.389
4.0	400	152.0	640.85	2 107.92	2 748.77	0.374
4.5	450	155.6	656.52	2 096.49	2 753.00	0.342
5.0	500	158.9	671.12	2 085.70	2 756.82	0.315
5.5	550	162.1	684.81	2 075.47	2 760.28	0.292
6.0	600	165.1	697.72	2 065.72	2 763.44	0.272
6.5	650	167.9	709.94	2 056.39	2 766.33	0.255
7.0	700	170.6	721.56	2 047.43	2 768.99	0.240
7.5	750	173.0	732.64	2 038.81	2 771.45	0.227
8.0	800	175.5	743.24	2 030.49	2 773.72	0.215
8.5	850	177.8	753.40	2 022.43	2 775.83	0.204
9.0	900	178.0	763.17	2 014.63	2 777.80	0.194
9.5	950	182.1	772.58	2 007.05	2 779.62	0.185
10.0	1 000	184.2	781.66	1 999.67	2 781.33	0.177
10.5	1 050	186.1	790.43	1 992.49	2 782.92	0.170
11.0	1 100	188.0	798.93	1 985.48	2 784.41	0.163
11.5	1 150	189.9	807.17	1 978.63	2 785.80	0.157
12.0	1 200	191.7	815.17	1 971.94	2 787.11	0.151
12.5	1 250	193.4	822.95	1 965.38	2 788.33	0.146
13.0	1 300	195.1	830.52	1 958.96	2 789.48	0.141
13.5	1 350	196.8	837.89	1 952.67	2 790.56	0.136
14.0	1 400	198.4	845.08	1 946.49	2 791.57	0.132
14.5	1 450	199.9	852.09	1 940.42	2 792.51	0.128
15.0	1 500	201.5	858.95	1 934.46	2 793.40	0.124
15.5	1 550	202.9	865.65	1 928.59	2 794.24	0.120
16.0	1 600	204.4	872.20	1 922.82	2 795.02	0.117
17.0	1 700	207.2	884.91	1 911.53	2 796.44	0.110
18.0	1 800	209.9	897.12	1 900.57	2 797.68	0.105
19.0	1 900	212.5	908.87	1 889.89	2 798.77	0.100
20.0	2 000	214.9	920.22	1 879.49	2 799.71	0.095
21.0	2 100	217.3	931.19	1 869.32	2 800.51	0.091
22.0	2 200	219.6	941.82	1 859.38	2 801.20	0.087
23.0	2 300	221.8	952.13	1 849.65	2 801.77	0.083
24.0	2 400	224.0	962.13	1 840.11	2 802.24	0.078
25.0	2 500	226.1	971.87	1 830.74	2 802.62	0.077
26.0	2 600	228.1	981.36	1 821.55	2 802.91	0.074
27.0	2 700	230.1	990.60	1 812.51	2 803.11	0.071
28.0	2 800	232.0	999.62	1 803.61	2 803.24	0.069
29.0	2 900	233.9	1 008.44	1 794.86	2 803.30	0.067
30.0	3 000	235.7	1 017.06	1 786.23	2 803.28	0.064
31.0	3 100	237.5	1 025.49	1 777.72	2 803.21	0.062
32.0	3 200	239.3	1 033.74	1 769.32	2 803.07	0.061
33.0	3 300	241.0	1 041.83	1 761.04	2 802.87	0.059
34.0	3 400	242.7	1 049.77	1 752.85	2 802.62	0.057
35.0	3 500	244.2	1 057.55	1 744.77	2 802.32	0.055
36.0	3 600	245.8	1 065.20	1 736.77	2 801.97	0.054

Dry Saturated Steam Tables						
Pressure		Temperature	Specific enthalpy			Specific volume steam
			Water (hf)	Evaporation (hfg)	Steam (hg)	
bar	kPa	°C	kJ/kg	kJ/kg	kJ/kg	m3/kg
37.0	3 700	247.4	1 072.71	1 728.86	2 801.57	0.052
38.0	3 800	248.9	1 080.09	1 721.04	2 801.13	0.051
39.0	3 900	250.4	1 087.35	1 713.29	2 800.64	0.050
40.0	4 000	251.9	1 094.50	1 705.62	2 800.12	0.049
41.0	4 100	253.3	1 101.53	1 698.02	2 799.55	0.047
42.0	4 200	254.7	1 108.46	1 690.49	2 798.95	0.046
43.0	4 300	256.1	1 115.28	1 683.02	2 798.30	0.045
44.0	4 400	257.5	1 122.01	1 675.62	2 797.63	0.044
45.0	4 500	258.8	1 128.64	1 668.28	2 796.92	0.043
46.0	4 600	260.2	1 135.19	1 660.99	2 796.18	0.042
47.0	4 700	261.5	1 141.64	1 653.76	2 795.40	0.041
48.0	4 800	262.7	1 148.02	1 646.58	2 794.60	0.040
49.0	4 900	264.0	1 154.31	1 639.45	2 793.76	0.039
50.0	5 000	265.2	1 160.53	1 632.36	2 792.90	0.039
51.0	5 100	266.5	1 166.68	1 625.33	2 792.00	0.038
52.0	5 200	267.7	1 172.75	1 618.33	2 791.08	0.037
53.0	5 300	268.8	1 178.75	1 611.38	2 790.14	0.036
54.0	5 400	270.0	1 184.69	1 604.48	2 789.16	0.036
55.0	5 500	271.2	1 190.56	1 597.60	2 788.17	0.035
56.0	5 600	272.3	1 196.37	1 590.77	2 787.14	0.034
57.0	5 700	273.4	1 202.12	1 583.97	2 786.10	0.034
58.0	5 800	274.5	1 207.82	1 577.21	2 785.03	0.033
59.0	5 900	275.6	1 213.45	1 570.48	2 783.94	0.032
60.0	6 000	276.7	1 219.04	1 563.78	2 782.82	0.032
61.0	6 100	277.8	1 224.56	1 557.12	2 781.68	0.031
62.0	6 200	278.8	1 230.04	1 550.48	2 780.52	0.031
63.0	6 300	279.9	1 235.47	1 543.87	2 779.34	0.030
64.0	6 400	280.9	1 240.85	1 537.29	2 778.14	0.030
65.0	6 500	281.9	1 246.19	1 530.73	2 776.92	0.029
66.0	6 600	282.9	1 251.48	1 524.20	2 775.67	0.029
67.0	6 700	283.9	1 256.72	1 517.69	2 774.41	0.028
68.0	6 800	284.9	1 261.93	1 511.20	2 773.13	0.028
69.0	6 900	285.9	1 267.09	1 504.74	2 771.82	0.027
70.0	7 000	286.8	1 272.21	1 498.29	2 770.50	0.027
71.0	7 100	287.8	1 277.29	1 491.87	2 769.16	0.027
72.0	7 200	288.7	1 282.34	1 485.47	2 767.80	0.026
73.0	7 300	289.7	1 287.34	1 479.08	2 766.42	0.026
74.0	7 400	290.6	1 292.31	1 472.71	2 765.03	0.025
75.0	7 500	291.5	1 297.25	1 466.36	2 763.61	0.025
76.0	7 600	292.4	1 302.15	1 460.03	2 762.18	0.025
77.0	7 700	293.3	1 307.02	1 453.71	2 760.73	0.024
78.0	7 800	294.2	1 311.86	1 447.40	2 759.26	0.024
79.0	7 900	295.1	1 316.67	1 441.11	2 757.78	0.024
80.0	8 000	295.9	1 321.45	1 434.83	2 756.27	0.023
81.0	8 100	296.8	1 326.19	1 428.56	2 754.75	0.023
82.0	8 200	297.6	1 330.91	1 422.31	2 753.22	0.023
83.0	8 300	298.5	1 335.60	1 416.06	2 751.66	0.022
84.0	8 400	299.3	1 340.26	1 409.83	2 750.09	0.022
85.0	8 500	300.1	1 344.90	1 403.60	2 748.50	0.022
86.0	8 600	301.0	1 349.51	1 397.39	2 746.90	0.021
87.0	8 700	301.8	1 354.09	1 391.18	2 745.27	0.021
88.0	8 800	302.6	1 358.65	1 384.98	2 743.64	0.021
89.0	8 900	303.4	1 363.19	1 378.79	2 741.98	0.020
90.0	9 000	304.2	1 367.70	1 372.61	2 740.31	0.020
92.0	9 200	305.8	1 376.66	1 360.25	2 736.91	0.020
94.0	9 400	307.3	1 385.53	1 347.92	2 733.45	0.019
96.0	9 600	308.8	1 394.32	1 335.60	2 729.93	0.019
98.0	9 800	310.3	1 403.04	1 323.30	2 726.34	0.018
100.0	10 000	311.8	1 411.68	1 311.00	2 722.68	0.018
102.0	10 200	313.2	1 420.25	1 298.70	2 718.95	0.017
104.0	10 400	314.6	1 428.76	1 286.40	2 715.16	0.017
106.0	10 600	316.1	1 437.20	1 274.10	2 711.30	0.017
108.0	10 800	317.4	1 445.59	1 261.79	2 707.37	0.016
110.0	11 000	318.8	1 453.92	1 249.46	2 703.38	0.016
112.0	11 200	320.1	1 462.20	1 237.12	2 699.31	0.015
114.0	11 400	321.5	1 470.43	1 224.75	2 695.18	0.015
116.0	11 600	322.8	1 478.61	1 212.36	2 690.97	0.015
118.0	11 800	324.1	1 486.76	1 199.94	2 686.70	0.014
120.0	12 000	325.4	1 494.86	1 187.48	2 682.35	0.014

Capacity (kg/hour)															
Pressure (bar)	Steam Velocity (m/s)	Nominal Pipe Size (mm)													
		15	20	25	32	40	50	65	80	100	125	150	200	250	300
0.4	15	7	14	24	37	52	99	145	213	394	648	917	1606	2590	3680
	25	10	25	40	62	92	162	265	384	675	972	1457	2806	4101	5936
	40	17	35	64	102	142	265	403	576	1037	1670	2303	4318	6909	9500
0.7	15	7	16	25	40	59	109	166	250	431	680	1006	1708	2791	3852
	25	12	25	45	72	100	182	287	430	716	1145	1575	2816	4629	6204
	40	18	37	68	106	167	298	428	630	1108	1715	2417	4532	7251	10323
1	15	8	17	29	43	65	112	182	260	470	694	1020	1864	2814	4045
	25	12	26	48	72	100	193	300	445	730	1160	1660	3099	4869	6751
	40	19	39	71	112	172	311	465	640	1150	1800	2500	4815	7333	10370
2	15	12	25	45	70	100	182	280	410	715	1125	1580	2814	4545	6277
	25	19	43	70	112	162	195	428	656	1215	1755	2520	4815	7425	10575
	40	30	64	115	178	275	475	745	1010	1895	2925	4175	7678	11997	16796
3	15	16	37	60	93	127	245	385	535	925	1505	2040	3983	6217	8743
	25	26	56	100	152	225	425	632	910	1580	2480	3440	6779	10269	14316
	40	41	87	157	250	357	595	1025	1460	2540	4050	5940	10479	16470	22950
4	15	19	42	70	108	156	281	432	635	1166	1685	2460	4618	7121	10358
	25	30	63	115	180	270	450	742	1080	1980	2925	4225	7866	12225	17304
	40	49	116	197	295	456	796	1247	1825	3120	4940	7050	12661	1963	27816
5	15	22	49	87	128	187	352	526	770	1295	2105	2835	5548	8586	11947
	25	36	81	135	211	308	548	885	1265	2110	3540	5150	8865	14268	20051
	40	59	131	225	338	495	855	1350	1890	3510	5400	7870	13761	23205	32244

Pressure (bar)	Steam Velocity (m/s)	Nominal Pipe Size (mm)													
		15	20	25	32	40	50	65	80	100	125	150	200	250	300
6	15	26	59	105	153	225	425	632	925	1555	2525	3400	6654	10297	14328
	25	43	97	162	253	370	658	1065	1520	2530	4250	6175	10629	17108	24042
	40	71	157	270	405	595	1025	1620	2270	4210	6475	9445	16515	27849	38697
7	15	29	63	110	165	260	445	705	952	1815	2765	3990	7390	12015	16096
	25	49	114	190	288	450	785	1205	1750	3025	4815	6900	12288	19377	27080
	40	76	177	303	455	690	1210	1865	2520	4585	7560	10880	19141	30978	43470
8	15	32	70	126	190	285	475	800	1125	1990	3025	4540	8042	12625	17728
	25	54	122	205	320	465	810	1260	1870	3240	5220	7120	13140	21600	33210
	40	84	192	327	510	730	1370	2065	3120	5135	8395	12470	21247	33669	46858
10	15	41	95	155	250	372	626	1012	1465	2495	3995	5860	9994	16172	22713
	25	66	145	257	405	562	990	1530	2205	3825	6295	8995	15966	25860	35890
	40	104	216	408	615	910	1635	2545	3600	6230	9880	14390	26621	41011	57560
14	15	50	121	205	310	465	810	1270	1870	3220	5215	7390	12921	20538	29016
	25	85	195	331	520	740	1375	2080	3120	5200	8500	12560	21720	34139	47128
	40	126	305	555	825	1210	2195	3425	4735	8510	13050	18630	35548	54883	76534

The values above are calculated for steel pipes BS 1387:1985 (replaced with the European standard EN 10255:2004) medium thickness. Using other standards with different inside diameters, the values above should be compensated.

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DANGER
Despite being indicated as generally suitable in the charts, variations in temperature, pressure and concentration of chemicals may cause failure.
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Chemical	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Aluminium	Titanium	Hastelloy C	Cast Bronze	Brass	Cast Iron	Carbon Steel	PVC	Teflon PTFE	Noryl	Nylon	Polyethylene PE	Polypropylene PP	Ryton	Carbon	Caramic Al_2O_3	Viton (FPM)	Buna N - Nitrile - NBR	Silicon	Neoprene	EPDM	Natural Rubber	Epoxy
Max Temperature In Deg C for Elastomers / Plastics												60	200	60	60		25 - 60				180	80		70	120	60	
Acetaldehyde	A	A	A	-	B	A	A	D	-	-	C	D	A	-	A	C	B	A	A	A	A	B	B	D	B	C	A
Acetamide	-	B	A	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-	A	A	A	-	A	A	D	A
Acetate Solv.	A	B	A	B	B	-	-	A	C	B	A	B	A	-	A	B	D	-	A	A	D	D	-	D	-	-	A
Acetic Acid,Glacial	-	B	A	A	B	A	A	C	C	D	A	C	A	C	D	B	B	A	A	A	D	D	B	C	B	C	B
Acetic Acid 20%	-	-	A	-	-	A	A	-	C	-	-	B	A	A	D	-	A	A	-	A	D	C	-	C	-	-	B
Acetic Acid 80%	-	-	A	-	-	A	A	-	C	-	-	D	A	B	D	-	B	-	-	A	D	C	-	D	-	-	B
Acetic Acid	-	B	A	B	B	A	A	C	C	D	C	A	A	A	D	B	A	A	A	A	C	C	-	C	B	C	A
Acetic Anhydride	B	A	A	B	B	A	A	C	D	B	D	D	A	D	D	A	A	A	A	A	D	A	C	B	B	C	A
Acetone	A	A	A	B	A	A	A	A	A	A	A	D	A	D	A	C	B	A	A	A	D	D	B	C	A	D	B
Acetyl Chloride	-	C	A	-	-	-	-	D	-	-	-	-	A	-	-	-	-	A	-	-	-	-	-	-	-	A	A
Acetylene	A	A	A	A	A	-	-	B	-	A	A	B	-	-	A	-	D	A	A	A	A	A	C	B	A	C	A
Acrylonitrile	A	A	C	-.	B	-	B	A	-	C	-	-	-	-	-	-	B	A	A	A	C	D	-	D	D	-	A
Aluminium Chloride 20%	-	D	C	D	B	A	A	D	-	D	A	A	-	A	A	B	A	A	A	A	A	A	-	A	A	A	A
Aluminium Chloride	C	D	C	-	D	C	A	C	-	D	B	A	A	A	D	-	A	A	A	A	A	A	C	A	-	-	A
Aluminium Flouride	-	D	C	D	-	D	B	-	-	-	A	A	A	A	D	B	A	-	A	-	A	A	C	A	-	C	A
Aluminium Hydroxide	-	A	A	A	A	-	-	A	-	D	A	A	A	A	A	-	A	-	A	A	A	A	-	A	-	A	A
Alum Potassium Sulfate (ALUM),10%	-	A	-	-	A	-	B	-	-	D	A	A	A	-	A	A	-	-	A	A	A	-	-	A	-	A	A
Alum Potassium Sulfate (ALUM) 100%	-	D	A	B	B	-	B	C	-	-	A	A	A	A	D	B	A	-	A	A	A	A	-	A	-	A	A
Aluminium Sulfate	-	C	C	A	A	A	A	C	C	D	A	A	A	A	A	B	A	A	A	A	A	A	-	A	A	A	A
Amines	A	A	A	-	A	B	A	B	-	A	B	C	A	B	A	-	-	-	A	A	D	D	C	B	B	C	A
Ammonia 10%	-	-	A	-	-	A	A	-	-	-	-	A	A	A	A	-	A	A	-	A	A	D	-	A	-	-	B
Ammonia Anhydrous	A	B	A	A	B	B	A	D	-	D	B	A	A	A	A	B	A	B	C	A	D	B	B	A	A	D	A
Ammonia, Liquids	-	A	A	A	D	-	B	D	-	A	A	A	A	A	-	D	A	-	A	A	D	B	B	A	A	D	A
Ammonia, Nitrate	-	A	A	A	C	-	-	D	-	-	A	B	-	A	-	-	A	-	A	A	-	A	-	C	-	-	A
Ammonium Bifluoride	-	C	A	-	D	-	B	-	-	-	-	A	-	A	-	-	A	-	-	A	A	A	-	A	-	-	A
Ammonium Carbonate	B	A	A	A	C	A	B	B	-	C	B	A	A	A	A	-	A	-	A	A	B	D	C	A	A	-	A
Ammonium Casenite	-	-	A	-	-	-	-	-	-	-	-	-	-	A	-	-	-	-	-	-	-	-	-	A	-	-	A
Ammonium Chloride	C	A	C	A	C	A	A	D	C	D	D	A	A	A	A	B	A	A	A	A	A	A	C	A	A	A	A
Ammonium Hydroxide	A	A	A	A	C	A	A	D	D	A	C	A	A	A	A	B	A	A	A	A	B	B	B	A	A	C	A
Ammonium Nitrate	A	A	A	A	B	A	A	D	D	A	D	A	A	A	D	B	A	A	A	A	A	A	C	A	A	A	A
Ammonium Oxalate	-	A	A	A	-	-	A	-	-	-	A	-	-	-	-	-	-	-	A	-	-	A	-	A	-	-	A
Ammonium Persulfate	-	A	A	A	C	A	A	A	-	D	A	A	A	A	D	-	A	-	A	A	C	A	-	A	A	A	A
Ammonium Phosphate, Dibasic	B	A	A	A	B	A	A	C	-	-	D	A	A	A	A	B	A	-	A	A	A	A	B	A	A	A	A
Ammonium Phosphate, Monobasic	-	A	A	A	B	A	A	D	-	-	A	A	A	A	A	B	A	-	A	A	A	A	B	A	A	A	A
Ammonium Phosphate, Tribasic	B	A	A	A	B	A	A	C	-	C	D	A	A	A	A	B	A	-	A	A	A	A	B	A	A	A	A
Ammonium Sulfate	C	A	B	A	B	A	A	B	C	C	C	A	A	A	D	B	A	A	A	A	D	A	B	A	A	A	A
Ammonium Thio-Sulfate	-	-	A	-	-	A	-	-	-	D	A	-	-	-	-	-	-	-	A	A	-	A	-	A	-	-	A
Amyl-Acetate	B	A	A	C	B	A	A	C	-	-	C	D	A	D	B	D	D	A	A	A	D	D	D	D	A	D	A
Amyl Alcohol	-	A	A	-	B	A	A	A	-	-	A	A	A	C	A	B	A	-	A	A	B	B	D	A	A	C	A
Amyl Chloride	-	C	B	-	D	-	A	A	-	-	A	D	A	D	C	D	D	-	A	A	A	D	-	D	D	D	A
Aniline	B	A	A	A	C	C	B	C	-	-	C	D	A	D	C	C	B	A	A	A	D	D	C	D	B	D	A
Anti-Freeze	-	A	A	-	A	-	A	B	B	B	C	A	A	A	A	B	A	A	A	A	A	A	C	A	A	A	A
Antimony Plating 54°C	-	-	A	-	-	A	A	-	-	-	-	A	A	A	D	-	A	-	-	A	A	A	D	A	-	-	B
Antimony Trichloride	-	D	D	-	D	-	A	-	-	-	-	A	A	-	D	A	-	-	-	A	-	-	-	C	-	A	A
Aqua Regia (80%, HCl, 20%, HNO)	-	D	D	-	D	A	D	D	-	-	-	D	A	D	D	D	C	-	-	D	C	D	C	D	D	D	D
Arochlor 1248	-	-	-	-	-	-	-	-	-	-	A	-	-	D	-	-	-	-	A	-	A	D	-	D	B	D	A
Aromatic Hydrocarbons	-	-	A	-	A	-	-	A	-	A	A	D	-	D	-	C	-	-	A	-	A	D	-	D	D	D	A
Arsenic Acid	B	A	A	-	D	-	-	D	B	D	D	A	A	A	A	B	A	-	A	A	A	A	-	A	-	C	A
Arsenic Plating 43°C	-	-	A	-	-	A	A	-	-	-	-	A	A	A	A	-	A	-	-	C	A	A	D	A	-	-	B
Asphalt	-	B	A	-	C	-	-	A	-	C	-	A	-	-	A	-	A	A	-	A	A	B	C	B	D	D	A
Barium Carbonate	B	A	A	A	B	A	A	B	-	B	B	A	A	A	A	B	A	-	A	A	A	A	-	A	-	A	A
Barium Chloride	C	A	A	A	D	A	A	B	-	N	C	A	A	A	B	B	A	A	A	A	A	A	B	A	A	A	A
Barium Cyanide	-	-	A	-	-	-	-	C	-	-	A	-	-	-	-	B	-	-	A	-	A	C	-	A	A	-	A
Barium Hydroxide	B	C	A	A	D	B	B	B	-	C	C	A	A	A	A	B	A	A	A	A	A	A	C	A	A	A	A
Barium Nitrate	-	A	A	-	-	A	-	D	-	A	A	B	-	A	-	-	-	-	A	A	A	A	-	A	A	-	B
Barium Sulfate	B	A	A	A	D	A	A	C	-	C	C	A	A	A	A	B	A	A	A	B	A	A	D	A	A	-	B
Barium Sulfide	B	A	A	-	D	-	-	C	-	C	C	A	A	A	A	B	A	-	A	A	A	A	C	A	A	A	A
Beer	A	A	A	-	A	A	A	A	B	D	D	A	A	A	D	B	D	-	A	A	A	D	C	A	A	A	A
Beet Sugar Liquids	A	A	A	-	A	-	-	A	B	A	-	A	A	A	A	-	A	-	A	A	A	A	-	B	A	A	A

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Max Temperature in Deg C for Elastomers / Plastics												60	200	60	60		25 - 60				180	80		70	120	60	60
Benzaldehyde	A	A	A	-	B	A	A	A	-	B	A	D	A	D	C	D	D	A	A	A	D	D	B	D	A	D	A
Benzene	B	A	A	A	B	A	B	B	A	B	C	D	A	D	A	D	D	A	A	A	A	D	-	D	D	D	A
Benzoic Acid	B	A	A	A	B	A	A	B	-	D	-	A	A	A	D	B	D	-	A	B	A	D	-	D	D	D	A
Benzol	-	A	A	-	B	A	A	B	A	-	-	D	A	D	A	-	A	-	A	A	D	D	-	D	-	-	A
Benzyl Alcohol	-	A	A	-	B	A	A	A	C	-	-	D	-	A	A	D	A	-	A	A	A	D	-	B	B	D	A
Borax (Sodium Borate)	-	A	A	A	C	-	A	A	B	A	C	A	A	A	A	B	A	A	A	A	A	B	C	A	A	C	A
Boric Acid	B	A	A	A	B	A	A	B	C	D	-	A	A	A	A	B	A	-	A	A	A	A	-	A	A	A	A
BRASS PLATING																											
Regular Brass Bath 38°C	-	-	A	-	-	A	A	-	-	-	-	A	A	A	A	-	A	-	-	C	A	A	D	A	-	-	B
High Speed Brass Bath 42°C	-	-	A	-	-	A	A	-	-	-	-	A	A	A	A	-	A	-	-	D	A	A	D	A	-	-	B
Brewery Slop	-	-	A	-	-	-	-	A	-	A	-	-	-	-	-	-	-	-	A	A	A	A	-	A	-	-	A
Bromine (Wet)	D	D	D	D	D	A	A	C	-	D	D	B	A	D	D	D	D	D	D	A	A	D	D	D	D	D	C
BRONZE PLATING																											
Copper-Cadmium Bronze Bath R.T.	-	-	A	-	-	A	A	-	-	-	-	A	A	A	A	-	A	-	-	C	A	A	D	A	-	-	B
Copper-Tin Bronze Bath 82°C	-	-	A	-	-	A	A	-	-	-	-	D	A	A	A	-	A	-	-	D	A	A	D	B	-	-	C
Copper-Zinc Bronze Bath 38°C	-	-	A	-	-	A	A	-	-	-	-	A	A	A	A	-	A	-	-	C	A	A	-	A	-	-	B
Butadiene	A	A	A	-	A	-	-	C	A	C	C	A	A	-	A	-	-	B	A	A	A	A	-	B	A	-	A
Butanes	A	A	A	-	A	-	-	A	A	C	C	A	A	D	A	C	D	A	A	A	A	A	D	B	D	D	A
Butanol	-	A	A	-	A	-	A	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Butter	B	B	A	-	A	-	-	D	-	D	-	-	-	B	-	-	-	-	A	A	A	A	-	B	A	D	A
Buttermilk	C	A	A	A	A	-	-	D	-	D	-	-	A	A	A	-	-	-	A	A	A	A	-	A	-	D	A
Butylene	-	-	A	-	A	-	-	A	A	A	A	B	A	-	-	-	-	A	A	A	A	B	-	-	D	D	A
Butyl Acetate	-	-	C	-	A	-	A	A	-	-	A	D	A	D	-	C	D	A	A	A	D	B	D	D	B	D	A
Butyl Alcohol	A	A	A	-	B	B	A	B	C	C	C	A	A	A	A	B	B	A	A	A	A	A	D	A	A	A	A
Butyric Acid	B	B	A	A	B	A	A	C	-	D	-	B	A	A	D	-	A	-	A	D	D	D	-	D	B	-	A
CADMIUM PLATING																											
Cyanide Bath 32°C	-	-	A	-	-	A	A	-	-	-	-	A	A	A	A	-	A	-	-	C	A	A	-	A	-	-	B
Fluoborate Bath 38°C	-	-	A	-	-	D	A	-	-	-	-	A	A	A	D	-	A	-	-	D	A	B	-	C	-	-	B
Calcium Bisulfate	C	D	A	-	D	-	-	D	D	D	-	A	A	-	A	-	-	-	-	-	A	A	C	C	-	A	A
Calcium Bisulfide	-	-	B	-	C	A	A	C	-	-	-	A	A	A	A	B	A	-	A	A	A	A	-	A	D	-	A
Calcium Bisufite	-	D	A	-	C	A	A	C	-	-	-	A	A	A	A	-	A	-	-	A	A	A	-	A	-	A	-
Calcium Carbonate	B	A	A	A	C	A	A	C	-	D	-	A	A	A	A	B	A	-	A	A	A	A	-	A	-	A	A
Calcium Chlorate	-	C	A	-	-	-	B	C	-	-	-	A	A	-	A	A	-	-	A	-	A	-	-	A	-	A	A
Calcium Chloride	C	A	D	C	C	A	A	B	-	C	-	A	A	A	A	B	A	A	A	A	A	A	B	D	A	A	A
Calcium Hydroxide	B	A	A	-	C	A	A	B	-	-	-	A	A	A	A	B	A	-	A	A	A	A	C	A	A	A	A
Calcium Hypochlorite	D	A	C	C	C	A	B	D	-	D	-	D	A	A	D	B	A	-	A	A	A	B	C	D	A	C	A
Calcium Sulfate	B	A	A	A	B	A	B	B	-	-	-	A	A	A	A	B	A	A	A	A	A	A	-	D	-	C	A
Calgon	-	A	A	-	-	-	-	C	-	D	-	-	-	A	-	-	A	-	A	A	A	A	-	A	-	-	A
Cane Juice	-	A	A	-	B	-	-	B	C	A	-	A	-	-	A	-	D	-	A	A	-	A	-	A	-	A	A
Carbolic Acid (Phenol)	B	A	A	A	B	C	A	B	D	D	D	A	A	C	D	D	B	A	A	D	A	D	-	D	D	D	B
Carbon Bisulfide	B	A	A	A	A	-	-	C	-	B	-	D	-	-	A	-	D	-	A	A	A	D	-	D	D	D	A
Carbon Dioxide (Wet)	-	A	A	-	C	-	A	C	C	C	-	-	A	-	-	-	-	-	A	A	-	-	-	-	-	-	-
Carbon Disulfide	-	B	A	-	C	-	-	C	C	B	C	D	A	D	A	D	D	A	A	B	A	D	-	D	D	D	A
Carbon Monoxide	-	A	A	-	A	-	-	-	-	-	-	A	-	B	A	B	A	-	A	A	A	A	B	B	A	C	A
Carbon Tetrachloride	B	C	B	A	C	A	A	C	A	C	D	C	A	D	A	D	D	C	A	A	A	C	C	D	-	D	C
Carbonated Water	B	A	A	A	A	-	-	B	-	D	-	A	-	A	A	-	A	-	A	A	A	A	-	A	A	-	A
Carbonic	B	A	B	A	A	-	A	B	-	D	-	A	A	A	A	B	A	-	A	A	A	B	B	A	A	A	A
Catsup	-	A	A	A	D	-	-	C	-	D	-	A	-	A	A	-	A	-	A	A	A	A	-	C	-	-	A
Chloracetic Acid	D	D	D	D	C	A	A	D	-	D	-	A	A	-	D	D	D	-	A	A	A	D	-	D	B	D	B
Chloric Acid	-	D	D	-	-	-	-	-	-	-	-	D	A	-	-	-	-	-	-	-	-	D	-	D	-	-	D
Chlorinated Glue	-	A	A	-	D	-	-	C	-	D	-	-	-	C	C	-	-	-	-	A	A	C	-	D	B	D	A
Chlorine, Anhydrous Liquid	-	D	D	D	D	D	A	D	-	C	-	D	A	A	D	D	D	C	A	D	A	D	-	D	B	D	B
Chlorine (Dry)	B	A	A	-	D	D	A	A	B	A	-	-	A	-	-	-	-	C	A	A	D	-	-	D	-	D	D
Chlorine Water	D	-	D	-	D	A	B	D	D	D	-	A	A	C	D	-	D	C	C	A	A	D	C	D	-	-	-
Chlorobenzene (Mono)	A	A	A	-	B	-	A	B	-	B	C	D	A	D	A	D	D	A	A	A	A	D	-	D	D	D	A
Chlorosulfonic Acid	D	D	-	D	D	A	B	D	-	-	D	C	A	D	D	D	D	D	-	C	D	D	D	D	D	D	C
Chlorox (Bleach)	-	A	A	-	C	-	A	A	-	D	C	A	A	A	D	-	D	C	A	A	A	C	-	B	B	D	A
Chocolate Syrup	-	A	A	-	A	-	-	-	-	D	-	-	-	A	A	-	A	-	-	A	A	A	-	A	-	D	A
Chromic Acid 5%	-	A	A	B	C	A	A	D	D	D	-	A	-	C	D	B	A	A	D	C	A	D	C	D	A	B	B

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Chemical	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Aluminium	Titanium	Hastelloy C	Cast Bronze	Brass	Cast Iron	Carbon Steel
Max Temperature in Deg C for Elastomers / Plastics											
Chromic Acid 10%	-	B	-	-	-	A	A	-	D	-	-
Chromic Acid 30%	-	B	-	-	-	A	A	-	D	-	-
Chromic Acid 50%	C	B	B	-	C	A	A	D	D	D	-
CHROMIUM PLATING											
Chromic-Sulfuric Bath 54°C	-	-	C	-	-	A	A	-	-	-	-
Fluosilicate Bath 35°C	-	-	C	-	-	C	A	-	-	-	-
Fluoride Bath 54°C	-	-	D	-	-	C	A	-	-	-	-
Black Chrome Bath 46°C	-	-	C	-	-	A	A	-	-	-	-
Barrel Chrome Bath 35°C	-	-	D	-	-	C	A	-	-	-	-
Cider	-	A	A	A	B	-	-	A	-	D	-
Citric Acid	-	A	A	A	C	A	A	D	C	D	-
Citric Oils	-	A	A	-	C	-	-	B	-	-	-
Coffee	A	A	A	A	A	-	-	B	-	C	-
Copper Chloride	C	D	D	B	D	A	A	D	-	D	-
Copper Cyanide	-	A	A	A	D	A	A	C	-	D	-
Copper Floborate	-	D	D	-	D	-	B	D	-	D	-
Copper Nitrate	B	A	A	B	D	A	A	D	-	-	-
COPPER PLATING (Cyanide)											
Copper Strike Bath 49°C	A	A	A	A	A	A	A	-	-	-	-
Rochelle Salt Bath 66°C	-	-	A	-	-	A	A	-	-	-	-
High Speed Bath 82°C	-	-	A	-	-	A	A	-	-	-	-
COPPER PLATING (Acid)											
Copper Sulfate Bath R.T.	-	-	D	-	-	A	A	-	-	-	-
Copper Fluoborate Bath 49°C	-	-	D	-	-	D	A	-	-	-	-
Copper Pyrophosphate 50°C	-	-	A	-	-	A	A	-	-	-	-
Copper (Electroless) 60°C	-	-	-	-	-	-	-	D	-	-	-
Copper Sulfate 5%	-	A	A	A	D	A	A	D	D	D	-
Cream	-	A	A	-	A	-	-	C	-	D	-
Cresols	-	A	A	-	B	-	-	D	C	-	-
Cresylic Acid	B	A	A	-	C	A	B	C	-	-	-
Cyclohexane	-	A	-	-	A	A	-	A	-	-	A
Cyanic Acid	-	A	-	-	-	-	-	-	-	-	-
Detergents	-	A	A	-	A	-	-	A	-	-	A
Diacetone Alcohol	-	A	A	-	A	A	A	A	C	-	A
Dichlorethane	-	A	A	-	-	-	A	-	-	-	-
Diesel Fuel	A	A	A	-	A	-	-	A	-	A	A
Diethylamine	A	A	-	-	A	-	-	A	-	-	-
Diethylene Gycol	-	A	-	-	-	-	-	A	-	-	-
Diphenyl Oxide	-	A	-	-	-	-	-	A	-	-	-
Dyes	-	A	A	-	B	-	-	C	-	-	-
Epsom Salts(Magnesium Sulfate)	B	A	A	A	A	A	B	B	-	-	-
Ethane	A	A	-	-	A	-	-	A	-	-	-
Ethanolamine	-	A	A	-	-	-	-	-	-	-	C
Ether	A	A	A	A	A	-	B	B	A	-	D
Ethyl Acetate	-	A	A	-	B	-	B	B	-	-	C
Ethyl Alcohol	-	A	A	A	B	A	A	A	C	A	A
Ethyl Chloride	-	A	A	A	B	A	B	B	-	C	D
Ethyl Sulfate	-	D	-	-	-	-	-	-	-	-	-
Ethylene Chloride	-	A	A	-	C	B	B	A	-	C	C
Ethylene Dichloride	-	A	A	-	D	A	B	C	-	-	C
Ethylene Glycol	-	A	A	-	A	-	A	B	B	B	C
Ethylene Oxide	-	-	A	-	A	-	-	A	-	-	-
Fatty Acids	-	A	A	-	B	A	A	C	-	D	-
Ferric Chloride	-	D	D	D	D	A	B	D	D	D	-
Ferric Nitrate	-	A	A	A	D	A	A	D	-	-	-
Ferric Sulfate	-	A	C	A	D	A	A	D	D	D	-
Ferrous Chloride	-	D	D	-	D	A	B	C	-	D	-
Ferrous Sulfate	B	A	C	-	D	A	B	C	-	D	D
Fluboric Acid	-	D	B	-	-	D	A	-	-	D	-
Fluorine	D	D	D	-	D	D	A	D	-	D	D
Fluosilicic Acid	-	-	B	-	D	D	B	-	-	D	-

Chemical	PVC	Teflon PTFE	Noryl	Nylon	Polyethylene PE	Polypropylene PP	Ryton	Carbon	Ceramic Al_2O_3	Viton (FPM)	Buna N - Nitrile - NBR	Silicon	Neoprene	EPDM	Natural Rubber	Epoxy
Max Temperature in Deg C for Elastomers / Plastics	60	200	60	60		25 - 60				180	80		70	120	60	
Chromic Acid 10%	A	A	A	D	-	A	-	-	A	A	D	-	D	-	-	C
Chromic Acid 30%	A	A	D	D	-	A	-	-	A	A	D	-	D	-	-	D
Chromic Acid 50%	B	A	D	D	C	B	B	D	A	A	D	-	D	A	D	C
CHROMIUM PLATING																
Chromic-Sulfuric Bath 54°C	A	A	D	D	-	A	-	-	A	C	D	-	D	-	-	D
Fluosilicate Bath 35°C	A	A	D	D	-	A	-	-	B	C	D	-	D	-	D	D
Fluoride Bath 54°C	A	A	D	D	-	A	-	-	B	C	D	-	D	-	-	D
Black Chrome Bath 46°C	A	A	D	D	-	A	-	-	A	C	D	-	D	-	-	D
Barrel Chrome Bath 35°C	A	A	D	D	-	A	-	-	A	C	D	-	D	-	-	D
Cider	A	-	A	-	B	-	-	A	A	A	A	-	A	-	-	A
Citric Acid	A	A	A	C	B	B	-	A	A	A	D	C	A	A	A	A
Citric Oils	-	-	A	-	-	A	-	A	A	A	A	C	D	-	-	A
Coffee	-	A	A	A	-	A	-	A	A	A	A	-	A	-	A	A
Copper Chloride	A	A	A	D	B	A	A	-	A	A	A	-	A	A	A	A
Copper Cyanide	A	A	A	A	B	A	A	A	A	B	B	-	A	A	A	C
Copper Floborate	A	A	-	-	A	-	-	A	-	A	B	-	A	-	A	A
Copper Nitrate	A	A	A	D	B	A	-	A	A	A	A	-	A	-	-	A
COPPER PLATING (Cyanide)																
Copper Strike Bath 49°C	A	A	A	A	-	A	-	-	C	B	-	-	A	-	-	A
Rochelle Salt Bath 66°C	D	A	A	A	-	A	-	-	D	A	A	-	B	-	-	C
High Speed Bath 82°C	D	A	A	A	-	A	-	-	D	A	A	-	B	-	-	C
COPPER PLATING (Acid)																
Copper Sulfate Bath R.T.	A	A	A	D	-	A	-	-	D	A	A	-	A	-	-	D
Copper Fluoborate Bath 49°C	A	A	A	D	-	A	-	-	D	A	B	-	C	-	-	D
Copper Pyrophosphate 50°C	A	A	A	A	-	A	-	-	B	A	A	-	A	-	-	B
Copper (Electroless) 60°C	A	A	A	A	-	A	-	-	D	A	D	-	D	-	-	B
Copper Sulfate 5%	A	A	A	D	B	A	A	A	A	A	A	C	A	-	C	A
Cream	-	-	A	A	-	A	-	A	A	A	A	-	C	-	-	A
Cresols	D	-	-	-	D	C	A	A	A	A	D	D	D	D	D	A
Cresylic Acid	B	A	-	D	C	-	-	A	A	A	D	-	D	D	D	A
Cyclohexane	-	-	D	-	-	D	A	A	A	A	A	D	D	D	D	A
Cyanic Acid	-	-	-	-	-	-	-	-	-	-	C	-	D	-	-	A
Detergents	A	-	A	A	B	A	A	A	A	A	A	-	B	A	C	A
Diacetone Alcohol	D	-	A	A	-	D	-	A	A	D	D	-	D	A	D	A
Dichlorethane	D	A	-	A	D	-	-	-	-	C	-	-	D	-	D	A
Diesel Fuel	-	-	D	-	-	D	A	A	A	A	A	-	D	D	D	A
Diethylamine	D	A	B	-	-	C	-	A	A	D	B	-	B	B	C	A
Diethylene Gycol	-	-	A	A	B	-	-	A	A	A	A	C	A	A	A	A
Diphenyl Oxide	-	-	-	-	-	-	-	A	A	A	D	-	D	D	D	A
Dyes	-	-	A	-	-	-	-	-	-	A	-	-	C	-	-	A
Epsom Salts(Magnesium Sulfate)	A	-	A	-	-	A	-	A	A	A	A	-	A	-	C	A
Ethane	-	-	D	-	-	-	-	A	A	A	A	-	B	D	D	A
Ethanolamine	-	-	-	-	-	-	A	A	A	D	B	C	B	-	C	A
Ether	D	-	D	C	-	-	A	A	A	C	D	-	D	C	D	A
Ethyl Acetate	D	A	D	A	C	C	A	A	A	D	D	C	D	B	D	A
Ethyl Alcohol	A	-	A	A	B	A	-	A	A	A	A	B	A	B	A	A
Ethyl Chloride	D	A	D	A	D	D	A	A	A	A	D	D	C	A	A	A
Ethyl Sulfate	-	-	-	-	-	-	-	A	A	A	A	-	-	-	-	A
Ethylene Chloride	D	A	D	-	-	D	A	A	A	A	D	D	D	C	D	A
Ethylene Dichloride	D	A	D	A	D	A	A	C	A	A	D	D	D	C	D	A
Ethylene Glycol	A	A	A	A	B	A	A	A	A	A	A	C	A	A	A	A
Ethylene Oxide	D	A	A	A	-	-	-	A	A	D	D	D	D	C	D	A
Fatty Acids	A	A	B	A	B	A	-	A	A	A	C	C	B	C	C	A
Ferric Chloride	A	A	A	D	B	A	A	A	A	A	D	C	B	A	A	A
Ferric Nitrate	A	A	A	D	B	A	A	A	A	A	A	D	A	A	A	A
Ferric Sulfate	A	A	A	A	-	A	A	C	A	A	B	C	A	-	A	A
Ferrous Chloride	A	A	A	D	B	A	A	A	A	A	B	C	A	-	A	A
Ferrous Sulfate	A	A	A	D	B	A	A	A	A	A	B	-	A	-	A	A
Fluboric Acid	A	A	B	C	B	A	-	A	D	A	B	-	A	-	-	A
Fluorine	C	C	-	D	C	-	-	D	-	-	-	-	-	-	-	D
Fluosilicic Acid	A	A	A	D	B	A	-	A	D	B	A	-	A	-	-	C

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Max Temperature in Deg C for Elastomers / Plastics												60	200	60	60		25 - 60				180	80		70	120	60	
Formaldehyde 40%	-	-	A	-	-	A	A	-	-	-	-	B	A	A	D	-	A	A	-	A	D	B	B	A	-	-	A
Formaldehyde	A	A	A	-	A	A	B	A	B	D	A	A	A	D	A	B	A	A	A	A	A	C	B	D	B	C	A
Formic Acid	C	A	B	B	D	C	A	C	C	D	D	D	A	A	D	B	A	A	A	A	B	D	C	D	A	C	B
Freon 11	A	-	A	-	B	-	-	B	-	C	B	B	A	D	A	C	-	A	A	A	C	C	D	D	D	D	A
Freon 12 (wet)	-	-	D	-	B	-	-	B	-	-	-	B	A	D	A	C	A	A	A	A	A	A	D	B	B	D	A
Freon 22	-	-	A	-	B	-	-	B	-	-	-	D	-	B	A	-	-	A	A	A	D	D	D	A	A	A	A
Freon 113	-	-	A	-	B	-	-	B	-	-	-	C	-	-	A	-	-	A	A	A	C	A	D	A	-	D	A
Freon T.F.	-	-	A	-	B	-	-	B	-	-	-	B	-	D	A	-	D	A	A	A	B	A	D	A	D	D	A
Fruit Juice	A	A	A	A	B	-	-	B	-	D	D	A	D	A	A	B	A	-	A	A	A	A	-	A	-	-	A
Fuel Oils	A	A	A	-	A	A	A	B	-	C	B	A	A	A	A	D	B	A	A	A	A	A	C	B	D	D	A
Furan Resin	-	A	A	-	A	-	-	A	-	A	A	-	A	-	-	-	-	A	-	A	A	D	-	D	-	D	A
Furfural	A	A	A	-	A	-	B	A	-	-	A	D	A	D	A	D	D	A	A	A	D	D	D	D	B	D	A
Gallic Acid	B	A	A	-	A	-	A	A	-	D	D	A	A	-	A	-	-	-	-	-	B	A	-	-	-	-	-
Gasoline	A	A	A	A	A	D	A	A	-	A	A	C	A	D	A	D	C	A	A	A	A	A	D	D	C	D	A
Gelatin	A	A	A	A	A	-	A	A	C	D	D	A	A	A	A	-	A	-	A	A	A	A	-	A	A	A	A
Glucose	A	-	A	-	A	-	-	A	A	B	B	A	A	B	A	B	A	-	A	A	A	A	B	A	A	A	A
Glue P.V.A.	B	B	A	-	B	A	-	A	-	-	A	A	A	-	A	-	-	-	A	A	A	A	-	A	-	-	A
Glycerine	A	A	A	A	A	A	A	A	B	B	B	A	A	A	A	-	A	-	A	A	A	A	B	A	A	A	A
Cycolic Acid	-	-	-	-	-	-	A	-	-	-	-		-	A	-	B	A	A	A	-	A	A	-	A	-	-	A
Gold Monocyanide	-	-	A	-	-	-	-	A	-	D	-	-	-	-	-	-	-	-	A	A	A	A	-	A	-	-	A
GOLD PLATING																											
Cyanide 66°C	-	-	A	-	-	A	A	C	-	-	-	D	A	A	A	-	A	-	-	B	A	A	-	A	-	-	D
Neutral 24°C	-	-	C	-	-	A	A	-	-	-	-	A	A	A	A	-	A	-	-	A	A	A	-	A	-	-	A
Acid 24°C	-	-	C	-	-	A	A	-	-	-	-	A	A	A	A	-	A	-	-	A	A	A	-	A	-	-	A
Indium Sulfamate Plating R.T.	-	-	C	-	-	A	A	-	-	-	-	A	A	A	D	-	A	-	-	A	A	A	-	A	-	-	A
Grape Juice	-	A	A	-	B	-	-	B	-	D	-	A	-	A	-	B	-	-	A	A	A	A	-	A	-	-	A
Grease	A	A	A	-	A	-	-	B	-	A	A	-	A	-	A	-	-	-	A	A	A	A	-	D	-	-	A
Heptane	A	-	A	-	A	-	A	A	-	-	B	A	A	D	A	D	D	A	A	A	A	A	-	B	D	-	A
Hexane	A	A	A	-	A	-	A	B	-	-	B	C	A	D	A	-	C	A	A	A	A	A	B	B	D	D	A
Hexyl Alcohol	-	A	A	-	A	A	A	A	C	-	A	A	-	A	A	-	A	-	A	A	A	A	D	B	A	A	A
Honey	-	A	A	-	A	-	-	A	-	A	-	A	-	A	A	-	A	-	A	A	A	A	-	A	A	-	A
Hydraulic Oils (Petrol)	A	A	A	-	A	-	-	B	-	A	A	-	A	-	A	-	D	-	A	A	A	A	-	B	D	D	A
Hydraulic Oils (Syn)	-	A	A	-	A	-	-	A	-	A	-	-	-	-	A	-	D	-	A	A	A	C	D	-	-	-	A
Hydrazine	-	A	A	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-	A	-	A	B	D	B	A	C	A
Hydrobromic Acid 20%	-	-	D	-	-	A	A	-	-	-	-	A	A	A	D	-	A	-	-	B	A	D	-	C	-	-	B
Hydrobromic Acid	D	D	D	D	D	A	A	D	-	D	D	A	A	C	D	B	B	-	A	A	A	D	D	D	A	A	A
Hydrochloric Acid (Dry Gas)	D	C	A	-	D	-	A	-	-	-	D	A	A	-	-	-	-	-	A	-	-	-	-	-	A	-	A
Hydrochloric Acid (20%)	-	D	D	D	D	C	B	D	-	D	-	A	A	A	D	A	A	D	A	A	A	C	-	C	A	C	A
Hydrochloric Acid (37%)	-	D	D	D	D	C	B	D	-	D	-	A	A	A	D	A	A	D	A	C	A	C	C	C	C	D	A
Hydrochloric Acid 100%	-	D	D	-	D	D	C	D	-	D	-	A	A	-	D	A	-	-	A	C	C	D	-	C	-	A	A
Hydrocyanic Acid	A	A	A	C	A	A	A	D	D	-	C	A	A	A	A	B	A	-	A	A	A	C	-	B	-	A	A
(Gas 10%)	-	D	D	-	-	-	-	-	-	-	-	A	A	-	-	-	-	-	-	-	-	-	-	C	A	C	A
Hydrofluoric Acid (20%)1	-	D	D	D	D	D	B	D	-	D	-	D	A	A	D	C	A	C	B	C	A	D	-	C	A	C	B
Hydrofluoric Acid (75%)	-	C	D	-	D	D	C	D	-	D	-	C	A	D	D	C	B	C	D	D	A	D	D	D	C	C	C
Hydrofluoric Acid 100%	D	D	D	-	D	D	B	D	-	D	D	C	A	-	-	D	-	C	D	D	-	D	-	D	-	D	A
Hydrofluosilicic Acid (20%)	-	D	D	-	D	D	B	A	-	D	-	D	A	B	D	-	A	-	A	D	A	B	-	B	A	A	C
Hydrofluosilicic Acid	-	D	D	-	C	-	C	D	-	-	-	-	A	-	-	-	-	-	A	-	-	-	D	A	-	-	-
Hydrogen Gas	A	A	A	-	A	-	-	A	-	B	B	A	A	-	-	-	-	-	-	-	A	-	-	-	-	-	A
Hydrogen Peroxide 10%	-	C	C	-	A	C	A	D	D	D	-	A	A	-	B	A	-	B	A	A	-	A	-	D	-	C	D
Hydrogen Peroxide 30%	-	-	B	-	-	B	A	-	D	-	-	A	A	-	B	-	A	C	-	-	A	D	-	C	-	-	B
Hydrogen Peroxide	-	A	B	A	A	B	A	D	D	D	D	A	A	B	B	B	A	C	-	A	A	D	C	D	C	C	A
Hydrogen Sulfide, Aqueous Solution	-	A	A	C	C	A	A	D	C	D	-	A	A	A	B	B	A	A	A	A	B	C	-	B	A	D	A
Hydrogen Sulfide (Dry)	A	C	A	-	D	-	A	D	C	B	B	A	A	-	B	-	-	A	-	A	A	-	-	-	-	A	A
Hydroxyacetic Acid (70%)	-	-	-	-	D	B	-	-	-	-	-	A	-	-	-	-	-	-	A	A	A	A	-	A	A	-	A
Ink	A	A	A	-	C	-	-	C	-	D	D	-	-	B	A	B	-	-	A	A	A	A	-	A	-	-	A
Iodine	-	D	D	D	D	A	B	D	-	D	-	D	A	A	D	D	D	-	D	A	A	B	-	D	B	D	A
Iodine (In Alcohol)	-	-	B	-	-	D	A	-	-	-	-	D	A	C	D	-	B	-	-	A	A	D	-	D	-	-	-
Iodoform	B	D	A	-	A	-	-	C	-	C	B	-	A	-	A	-	-	-	-	-	C	-	-	-	-	-	-
IRON PLATING																											
Ferrous Chloride Bath 190A° F	-	-	D	-	-	A	D	-	-	-	-	D	A	A	D	-	C	-	-	A	A	B	-	D	-	-	D
Ferrous Sulfate Bath 150A° F	-	-	C	-	-	A	A	-	-	-	-	D	A	A	D	-	A	-	-	A	A	A	-	B	-	-	D

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Chemical	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Aluminium	Titanium	Hastelloy C	Cast Bronze	Brass	Cast Iron	Carbon Steel	PVC	Teflon PTFE	Noryl	Nylon	Polyethylene PE	Polypropylene PP	Ryton	Carbon	Ceramic Al_2O_3	Viton (FPM)	Buna N - Nitrile - NBR	Silicon	Neoprene	EPDM	Natural Rubber	Epoxy
Max Temperature in Deg C for Elastomers / Plastics												60	200	60	60		25 - 60				180	80		70	120	60	
Ferrous Am. Sulfate Bath 150A° F	-	-	C	-	-	A	A	-	-	-	-	D	A	A	D	-	A	-	-	A	A	A	-	B	-	-	D
Sulfate-Chloride Bath 160A° F	-	-	D	-	-	A	D	-	-	-	-	D	A	A	D	-	A	-	-	A	A	B	-	C	-	-	D
Fluoborate Bath 63°C	-	-	D	-	-	D	B	-	-	-	-	D	A	A	D	-	A	-	-	D	A	B	-	C	-	-	D
Sulfamate 63°C	-	-	D	-	-	A	B	-	-	-	-	A	A	A	D	-	A	-	-	A	A	A	-	A	-	-	A
Isobutyl Alcohol	-	A	A	-	B	A	A	A	C	-	A	-	-	A	A	-	-	-	A	A	A	C	B	A	A	A	A
Isopropyl Alcohol	-	A	A	-	B	A	A	A	C	C	A	-	-	A	A	-	A	-	A	A	A	C	C	B	A	A	A
Isopropyl Acetate	-	-	B	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	D	D	-	D	B	D	A
Isopropyl Ether	A	-	A	-	A	-	-	A	-	-	A	-	A	D	-	-	D	-	A	A	D	B	-	D	D	D	-
Isotane	-	-	-	-	A	-	-	-	-	-	-	-	-	D	-	-	D	-	-	A	A	A	-	-	-	D	A
Jet Fuel (JP3,JP4,JP5)	A	A	A	-	A	-	-	A	-	A	A	A	A	D	A	-	D	A	A	A	A	A	D	D	D	D	A
Kerosene	A	A	A	A	A	A	A	A	A	A	B	A	A	D	A	D	D	A	A	A	A	A	D	D	A	D	A
Ketones	A	A	A	-	B	A	A	A	-	A	A	D	A	D	A	D	D	A	C	A	D	D	-	D	D	C	C
Lacquers	A	A	A	-	A	-	-	A	C	C	C	-	-	C	A	-	A	-	A	A	D	D	-	D	-	D	A
Lacquer Thinners	-	-	A	-	-	A	A	-	C	-	-	C	A	D	A	-	B	-	-	A	-	D	-	D	A	-	-
Lactic Acid	A	A	B	C	C	A	A	D	-	D	D	A	A	A	C	B	A	A	A	A	B	B	-	A	B	A	A
Lard	B	A	A	A	A	-	-	A	-	A	C	A	-	-	A	-	A	-	A	A	A	A	C	B	-	D	A
Latex	-	A	A	-	A	-	-	A	-	-	-	-	-	A	A	B	-	-	-	A	A	A	-	C	A	-	A
Lead Acetate	B	A	A	-	D	A	A	C	-	-	D	A	A	A	A	B	A	-	A	A	D	B	-	D	A	A	A
Lead Fluoborate Plating	-	-	C	-	-	D	A	-	-	-	-	A	A	A	D	-	A	-	-	D	A	B	-	C	-	-	A
Lead Sulfamate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	-	-	-	A	B	C	A	D	C	A
Ligroin	-	-	A	-	-	-	-	A	-	-	-	-	-	D	-	-	D	-	-	A	A	A	-	B	A	D	A
Lime	-	A	A	-	C	A	-	A	-	A	-	A	-	A	-	-	-	-	A	A	A	A	C	B	D	-	A
Lubricants	-	A	A	-	A	A	A	B	-	-	-	A	A	-	A	-	A	A	A	A	A	A	C	D	-	D	A
Magnesium Carbonate	-	A	A	A	-	-	B	-	-	-	-	A	-	A	-	B	A	-	-	A	-	A	-	A	A	-	A
Magnesium Chloride	B	B	B	A	D	A	A	B	C	D	C	A	A	A	A	B	A	A	-	A	A	A	-	A	A	A	A
Magnesium Hydroxide	A	A	A	-	D	A	A	C	B	B	B	A	A	A	A	B	A	A	A	A	A	B	-	B	-	C	A
Magnesium Nitrate	-	A	A	A	-	A	A	-	-	-	-	A	A	A	A	B	A	-	-	A	A	A	-	A	-	-	A
Magnesium Oxide	-	A	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	-	A	-	A	A	-	A
Magnesium Sulfate	B	B	A	-	B	A	B	B	B	C	B	A	A	A	A	B	A	A	A	A	A	A	-	A	D	C	A
Maleic Acid	C	A	A	A	B	A	A	C	-	-	B	A	A	A	A	-	C	-	A	A	A	D	-	A	D	D	A
Maleic Anhydride	-	-	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	A	A	A	D	-	D	-	D	A
Malic Acid	B	A	A	-	C	-	A	D	-	-	D	A	A	-	A	-	-	-	-	A	C	-	-	A	-	A	-
Mash	-	A	A	-	-	-	-	A	-	-	-	-	-	A	-	-	-	-	A	A	-	A	-	A	-	-	A
Mayonnaise	A	A	A	-	D	-	-	D	-	D	D	-	A	A	A	-	A	-	A	A	A	A	-	-	-	-	A
Melamine	-	D	D	-	-	-	-	D	-	-	-	-	-	-	-	-	-	-	A	A	-	C	-	-	-	-	A
Mercuric Chloride (Dilute Solution)	D	D	D	D	D	A	B	D	D	D	D	A	A	A	A	B	A	-	A	A	A	A	-	A	A	A	A
Mercuric Cyanide	A	A	A	-	D	A	-	D	-	-	D	A	A	A	-	B	A	-	A	A	-	A	-	-	-	-	A
Mercury	A	A	A	A	C	C	A	D	D	A	A	A	A	A	A	B	A	-	A	A	A	A	-	A	A	A	A
Methanol (See Alcohol Methyl)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Methyl Acetate	A	-	A	-	A	-	A	A	-	-	B	-	A	-	-	-	-	-	A	A	D	D	D	B	B	D	-
Methyl Acetone	A	-	A	-	A	-	-	A	-	A	A	-	A	D	-	-	-	-	-	A	D	D	-	D	-	-	C
Methyl Alcohol 10%	A	-	A	-	C	-	A	C	-	-	B	A	A	-	A	-	-	-	-	-	-	B	-	-	-	A	A
Methyl Alcohol	-	A	A	A	B	A	A	A	C	A	A	B	A	A	A	B	A	-	A	A	C	B	-	A	A	A	A
Methyl Bromide	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	D	-	-	A	A	A	B	-	D	D	D	B
Methyl Butyl Ketone	-	-	A	-	A	-	-	-	-	-	-	-	-	D	-	-	-	-	A	A	D	D	C	D	A	D	B
Methyl Cellosolve	-	-	-	-	A	-	-	A	-	-	-	-	-	C	-	-	A	-	A	A	D	D	-	D	B	D	C
Methyl Chloride	-	C	A	-	D	A	A	A	-	-	-	D	A	D	A	D	D	-	A	A	A	D	D	D	C	D	A
Methyl Dichloride	-	-	-	-	-	-	-	-	-	-	-	-	-	D	-	-	-	-	A	A	A	D	-	D	D	D	A
Methyl Ethyl Ketone	-	A	A	-	A	A	A	A	-	-	-	D	A	D	A	D	A	A	A	A	D	D	C	D	A	D	B
Methyl Isobutyl Ketone	-	-	A	-	-	A	A	-	-	-	-	D	A	D	A	-	C	A	A	A	D	D	C	D	C	D	B
Methyl Isopropyl Ketone	-	-	A	-	-	-	-	-	-	-	-	-	-	D	A	-	-	-	A	A	D	D	B	D	B	D	B
Methyl Methacrylate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	D	D	-	D	D	D	A
Methylamine	A	-	A	-	A	-	-	D	-	B	B	-	-	B	-	-	-	-	A	A	-	B	-	-	-	-	A
Methylene Chloride	A	A	A	-	A	A	A	A	C	-	B	D	A	D	D	D	D	-	A	A	B	D	-	D	D	D	A
Milk	A	A	A	A	A	-	-	C	C	D	D	A	-	A	A	B	A	-	A	A	A	A	B	A	A	A	A
Molasses	A	A	A	A	A	-	-	A	B	A	A	A	-	B	A	B	A	-	A	A	A	A	-	A	-	-	A
Mustard	A	A	A	A	B	-	-	B	-	C	B	A	-	B	A	-	A	-	A	A	A	B	C	C	-	-	A
Naptha	A	A	A	A	A	A	A	B	-	B	B	A	A	D	A	D	A	A	A	A	A	B	D	D	D	D	A
Napthalene	B	A	B	-	B	A	A	C	-	B	A	D	A	D	-	D	B	A	A	A	C	D	-	D	D	D	A
Nickel Chloride	-	A	B	-	D	A	A	D	-	D	-	A	A	A	A	B	A	-	A	A	A	A	-	A	A	A	A

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Despite being indicated as generally suitable in the charts, variations in temperature, pressure and concentration of chemicals may cause failure.
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Chemical	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Aluminium	Titanium	Hastelloy C	Cast Bronze	Brass	Cast Iron	Carbon Steel	PVC	Teflon PTFE	Noryl	Nylon	Polyethylene PE	Polypropylene PP	Ryton	Carbon	Ceramic Al_2O_3	Viton (FPM)	Buna N - Nitrile - NBR	Silicon	Neoprene	EPDM	Natural Rubber	Epoxy
Max Temperature in Deg C for Elastomers / Plastics												60	200	60	60		25 - 60				180	80		70	120	60	
NICKEL PLATING																											
Watts Type 71°C	–	–	C	–	–	A	A	–	–	–	–	D	A	A	A	–	A	–	–	A	A	A	–	A	–	–	D
High Chloride 71°C	–	–	C	–	–	A	A	–	–	–	–	D	A	A	D	–	A	–	–	A	A	A	–	B	–	–	D
Fluoborate 77°C	–	–	C	–	–	D	A	D	–	–	–	D	A	A	D	–	A	–	–	D	A	B	–	C	–	–	D
Sulfamate 71°C	–	–	C	–	–	A	A	–	–	–	–	A	A	A	A	–	A	–	–	A	A	A	–	A	–	–	A
Electroless 93°C	–	–	–	–	–	–	–	–	–	–	–	D	A	D	D	–	D	–	–	A	A	D	–	D	–	–	B
Nickel Sulfate	B	A	B	–	D	A	B	C	C	D	D	A	A	A	A	B	A	–	A	A	A	A	–	A	A	C	A
Nitric Acid (10% Sol)	A	A	A	A	D	A	A	D	–	D	D	A	A	A	D	B	A	D	C	B	A	D	–	D	B	D	A
Nitric Acid (20% Sol)	–	A	A	A	D	A	A	D	–	D	–	A	A	A	D	B	A	C	D	C	A	D	–	D	D	D	B
Nitric Acid (50% Sol)	–	A	A	A	D	A	A	D	–	D	–	A	A	A	D	C	D	C	D	A	A	D	–	D	D	D	D
Nitric Acid (Concentrated Solution)	–	D	B	A	B	A	B	D	D	D	–	D	A	D	D	D	D	C	D	A	B	D	–	D	D	D	D
Nitrobenzene	B	A	B	–	C	A	B	D	–	B	B	D	A	D	C	D	C	B	A	A	D	D	D	D	D	D	B
OILS																											
Aniline	–	A	A	–	C	A	D	A	–	A	–	D	A	D	C	–	A	–	A	A	A	D	–	D	B	D	A
Anise	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	–	–	–	D	–	–	A
Bay	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	A	–	–	D	–	–	A
Bone	–	A	A	–	–	–	–	A	–	–	–	–	–	–	–	–	–	–	A	A	A	A	–	D	–	–	A
Castor	–	A	A	–	A	–	–	A	–	A	–	A	–	–	–	–	–	–	A	A	A	A	–	A	B	A	A
Cinnamon	–	A	A	–	–	–	–	–	–	–	–	–	A	–	–	–	A	–	A	A	D	–	–	D	–	–	A
Citric	–	A	A	–	–	–	–	D	–	D	–	–	–	–	A	–	A	–	A	A	A	A	–	D	–	–	A
Clove	–	A	A	–	–	–	–	–	–	–	–	–	–	–	A	–	B	–	A	A	–	A	–	–	–	–	A
Coconut	–	A	A	–	B	–	–	A	–	A	–	–	–	–	A	–	A	–	A	A	A	A	–	A	A	D	A
Cod Liver	–	A	A	–	B	–	–	–	–	–	–	–	–	–	A	–	A	–	A	A	A	A	–	B	A	D	A
Corn	–	A	A	A	B	–	–	B	–	A	–	–	–	–	A	–	A	–	A	A	A	A	–	D	C	D	A
Cotton Seed	B	A	A	A	B	–	–	B	–	A	C	A	A	–	A	–	A	A	A	A	A	A	–	D	C	D	A
Cresole	–	A	A	–	A	–	–	–	–	–	–	–	–	–	–	–	D	–	A	A	A	A	–	B	D	D	A
Diesel Fuel (2D,3D,4D,5D)	–	A	A	–	A	–	–	A	–	–	–	–	–	D	A	–	A	A	A	A	A	A	–	D	D	D	A
Fuel (1,2,3,5A,5B,6)	–	A	A	–	A	A	A	A	–	–	–	A	A	D	–	–	B	–	A	A	A	B	–	D	D	D	A
Ginger	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	A	A	–	A	–	–	A
Hydraulic Oils (Petrol)	A	A	A	–	A	–	–	B	–	A	A	–	A	–	A	–	D	–	A	A	A	A	–	B	D	D	A
Hydraulic Oils (Syn)	–	A	A	–	A	–	–	A	–	A	–	–	–	–	A	–	D	–	A	A	A	C	D	–	–	–	A
Lemon	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	D	–	A	A	A	–	–	D	–	–	A
Linseed	–	A	A	A	A	–	–	A	–	A	–	A	–	–	A	–	A	–	A	A	A	A	–	D	D	D	A
Mineral	A	A	A	A	A	–	–	A	–	A	B	A	–	B	A	–	B	A	A	A	A	A	–	B	D	D	A
Olive	A	A	A	–	A	–	–	B	–	A	B	A	A	–	A	–	A	–	A	A	A	A	C	B	–	D	A
Orange	–	A	A	–	–	–	–	–	–	–	–	–	A	–	A	–	A	–	A	A	A	A	–	D	–	–	A
Palm	–	A	A	–	A	–	–	B	–	–	–	A	–	–	A	–	–	–	A	A	A	A	–	D	–	–	A
Peanut	–	A	A	–	A	–	–	A	–	A	–	A	–	–	–	–	D	–	A	A	A	A	–	D	–	D	A
Peppermint	–	A	A	–	–	–	–	A	–	–	–	–	–	–	–	–	D	–	A	A	A	D	–	D	–	–	A
Pine	A	A	A	–	A	–	–	D	–	C	B	A	A	–	–	–	–	–	A	A	A	A	–	D	–	D	A
Rape Seed	–	A	A	–	–	–	–	A	–	–	–	A	–	–	–	–	–	–	A	A	A	B	–	D	–	D	A
Rosin	–	A	A	–	A	–	–	–	–	–	–	–	–	–	A	–	A	–	A	A	A	A	–	–	–	–	A
Sesame Seed	–	A	A	–	A	–	–	A	–	A	–	A	–	–	–	–	–	–	A	A	A	A	–	D	–	–	A
Silicone	–	A	A	–	–	–	–	A	–	A	–	–	–	A	A	–	A	–	A	A	A	A	–	A	–	A	A
Soybean	–	A	A	–	A	–	–	B	–	A	–	A	–	–	A	–	A	–	A	A	A	A	–	D	–	D	A
Sperm	–	A	A	–	–	–	–	A	–	–	–	A	–	–	–	–	–	–	A	A	A	A	–	D	–	–	A
Tanning	–	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	A	A	–	D	–	–	A
Turbine	–	A	A	–	A	–	–	A	–	A	–	A	–	–	–	–	–	–	A	A	A	A	–	D	–	D	A
Octyl Alcohol	–	A	A	–	A	A	A	A	C	–	A	–	–	A	A	–	–	–	A	A	A	B	–	B	A	C	A
Oleic Acid	B	A	A	B	B	–	B	B	C	C	C	A	A	C	A	D	C	–	A	A	B	B	D	D	D	D	A
Oleum 25%	–	–	–	–	–	–	A	–	–	–	–	D	A	D	–	–	–	–	–	A	A	D	D	D	D	–	D
Oleum	B	–	A	–	B	–	–	C	C	–	B	D	A	–	–	–	D	–	–	A	A	C	D	D	D	D	A
Oxalic Acid (cold)	C	A	B	A	C	C	B	B	C	D	D	A	A	C	D	A	A	–	A	A	A	B	C	B	A	C	A
Paraffin	A	A	A	A	A	–	–	A	–	B	B	A	A	B	A	–	A	–	A	A	A	A	–	–	–	–	A
Pentane	A	C	C	–	A	–	B	A	–	B	B	–	A	D	A	–	–	–	A	A	A	A	–	B	D	D	A
Perchloroethylenen	B	A	A	–	A	–	–	C	–	B	B	–	A	D	–	–	D	A	A	A	A	C	D	D	D	D	A
Petrolatum	A	–	A	–	B	–	–	B	–	C	C	–	A	D	A	–	–	–	A	A	A	A	–	B	A	D	A
Phenol 10%	B	A	A	–	A	–	B	C	–	B	D	A	A	–	D	–	–	A	–	–	B	D	–	C	D	C	C
Phenol (Carbolic Acid)	B	A	A	A	B	C	A	B	D	D	D	A	A	C	D	D	B	A	A	D	A	D	–	D	D	D	B
Phosphoric Acid 40%	–	B	A	A	D	A	A	D	D	D	–	A	A	A	D	B	A	A	B	C	A	D	–	D	B	C	A
Phosphoric Acid 100%	–	C	B	B	D	B	A	D	D	D	–	A	A	A	D	C	A	A	B	D	A	D	–	D	B	C	C

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A = No effect
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- = No data - Refer to A.S.E.

DANGER
Despite being indicated as generally suitable in the charts, variations in temperature, pressure and concentration of chemicals may cause failure.
SERIOUS INJURY MAY RESULT
This is for initial reference only and must be cross checked by relevant authority.

Chemical	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Aluminium	Titanium	Hastelloy C	Cast Bronze	Brass	Cast Iron	Carbon Steel	PVC	Teflon PTFE	Noryl	Nylon	Polyethylene PE	Polypropylene PP	Ryton	Carbon	Ceramic Al_2O_3	Viton (FPM)	Buna N - Nitrile - NBR	Silicon	Neoprene	EPDM	Natural Rubber	Epoxy
Max Temperature in Deg C for Elastomers / Plastics												60	200	60	60		25 - 60				180	80		70	120	60	
Phosphoric Acid Crude	-	D	C	C	D	C	A	D	D	D	D	-	A	-	D	C	-	A	C	D	A	D	-	D	B	-	A
Phosphoric Anhydride (Dry or Moist)	-	A	A	-	-	-	-	-	D	-	-	D	A	-	-	-	-	-	A	-	D	D	-	D	-	A	-
Phosphoric Anhydride (Molten)	-	A	A	-	D	-	-	D	D	-	-	D	A	-	A	D	-	-	-	-	D	C	-	D	-	D	A
Photographic (Developer)	-	C	A	C	C	A	A	-	-	D	-	A	-	A	-	B	A	-	A	A	A	A	-	A	-	-	A
Phthalic Anhydride	B	A	B	-	B	-	A	B	-	C	C	-	A	-	A	-	-	-	-	-	A	C	-	-	-	-	-
Picric Acid	B	A	A	-	C	-	A	D	D	D	D	A	A	-	A	A	-	-	-	-	A	A	D	A	-	A	A
Potash	-	A	-	A	C	-	A	C	-	B	-	A	-	A	A	B	A	-	A	A	A	A	-	B	-	B	A
Potassium Bicarbonate	-	A	-	B	C	A	B	B	-	D	-	A	A	A	A	B	A	A	A	A	A	A	-	A	-	B	A
Potassium Bromide	A	A	-	B	C	A	B	C	-	D	D	A	A	A	C	B	A	C	A	A	A	A	-	A	A	B	A
Potassium Carbonate	B	A	-	A	C	A	A	C	-	B	B	A	A	A	A	B	A	A	A	A	A	B	-	A	-	B	A
Potassium Chlorate	B	A	A	A	B	A	B	B	-	B	B	A	A	A	D	B	A	A	A	A	A	A	-	A	-	B	A
Potassium Chloride	C	A	A	B	B	A	A	C	C	B	B	A	A	A	B	B	A	A	A	A	A	A	-	A	A	A	A
Potassium Chromate	-	-	B	B	A	-	B	A	-	A	-	A	-	A	-	B	-	A	A	D	A	A	-	A	-	B	C
Potassium Cyanide Solutions	B	A	B	A	D	A	A	D	-	B	B	A	A	A	A	B	A	A	C	A	B	A	-	A	A	A	A
Potassium Dichromate	B	A	A	A	A	A	B	C	-	B	C	A	A	A	D	B	A	A	A	A	B	A	-	A	A	A	A
Potassium Ferrocyanide	B	A	-	A	C	-	B	A	-	-	C	A	A	-	A	A	-	-	-	-	-	D	-	-	-	A	A
Potassium Hydroxide (50%)	A	B	B	B	D	C	A	D	D	C	A	A	A	A	A	B	A	A	-	D	B	B	C	A	A	C	A
Potassium Nitrate	B	A	B	A	B	A	B	B	-	-	B	A	A	A	C	B	A	C	A	A	B	A	-	A	A	A	A
Potassium Permanganate	B	A	B	B	B	B	B	B	-	B	B	A	A	A	D	B	B	A	A	A	B	A	-	A	-	B	B
Potassium Sulfate	B	A	B	B	A	A	A	B	B	B	B	A	A	A	C	B	A	A	A	A	A	A	C	A	A	C	A
Potassium Sulfide	A	A	-	A	B	-	B	B	-	B	B	A	A	-	-	-	-	-	-	-	-	A	-	-	-	-	-
Propane (Liquified)	A	A	-	A	A	-	-	A	A	-	B	D	A	D	A	-	D	-	A	A	A	A	D	B	D	D	A
Propyl Alcohol	-	A	A	-	A	A	A	A	-	-	A	A	A	A	A	-	A	-	A	A	A	A	B	A	A	A	A
Propylene Glycol	B	B	-	A	A	-	-	B	-	B	B	-	A	-	B	B	-	-	A	A	A	A	-	C	-	-	A
Pyridine	-	C	-	B	B	-	-	-	-	B	A	-	A	D	-	C	B	A	A	A	D	D	-	D	B	D	A
Pyrogallic Acid	B	A	A	A	B	-	A	B	-	B	B	A	A	-	A	-	-	-	A	A	A	A	-	-	-	-	A
Rhodium Plating 49°C	-	-	D	-	-	D	D	-	-	-	-	A	A	A	D	-	A	-	-	A	A	A	-	B	-	-	A
Rosins	A	A	A	A	A	-	B	A	C	-	C	-	A	-	A	-	A	-	A	A	-	A	-	-	-	-	A
Rum	-	A	-	A	-	-	-	-	-	-	-	A	-	A	A	-	A	-	A	A	A	A	-	A	-	-	A
Rust Inhibitors	-	A	-	A	-	-	-	A	-	A	-	-	-	-	-	-	A	-	A	A	A	A	-	C	-	-	A
Salad Dressing	-	A	-	A	B	-	-	B	-	D	-	A	-	A	A	-	A	-	A	A	A	A	-	-	-	-	A
Sea Water	A	A	A	A	C	A	-	C	-	-	D	A	A	A	A	B	A	-	A	A	A	A	B	B	A	A	A
Shellac (Bleached)	A	A	-	A	A	-	-	A	B	B	A	-	A	-	A	-	A	-	-	A	-	A	-	-	-	-	A
Shellac (Orange)	A	A	-	A	A	-	-	A	C	C	A	-	A	-	A	-	A	-	-	A	-	A	-	-	-	-	A
Silicone	-	B	-	A	B	-	-	A	-	-	-	-	-	A	A	-	A	-	A	A	A	A	B	A	A	A	A
Silver Bromide	-	C	C	B	D	-	-	-	-	-	-	-	-	A	-	-	-	-	A	-	-	-	-	-	-	-	A
Silver Nitrate	B	A	B	A	D	A	A	D	-	D	D	A	A	A	A	B	A	-	A	A	A	C	-	A	C	A	A
Silver Plating 49°C	-	-	A	-	-	A	A	-	-	-	-	A	A	A	A	-	A	-	-	B	A	A	-	A	-	-	A
Soap Solutions	A	A	A	A	C	A	B	B	A	B	A	B	A	A	A	B	A	A	A	A	A	A	B	B	-	C	A
(Sodium Carbonate)	B	A	B	B	C	A	A	B	B	B	B	A	A	A	A	B	A	A	B	A	A	A	-	A	A	A	A
Sodium Acetate	B	A	A	B	B	A	A	B	-	C	C	A	A	A	A	B	A	-	A	A	D	D	-	C	-	A	A
Sodium Aluminate	B	-	-	A	C	B	B	B	-	-	C	-	A	A	A	-	-	A	A	A	A	A	-	A	A	B	A
Sodium Bicarbonate	B	A	A	A	A	A	-	B	A	C	C	A	A	A	A	B	A	A	A	A	A	A	C	A	A	A	A
Sodium Bisulfate	A	A	-	A	D	B	B	C	C	D	D	A	A	A	C	B	A	A	A	A	B	A	C	A	-	A	A
Sodium Bisulfite	-	A	-	A	A	A	B	C	-	D	-	A	A	A	D	B	A	A	A	A	A	A	C	A	-	A	A
Sodium Borate	B	A	-	A	C	-	A	A	-	C	C	C	A	-	A	A	-	-	-	-	A	-	B	A	-	-	-
Sodium Carbonate	B	A	B	B	C	A	A	B	B	B	B	A	A	A	A	B	A	A	B	A	A	A	-	A	A	A	A
Sodium Chlorate	B	A	-	A	B	A	B	B	-	-	C	A	A	A	A	B	A	A	A	A	A	D	-	A	-	A	A
Sodium Chloride	B	A	C	B	C	A	A	B	C	B	C	A	A	A	A	B	A	A	A	A	A	A	C	A	A	B	A
Sodium Chromate	A	A	A	-	D	-	B	B	-	B	B	-	A	A	A	-	A	A	A	B	B	A	-	A	-	-	C
Sodium Cyanide	B	A	-	A	D	A	-	D	D	B	B	A	A	A	C	B	A	A	A	A	A	A	D	A	A	A	A
Sodium Fluoride	B	C	-	C	C	A	A	C	-	D	D	D	A	-	A	C	-	-	-	-	C	D	-	D	-	D	A
Sodium Hydrosulfite	-	-	-	-	A	-	A	C	-	-	-	C	A	-	A	-	-	-	-	A	A	-	-	A	-	A	-
Sodium Hydroxide (20%)	-	A	A	A	D	A	A	C	D	A	-	A	A	A	C	B	A	A	C	D	A	A	D	B	A	A	A
Sodium Hydroxide (50%)	-	A	B	-	D	A	A	C	D	B	-	A	A	A	C	C	A	B	C	D	A	D	D	C	-	A	A
Sodium Hydroxide (80%)	-	A	D	-	D	A	B	C	D	C	-	A	A	A	C	C	A	B	C	D	B	D	D	C	-	B	A
Sodium Hypochlorite (20%)	-	C	C	C	C	A	A	D	D	D	-	A	A	A	A	B	D	C	D	A	A	C	D	D	B	C	B
Sodium Hypochlorite	D	-	A	-	D	A	A	D	-	D	D	A	A	A	A	-	A	C	-	D	D	B	C	A	-	-	A
Sodium Hyposulfate	-	A	A	-	D	-	-	D	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	C	-	C	C
Sodium Metaphosphate	A	-	A	-	A	-	-	C	C	B	B	-	A	-	A	-	D	-	A	A	A	A	-	B	A	A	A
Sodium Metasilicate	A	-	A	-	B	-	-	B	-	C	C	-	A	-	-	-	-	-	A	-	A	A	D	A	-	-	A

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Chemical	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Aluminium	Titanium	Hastelloy C	Cast Bronze	Brass	Cast Iron	Carbon Steel	PVC	Teflon PTFE	Noryl	Nylon	Polyethylene PE	Polypropylene PP	Ryton	Carbon	Ceramic Al_2O_3	Viton (FPM)	Buna N - Nitrile - NBR	Silicon	Neoprene	EPDM	Natural Rubber	Epoxy
Max Temperature in Deg C for Elastomers / Plastics												60	200	60	60		25 - 60				180	80		70	120	60	
Sodium Nitrate	B	A	A	A	A	A	B	B	C	A	B	A	A	A	A	B	A	-	A	A	B	C	D	B	A	C	A
Sodium Perborate	B	-	C	-	B	-	-	C	C	B	B	-	A	A	A	-	A	-	A	A	A	B	D	B	A	C	A
Sodium Peroxide	B	A	A	-	C	-	B	C	C	D	C	A	A	-	D	-	-	-	A	A	A	C	D	B	A	C	A
Sodium Polyphosphate(Mono,Di,Tri)	-	A	A	-	D	A	A	C	-	-	-	-	A	A	-	-	-	-	A	A	A	A	-	D	A	A	A
Sodium Silicate	B	A	B	A	C	A	B	C	C	-	B	A	A	A	A	-	A	-	A	A	A	A	-	A	A	A	A
Sodium Sulfate	B	A	A	C	B	A	B	B	B	A	B	A	A	A	A	B	A	A	A	A	A	A	-	A	A	C	A
Sodium Sulfide	B	A	B	-	D	A	B	D	D	A	B	A	A	A	A	B	A	A	A	A	A	C	-	A	A	C	A
Sodium Sulfite	-	C	C	-	C	A	A	C	-	A	-	A	A	-	D	A	-	-	A	A	A	A	-	A	-	A	A
Sodium Tetraborate	-	-	A	-	-	-	-	-	-	-	-	A	-	A	-	-	-	-	A	A	A	A	-	-	-	-	A
Sodium Thiosulphate ("Hypo")	A	A	A	-	B	A	-	D	D	C	B	A	A	A	A	-	A	A	A	A	A	B	-	A	A	C	A
Sorghum	-	A	A	-	-	-	-	-	-	A	-	-	-	-	A	-	-	-	A	A	A	A	-	A	-	-	A
Soy Sauce	-	A	A	-	A	-	-	A	-	D	-	-	-	A	A	-	-	-	A	A	A	A	-	A	-	D	A
Stannic Chloride	D	D	D	-	D	A	B	D	-	D	D	A	A	A	A	B	A	-	-	A	A	A	D	A	A	A	A
Stannic Fluoborate	-	-	A	-	-	-	-	-	-	D	-	-	-	A	-	A	-	-	-	A	A	A	-	A	-	-	A
Stannous Chloride	D	D	C	-	D	A	A	D	-	D	D	A	A	-	D	A	-	-	-	-	B	C	D	D	-	A	A
Starch	B	A	A	-	A	-	-	B	-	C	C	A	A	A	A	B	-	-	A	A	A	A	-	A	-	-	A
Stearic Acid	B	A	A	A	B	A	A	C	C	C	C	A	A	A	A	B	D	-	A	A	A	B	D	B	B	C	A
Stoddard Solvent	A	A	A	A	A	A	A	A	A	B	B	A	A	D	A	D	D	A	A	A	A	B	D	D	D	D	A
Styrene	A	A	A	-	A	-	-	A	-	-	A	-	A	A	-	-	-	-	A	A	B	D	D	D	D	D	A
Sugar (Liquids)	A	A	A	A	A	-	A	A	-	B	B	-	A	A	A	-	A	-	A	A	A	A	-	B	-	A	A
Sulfate Liquors	-	C	C	-	B	-	A	C	-	-	-	-	-	-	-	-	A	-	A	A	-	-	-	C	-	-	A
Sulfur Chloride	-	D	D	D	D	-	-	C	D	-	-	A	A	A	A	A	D	-	A	C	A	D	-	D	D	D	C
Sulfur Dioxide	-	A	A	C	A	A	B	B	-	-	-	D	A	D	D	C	D	A	A	A	D	D	C	B	A	D	A
Sulfur Dioxide (Dry)	A	A	A	-	A	-	A	A	C	A	B	D	A	-	A	D	-	-	A	A	A	-	-	D	-	D	D
Sulfur Trioxide (Dry)	A	A	C	-	A	-	-	B	-	B	B	A	A	D	D	-	-	-	B	A	A	D	-	D	B	C	A
Sulfuric Acid (to 10%)	-	D	C	C	C	A	A	D	D	D	-	A	A	A	D	B	A	A	A	A	A	C	-	D	D	C	A
Sulfuric Acid (10%-75%)	-	D	D	D	D	C	B	D	D	D	-	A	A	B	D	C	A	B	A	D	A	D	-	D	D	D	B
Sulfuric Acid 75%-100%	-	-	D	-	-	D	B	-	D	-	-	B	A	A	D	-	B	C	-	A	A	D	-	D	-	-	D
Sulfurous Acid	C	C	B	C	C	A	B	D	-	D	D	A	A	A	D	B	A	-	B	A	A	C	D	B	B	C	A
Sulfuryl Chloride	-	-	-	-	-	-	-	-	-	-	-	A	A	-	-	-	-	-	-	A	-	-	-	-	-	-	A
Syrup	-	A	A	A	A	-	-	D	-	-	-	A	-	A	A	-	A	-	A	A	A	A	-	B	-	A	A
Tallow	-	A	A	-	A	-	-	-	-	-	-	-	-	A	A	C	-	-	A	A	A	A	-	-	-	-	A
Tannic Acid	B	A	A	A	C	A	B	B	-	C	C	A	A	A	D	B	A	-	A	A	A	D	C	A	A	A	A
Tanning Liquors	-	A	A	-	C	A	A	A	-	-	-	A	A	-	-	-	A	-	A	A	A	C	-	-	-	-	A
Tartaric Acid	B	A	B	B	C	A	B	A	C	D	D	A	A	A	A	B	A	-	A	A	A	D	C	A	-	A	A
Tetrachlorethane	-	-	A	-	-	A	A	-	-	-	-	D	A	D	A	-	A	-	A	A	A	D	-	-	D	D	A
Tetrahydrofuran	-	A	A	-	D	-	-	D	-	D	A	D	A	D	A	D	C	A	A	A	B	D	-	D	B	D	A
Tin-Fluoborate Plating 38°C	-	-	C	-	-	D	A	-	-	-	-	A	A	A	D	-	A	-	-	D	A	B	-	C	-	-	A
Tin-Lead Plating 38°C	-	-	C	-	-	D	A	-	-	-	-	A	A	A	D	-	A	-	-	D	A	B	-	C	-	-	A
Toluene, Toluol	A	A	A	-	A	A	A	A	A	A	A	D	A	D	A	D	D	A	A	A	C	D	D	D	D	D	A
Tomato Juice	A	A	A	-	A	-	-	C	-	C	C	-	A	A	A	-	A	A	A	A	A	A	-	A	-	-	A
Trichlorethane	-	C	A	-	C	A	A	C	-	C	-	-	A	D	-	-	-	-	A	A	A	D	D	D	D	D	A
Trichlorethylene	B	A	A	-	B	A	A	B	A	C	B	D	A	D	C	D	D	C	A	A	A	D	D	D	D	D	A
Trichloropropane	-	-	A	-	-	-	-	A	-	-	-	-	-	D	-	-	-	-	A	A	A	A	-	A	-	-	A
Tricresylphosphate	-	-	A	-	-	B	A	A	-	-	-	D	A	A	-	-	-	-	A	A	B	D	-	D	A	-	A
Triethylamine	-	-	-	-	-	-	-	A	-	-	-	A	-	B	-	-	-	-	A	A	A	A	D	B	-	-	A
Turpentine	B	A	A	-	C	-	A	B	C	B	B	A	A	D	A	D	B	A	A	A	A	D	-	D	D	D	A
Urine	-	A	A	-	B	-	-	C	-	B	-	A	-	A	A	B	A	-	A	A	A	A	-	D	A	-	A
Varnish (Use Viton ® for Aromatic)	A	A	A	A	A	-	-	A	B	-	C	-	A	D	A	-	A	-	A	A	A	B	C	D	-	D	A
Vegetable Juice	-	A	A	-	A	-	-	C	-	D	-	-	-	A	A	-	-	-	A	A	A	A	B	D	-	D	A
Vinegar	A	A	A	A	D	A	A	B	B	C	D	A	A	A	A	B	A	A	A	A	A	C	-	B	A	C	A
Water, Fresh	A	A	A	-	A	-	-	A	C	B	D	A	A	A	A	D	A	A	A	A	A	A	-	B	A	A	A
Water, Salt	-	A	A	-	B	-	-	B	C	D	-	A	-	A	A	-	A	A	A	A	A	A	-	B	A	A	A
Water, Acid , Mine	-	A	A	-	C	-	-	C	D	C	-	A	-	A	A	-	A	B	A	A	A	A	-	B	-	B	A
Water, Distilled , Lab Grade 7	-	A	A	-	B	-	-	A	-	D	-	A	A	A	A	-	A	A	A	A	A	A	-	B	A	A	A
Weed Killers	-	A	A	-	C	-	-	C	-	-	-	-	-	-	A	-	-	-	A	A	A	B	-	C	-	-	A
Whey	-	A	A	-	B	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	-	-	-	-	A
Whiskey and Wines	A	A	A	A	D	-	-	B	B	D	D	A	A	A	A	B	A	-	A	A	A	A	B	A	A	A	A
White Liquor (Pulp Mill)	-	A	A	-	-	-	A	D	-	C	-	A	A	A	A	-	A	-	A	A	A	A	-	A	-	-	A
White Water (Paper Mill)	-	A	A	-	-	-	-	A	-	-	-	-	-	-	A	-	A	-	A	A	A	-	-	A	-	-	A

Warning

The information on this chart was collected from reputable sources and is to be used ONLY as a guide by experienced personnel. We make no representations on the suitability of any materials for your applications.

A = No effect
B = Minor effect
C = Moderate effect
D = Severe effect
- = No data - Refer to A.S.E.

DANGER

Despite being indicated as generally suitable in the charts, variations in temperature, pressure and concentration of chemicals may cause failure.

SERIOUS INJURY MAY RESULT

This is for initial reference only and must be cross checked by relevant authority.

Chemical	303 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Aluminium	Titanium	Hastelloy C	Cast Bronze	Brass	Cast Iron	Carbon Steel
Max Temperature in Deg C for Elastomers / Plastics											
Xylene	A	A	A	–	A	–	A	A	A	A	B
Zinc Chloride	D	A	B	B	D	A	B	D	D	D	D
Zinc Hydrosulfate	B	A	A	A	D	A	B	B	C	C	D
Zinc Hydrosulphite	–	–	A	–	D	–	–	D	–	D	–
ZINC PLATING											
Acid Chloride 60°C	–	–	D	–	–	A	D	–	–	–	–
Acid Sulfate Bath 66° C	–	–	C	–	–	A	A	–	–	–	–
Acid Fluoborate Bath R.T.	–	–	–	C	–	D	–	–	–	–	–
Alkaline Cyanide Bath R.T.	–	–	–	A	–	A	A	–	–	–	–
Zinc Sulfate	B	A	A	A	D	A	B	B	C	C	D

Chemical	PVC	Teflon PTFE	Noryl	Nylon	Polyethylene PE	Polypropylene PP	Ryton	Carbon	Ceramic Al_2O_3	Viton (FPM)	Buna N - Nitrile - NBR	Silicon	Neoprene	EPDM	Natural Rubber	Epoxy
Max Temperature in Deg C for Elastomers / Plastics	60	200	60	60		25 - 60				180	80		70	120	60	
Xylene	D	A	D	A	D	D	A	A	A	A	D	D	D	D	D	A
Zinc Chloride	A	A	A	A	B	A	A	A	A	A	A	–	A	A	A	A
Zinc Hydrosulfate	C	A	A	A	B	A	A	A	A	A	A	–	A	A	C	A
Zinc Hydrosulphite	–	–	A	–	–	–	A	A	A	–	A	–	A	A	–	A
ZINC PLATING																
Acid Chloride 60°C	A	A	A	D	–	A	–	–	A	A	A	–	A	–	–	A
Acid Sulfate Bath 66° C	D	A	A	D	–	A	–	–	A	A	A	–	B	–	–	D
Acid Fluoborate Bath R.T.	A	A	A	D	–	A	–	–	D	A	B	–	C	–	–	A
Alkaline Cyanide Bath R.T.	A	A	A	A	–	A	–	–	D	A	A	–	A	–	–	A
Zinc Sulfate	C	A	A	A	B	A	A	A	A	A	A	–	A	A	C	A

COMMON MATERIALS USED IN VALVES

300 SERIES STAINLESS STEELS	An alloy of iron, carbon, nickle & chromium. This series in usually non magnetic and has more ductility than the 400 series. Austinectic in structure 316 has very good corrosion resistance to a wide range of environments, it is not susceptable to stress corrosion cracking and is not effected by heat treatment. Most common uses in valves are body castings or forgings, stems, balls etc.
400 SERIES STAINLESS STEELS	An alloy of iron, carbon & chromium. This series is usually magnetic due to its martensitic structure and iron content. 400 series stainless steel is more resistantto high temperature oxidisation and has improved physical and mechanical properties over carbon steel. Most 400 series materials are heat treatable. Most common uses in valves are stems, backseat bushings and wedges in steel gate valves, also for spindles in butterfly valves.
17-4 PH STAINLESS STEEL	Is a martensitic percipitation / age hardening stainless steel offering high strength and hardness. It has corrosion resitance much higher thanthat of 400 series stainless steels and in most conditions approaching that of the 300 series. Primarily used for valve spindles and stems.
CARBON STEEL	Has very good mechanical propertiesand has good resistance to stress cracking and sulphides. Carbon steel has both high and low temperature strength, is very tough and has excellent fatigue strength. Mainly used in gate, globe, ball and check valve bodies and bonnets. In these applications can be used in temperatures up to 400 Deg C for extended periods.
CAST (GREY) IRON	An alloy of iron, carbon and silicon, it is easy to cast and has good pressure tightness in 'as cast' condition. Grey iron has excellent dampening properties and is easily machined. Good quality cast iron makes excellent valve bodies and bonnets. Care should be taken when purchasing iron valves from certain parts of the world as the material quality is low and castings can also be porous or brittle.
DUCTILE (SG) IRON	Has a composition similar to Grey Iron. Special treatment modifies the metalurgical structure with higher mechanical properties, some grades are heat treated to improve ductility. Ductile iron has the strength of steel with the advantage of being able to be cast and machined as easily as grey iron. Uses in valves include bodies, bonnets etc.
BRASS	Generally good corrosion resistance. Can be susceptable to de-zincification in specific applications some DR (dezinc resistant) alloys are now widely used in the water industry. Primary uses in valves are for small valve bodies, bonnets & stems.
BRONZE	Bronze is widely used and accepted as the industry standard for pressure rated valves in sizes up to 50mm. Used extensively in steam system valves and in marine applications due to its high resistance to pitting corrosion. Bronze is easy to machine and is used for valve bodies and bonnets and in special alloys for stems and valve discs etc.
ALUMINIUM	A non-ferrous metal, very lightweight being approximately one third the weight of steel. Aluminium exhibits excellent atmospheric corrosion resistance but can be very reactive to other metals. In valves it is used for light weight bodies (usually non-wetted) or for handwheels or identification tags.

Useful Engineering Tables

Table CG-29. Schedule 40 Pipe, Standard Dimensions

Size (in)	Diameters		Nominal Thickness (in)	Circumference		Transverse Areas			Length of Pipe Per sq ft		Length of Pipe Containing One Cubic Foot	Nominal Weight Per Foot		Number of Threads Per Inch of Screw
	External (in)	Approximate Internal (in)		External (in)	Internal (in)	External (sq in)	Internal (sq in)	Metal (sq in)	External Surface Feet	Internal Surface Feet	Feet	Plain Ends	Threaded and Coupled	
1/8	0.405	0.269	0.068	1.272	0.845	0.129	0.057	0.072	9.431	14.199	2533.775	0.244	0.245	27
1/4	0.540	0.364	0.088	1.696	1.114	0.229	0.104	0.125	7.073	10.493	1383.789	0.424	0.425	18
3/8	**0.675**	**0.493**	**0.091**	**2.121**	**1.549**	**0.358**	**0.191**	**0.167**	**5.658**	**7.747**	**754.360**	**0.567**	**0.568**	**18**
1/2	0.840	0.622	0.109	2.639	1.954	0.554	0.304	0.250	4.547	6.141	473.906	0.850	0.852	14
3/4	1.050	0.824	0.113	3.299	2.589	0.866	0.533	0.333	3.637	4.635	270.034	1.130	1.134	14
1	**1.315**	**1.049**	**0.133**	**4.131**	**3.296**	**1.358**	**0.864**	**0.494**	**2.904**	**3.641**	**166.618**	**1.678**	**1.684**	**11-1/2**
1-1/4	1.660	1.380	0.140	5.215	4.335	2.164	1.495	0.669	2.301	2.767	96.275	2.272	2.281	11-1/2
1-1/2	1.900	1.610	0.145	5.969	5.058	2.835	2.036	0.799	2.010	2.372	70.733	2.717	2.731	11-1/2
2	**2.375**	**2.067**	**0.154**	**7.461**	**6.494**	**4.430**	**3.355**	**1.075**	**1.608**	**1.847**	**42.913**	**3.652**	**3.678**	**11-1/2**
2-1/2	2.875	2.469	0.203	9.032	7.757	6.492	4.788	1.704	1.328	1.547	30.077	5.793	5.819	8
3	3.500	3.068	0.216	10.996	9.638	9.621	7.393	2.228	1.091	1.245	19.479	7.575	7.616	8
3-1/2	**4.000**	**3.548**	**0.226**	**12.566**	**11.146**	**12.566**	**9.886**	**2.680**	**0.954**	**1.076**	**14.565**	**9.109**	**9.202**	**8**
4	4.500	4.026	0.237	14.137	12.648	15.904	12.730	3.174	0.848	0.948	11.312	10.790	10.889	8
5	5.563	5.047	0.258	17.477	15.856	24.306	20.006	4.300	0.686	0.756	7.198	14.617	14.810	8
6	**6.625**	**6.065**	**0.280**	**20.813**	**19.054**	**34.472**	**28.891**	**5.581**	**0.576**	**0.629**	**4.984**	**18.974**	**19.185**	**8**
8	8.625	7.981	0.322	27.096	25.073	58.426	50.027	8.399	0.442	0.478	2.878	28.554	28.809	8
10	10.750	10.020	0.365	33.772	31.479	90.763	78.855	11.908	0.355	0.381	1.826	40.483	41.132	8
12	**12.750**	**11.938**	**0.406**	**40.055**	**37.699**	**127.640**	**111.900**	**15.740**	**0.299**	**0.318**	**1.288**	**53.600**	**—**	**—**
14	14.000	13.125	0.437	43.982	41.217	153.940	135.300	18.640	0.272	0.280	1.069	63.000	—	—
16	16.000	15.000	0.500	50.265	47.123	201.050	176.700	24.350	0.238	0.254	0.817	78.000	—	—
18	**18.000**	**16.874**	**0.563**	**56.548**	**52.998**	**254.850**	**224.000**	**30.850**	**0.212**	**0.226**	**0.643**	**105.000**	**—**	**—**
20	20.000	18.814	0.593	62.831	59.093	314.150	278.000	36.150	0.191	0.203	0.519	123.000	—	—
24	24.000	22.626	0.687	75.398	71.063	452.400	402.100	50.300	0.159	0.169	0.358	171.000	—	—

Table CG-30. Equivalent Length of Pipe to Be Added for Fittings–Schedule 40 Pipe

Pipe Size (in)	Length in Feet to Be Added Run				
	Standard Elbow	Side Outlet Tee	Gate Valve*	Globe Valve*	Angle Valve*
1/2	1.3	3	0.3	14	7
3/4	1.8	4	0.4	18	10
1	**2.2**	**5**	**0.5**	**23**	**12**
1-1/4	3.0	6	0.6	29	15
1-1/2	3.5	7	0.8	34	18
2	**4.3**	**8**	**1.0**	**46**	**22**
2-1/2	5.0	11	1.1	54	27
3	6.5	13	1.4	66	34
3-1/2	**8.0**	**15**	**1.6**	**80**	**40**
4	9.0	18	1.9	92	45
5	11.0	22	2.2	112	56
6	**13.0**	**27**	**2.8**	**136**	**67**
8	17.0	35	3.7	180	92
10	21.0	45	4.6	230	112
12	**27.0**	**53**	**5.5**	**270**	**132**

*Valve in full open position

Table CG-31. Thermal Expansion of Pipe

Temp (°F)	Elongation in Inches Per 100 ft From -20°F Up			
	Cast Iron Pipe	Steel Pipe	Wrought Iron Pipe	Copper Pipe
-20	0.000	0.000	0.000	0.000
0	0.127	0.145	0.152	0.204
20	**0.255**	**0.293**	**0.306**	**0.442**
40	0.390	0.430	0.465	0.655
60	0.518	0.593	0.620	0.888
80	**0.649**	**0.725**	**0.780**	**1.100**
100	0.787	0.898	0.939	1.338
120	0.926	1.055	1.110	1.570
140	**1.051**	**1.209**	**1.265**	**1.794**
160	1.200	1.368	1.427	2.008
180	1.345	1.528	1.597	2.255
200	**1.495**	**1.691**	**1.778**	**2.500**
240	1.780	2.020	2.110	2.960
280	2.085	2.350	2.465	3.422
320	**2.395**	**2.690**	**2.800**	**3.900**
360	2.700	3.029	3.175	4.380
400	3.008	3.375	3.521	4.870
500	**3.847**	**4.296**	**4.477**	**6.110**
600	4.725	5.247	5.455	7.388

From Piping Handbook, by Walker and Crocker, by special permission. Table CG-31 gives the expansion from -20°F to temperature in question. To obtain the amount of expansion between any two temperatures, take the difference between the figures in the table for those temperatures. For example, if cast iron pipe is installed at a temperature of 80°F and is operated at 240°F, the expansion would be 1.780 - 0.649 = 1.131 in.

Table CG-32. Diameters and Areas of Circles and Drill Sizes

Drill Size	Diameter	Area	Drill Size	Diameter	Area	Drill Size	Diameter	Area	Drill Size	Diameter	Area	Diameter	Area
3/64	.0469	.00173	27	.1440	.01629	C	.2420	.04600	27/64	.4219	.13920		
55	.0520	.00212	26	.1470	.01697	D	.2460	.04753	7/16	.4375	.15033		
54	**.0550**	**.00238**	**25**	**.1495**	**.01705**	**1/4**	**.2500**	**.04909**	**29/64**	**.4531**	**.16117**		
53	.0595	.00278	24	.1520	.01815	E	.2500	.04909	15/32	.4688	.17257		
1/16	.0625	.00307	23	.1540	.01863	F	.2570	.05187	31/64	.4844	.18398		
52	**.0635**	**.00317**	**5/32**	**.1562**	**.01917**	**G**	**.2610**	**.05350**	**1/2**	**.5000**	**.19635**		
51	.0670	.00353	22	.1570	.01936	17/64	.2656	.05515	33/64	.5156	.20831		
50	.0700	.00385	21	.1590	.01986	H	.2660	.05557	17/32	.5312	.22166		
49	**.0730**	**.00419**	**20**	**.1610**	**.02036**	**I**	**.2720**	**.05811**	**9/16**	**.5625**	**.24850**		
48	.0760	.00454	19	.1660	.02164	J	.2770	.06026	19/32	.5937	.27688		
5/64	.0781	.00479	18	.1695	.02256	K	.2810	.06202	5/8	.6250	.30680		
47	**.0785**	**.00484**	**11/64**	**.1719**	**.02320**	**9/32**	**.2812**	**.06213**	**21/32**	**.6562**	**.33824**		
46	.0810	.00515	17	.1730	.02351	L	.2900	.06605	11/16	.6875	.37122		
45	.0820	.00528	16	.1770	.02461	M	.2950	.06835	23/32	.7187	.40574		
44	**.0860**	**.00581**	**15**	**.1800**	**.02545**	**19/64**	**.2969**	**.06881**	**3/4**	**.7500**	**.44179**		
43	.0890	.00622	14	.1820	.02602	N	.3020	.07163	25/32	.7812	.47937		
42	.0935	.00687	13	.1850	.02688	5/16	.3125	.07670	13/16	.8125	.51849		
3/32	**.0938**	**.00690**	**3/16**	**.1875**	**.02761**	**O**	**.3160**	**.07843**	**27/32**	**.8437**	**.55914**		
41	.0960	.00724	12	.1890	.02806	P	.3230	.08194	7/8	.8750	.60132		
40	.0980	.00754	11	.1910	.02865	21/64	.3281	.08449	29/32	.9062	.64504		
39	**.0995**	**.00778**	**10**	**.1935**	**.02941**	**Q**	**.3320**	**.08657**	**15/16**	**.9375**	**.69029**		
38	.1015	.00809	9	.1960	.03017	R	.3390	.09026	31/32	.9687	.73708		
37	.1040	.00850	8	.1990	.03110	11/32	.3438	.09281	1	1.0000	.78540		
36	**.1065**	**.00891**	**7**	**.2010**	**.03173**	**S**	**.3480**	**.09511**	**1-1/16**	**1.0625**	**.88664**		
7/64	.1094	.00940	13/64	.2031	.03241	T	.3580	.10066	1-1/8	1.1250	.99402		
35	.1100	.00950	6	.2040	.03268	23/64	.3594	.10122	1-3/16	1.1875	1.1075		
34	**.1110**	**.00968**	**5**	**.2055**	**.03317**	**U**	**.3680**	**.10636**	**1-1/4**	**1.2500**	**1.2272**		
33	.1130	.01003	4	.2090	.03431	3/8	.3750	.11045	1-5/16	1.3125	1.3530		
32	.1160	.01039	3	.2130	.03563	V	.3770	.11163	1-3/8	1.3750	1.4849		
31	**.1200**	**.01131**	**7/32**	**.2188**	**.03758**	**W**	**.3860**	**.11702**	**1-7/16**	**1.4375**	**1.6230**		
1/8	.1250	.01227	2	.2210	.03836	25/64	.3906	.11946	1-1/2	1.5000	1.7671		
30	.1285	.01242	1	.2280	.04083	X	.3970	.12379	1-5/8	1.6250	2.0739		
29	**.1360**	**.01453**	**A**	**.2340**	**.04301**	**Y**	**.4040**	**.12819**	**1-3/4**	**1.7500**	**2.4053**		
28	.1405	.01550	15/64	.2344	.04314	13/32	.4062	.12962	1-7/8	1.8750	2.7612		
9/64	.1406	.01553	B	.2380	.04449	Z	.4130	.13396	2	2.0000	3.1416		

Conversion Factors

Power

Multiply	By	To Get
Boiler hp	33,472	Btu/hr
Boiler hp	34.5	lbs H_2O evap. at 212°F
Horsepower	2,540	Btu/hr
Horsepower	550	ft-lbs/sec
Horsepower	33,000	ft-lbs/min
Horsepower	42.42	Btu/min
Horsepower	0.7457	Kilowatts
Kilowatts	3,415	Btu/hr
Kilowatts	56.92	Btu/min
Watts	44.26	ft-lbs/min
Watts	0.7378	ft-lbs/sec
Watts	0.05692	Btu/min
Tons refrig.	12,000	Btu/hr
Tons refrig.	200	Btu/min
Btu/hr	0.00002986	Boiler hp
lbs H_2O evap. at 212°F	0.0290	Boiler hp
Btu/hr	0.000393	Horsepower
ft-lbs/sec	0.00182	Horsepower
ft-lbs/min	0.0000303	Horsepower
Btu/min	0.0236	Horsepower
Kilowatts	1.341	Horsepower
Btu/hr	0.000293	Kilowatts
Btu/min	0.01757	Kilowatts
ft-lbs/min	0.02259	Watts
ft-lbs/sec	1.355	Watts
Btu/min	1.757	Watts
Btu/hr	0.0000833	Tons Refrig.
Btu/min	0.005	Tons Refrig.

Energy

Multiply	By	To Get
Btu	778	ft-lbs
Btu	0.000393	hp-hrs
Btu	0.000293	kw-hrs
Btu	0.0010307	{lbs H_2O evap.) at 212°F
Btu	0.293	Watt-hrs
ft-lbs	0.3765	Watt-hrs
latent heat} of ice	143.33	Btu/lb H_2O
lbs H_2O evap.} at 212°F	0.284	kw-hrs
lbs H_2O evap.} at 212°F	0.381	hp-hrs
ft-lbs	0.001287	Btu
hp-hrs	2,540	Btu
kw-hrs	3,415	Btu
lbs H_2O evap.} at 212°F	970.4	Btu
Watt-hrs	3.415	Btu
Watt-hrs	2,656	ft-lbs
Btu/lb H_2O	0.006977	{Latent heat of ice
kw-hrs	3.52	{lbs H_2O evap. at 212°F
hp-hrs	2.63	{lbs H_2O evap. at 212°F

Pressure

Multiply	By	To Get
atmospheres	29.92	{in Mercury (at 62°F)
atmospheres	406.8	{in H_2O (at 62°F)
atmospheres	33.90	{ft. H_2O (at 62°F)
atmospheres	14.70	lbs/in²
atmospheres	1.058	ton/ft²
in. H_2O} (at 62°F)	0.0737	{in. Mercury (at 62°F)
ft H_2O} (at 62°F)	0.881	{in. Mercury (at 62°F)
ft H_2O} (at 62°F)	0.4335	lbs/in²
ft H_2O} (at 62°F)	62.37	lbs/ft²
in. Mercury} (at 62°F)	70.73	lbs/ft²
in. Mercury} (at 62°F)	0.4912	lbs/in²
in. Mercury} (at 62°F)	0.03342	atmospheres
in. H_2O} (at 62°F)	0.002458	atmospheres
ft. H_2O} (at 62°F)	0.0295	atmospheres
lbs/in²	0.0680	atmospheres
ton/ft²	0.945	atmospheres
in. Mercury} (at 62°F)	13.57	{in. H_2O (at 62°F)
in. Mercury} (at 62°F)	1.131	{ft H_2O (at 62°F)
{ft H_2O lbs/in²	2.309	(at 62°F)
{ft H_2O) lbs/ft²	0.01603	(at 62°F)
{in. Mercury lbs/ft²	0.014138	(at 62°F)
{in Mercury lbs/in²	2.042	(at 62°F)
lbs/in²	0.0689	Bar
lbs/in²	0.0703	kg/cm²

Velocity of Flow

Multiply	By	To Get
ft/min	0.01139	miles/hr
ft/min	0.01667	ft/sec
cu ft/min	0.1247	gal/sec
cu ft/sec	448.8	gal/min
miles/hr	88	ft/min
ft/sec	60	ft/min
gal/sec	8.02	cu ft/min
gal/min	0.002228	cu ft/sec

Temperature

°F = (°C x 1.8) + 32
°C = (°F - 32) ÷ 1.8

Weight

Multiply	By	To Get
lbs	7,000	grains
lbs H_2O (60°F)	0.01602	cu ft H_2O
lbs H_2O (60°F)	0.1198	gal H_2O
tons (long)	2,240	lbs
tons (short)	2,000	lbs
grains	0.000143	lbs
lbs H_2O cu ft H_2O	62.37	(60°F)
lbs H_2O gal H_2O	8.3453	(60°F)
lbs	0.000446	tons (long)
lbs	0.000500	tons (short)

Circular Measure

Multiply	By	To Get
Degrees	0.01745	Radians
Minutes	0.00029	Radians
Diameter	3.142	Circumference
Radians	57.3	Degrees
Radians	3,438	Minutes
Circumference	0.3183	Diameter

Volume

Multiply	By	To Get
Barrels (oil)	42	gal (oil)
cu ft	1,728	cu in
cu ft	7.48	gal
cu in	0.00433	gal
gal (oil)	0.0238	barrels (oil)
cu in	0.000579	cu ft
gal	0.1337	cu ft
gal	231	cu in

Heat Transmission

Multiply	By	To Get
Btu/in} /sq ft /hr/°F	0.0833	{Btu/ft /sq ft /hr/°F
Btu/ft} /sq ft /hr/°F	12	{Btu/in /sq ft /hr/°F

Fractions and Decimals

Multiply	By	To Get
Sixty-fourths	0.015625	Decimal
Thirty-seconds	0.03125	Decimal
Sixteenths	0.0625	Decimal
Eighths	0.125	Decimal
Fourths	0.250	Decimal
Halves	0.500	Decimal
Decimal	64	Sixty-fourths
Decimal	32	Thirty-seconds
Decimal	16	Sixteenths
Decimal	8	Eighths
Decimal	4	Fourths
Decimal	2	Halves

Gallons shown are U.S. standard.

Specific Heat—Specific Gravity

Table CG-33. Physical Properties of Liquids and Solids

	Liquid (L) or Solid (S)	sp gr @ 60-70°F	sp ht @ 60°F Btu/lb-°F
Acetic acid 100%	L	1.05	0.48
Acetic acid 10%	L	1.01	0.96
Acetone, 100%	**L**	**0.78**	**0.514**
Alcohol, ethyl, 95%	L	0.81	0.60
Alcohol, methyl, 90%	L	0.82	0.65
Aluminum	**S**	**2.64**	**0.23**
Ammonia, 100%	L	0.61	1.10
Ammonia, 26%	L	0.90	1.00
Aroclor	**L**	**1.44**	**0.28**
Asbestos board	S	0.88	0.19
Asphalt	L	1.00	0.42
Asphalt, solid	**S**	**1.1-1.5**	**0.22-0.4**
Benzene	L	0.84	0.41
Brickwork & Masonry	S	1.6-2.0	0.22
Brine - calcium chloride, 25%	**L**	**1.23**	**0.689**
Brine - sodium chloride, 25%	L	1.19	0.786
Clay, dry	S	1.9-2.4	0.224
Coal	**S**	**1.2-1.8**	**0.26-0.37**
Coal tars	S	1.20	0.35@40
Coke, solid	S	1.0-1.4	0.265
Copper	**S**	**8.82**	**0.10**
Cork	S	0.25	0.48
Cotton, cloth	S	1.50	0.32
Cottonseed oil	**L**	**0.95**	**0.47**
Dowtherm A	L	0.99	0.63
Dowtherm C	L	1.10	0.35-0.65
Ethylene glycol	**L**	**1.11**	**0.58**
Fatty acid - palmitic	L	0.85	0.653
Fatty acid - stearic	L	0.84	0.550
Fish, fresh, average	**S**		**0.75-0.82**
Fruit, fresh, average	S		0.80-0.88
Gasoline	L	0.73	0.53
Glass, Pyrex	**S**	**2.25**	**0.20**
Glass, wool	S	0.072	0.157
Glue, 2 parts water 1 part dry glue	L	1.09	0.89
Glycerol, 100% (glycerin)	**L**	**1.26**	**0.58**
Honey	L		0.34
Hydrochloric acid, 31.5% (muriatic)	L	1.15	0.60
Hydrochloric acid, 10% (muriatic)	**L**	**1.05**	**0.75**
Ice	S	0.90	0.50
Ice Cream	S		0.70
Lard	**S**	**0.92**	**0.64**
Lead	S	11.34	0.031
Leather	S	0.86-1.02	0.36
Linseed oil	**L**	**0.93**	**0.44**
Magnesia, 85%	L	0.208	0.27
Maple syrup	L		0.48
Meat, fresh, average	**S**		**0.780**
Milk	L	1.03	0.90-0.93
Nickel	S	8.90	0.11
Nitric acid, 95%	**L**	**1.50**	**0.50**
Nitric acid, 60%	L	1.37	0.64
Nitric acid, 10%	L	1.05	0.90
No. 1 Fuel Oil (kerosene)	**L**	**0.81**	**0.47**
No. 2 Fuel Oil	L	0.86	0.44
No. 3 Fuel Oil	L	0.88	0.43
No. 4 Fuel Oil	**L**	**0.90**	**0.42**
No. 5 Fuel Oil	L	0.93	0.41
No. 6 Fuel Oil	L	0.95	0.40

Table CG-33. (cont.) Physical Properties of Liquids and Solids

	Liquid (L) or Solid (S)	sp gr @ 60-70°F	sp ht @ 60°F Btu/lb-°F
API Mid-continent crude	L	.085	0.44
API gas oil	L	0.88	0.42
Paper	**S**	**1.7-1.15**	**0.45**
Paraffin	S	0.86-0.91	0.62
Paraffin, melted	L	0.90	0.69
Phenol (carbolic acid)	**L**	**1.07**	**0.56**
Phosphoric acid, 20%	L	1.11	0.85
Phosphoric acid, 10%	L	1.05	0.93
Phthalic anhydride	**L**	**1.53**	**0.232**
Rubber, vulcanized	S	1.10	0.415
SAE - SW (#8 machine lube oil)	L	0.88	
SAE - 20 (#20 machine lube oil)	**L**	**0.89**	
SAE - 30 (#30 machine lube oil)	L	0.89	
Sand	S	1.4-1.76	0.19
Sea water	**L**	**1.03**	**0.94**
Silk	S	1.25-1.35	0.33
Sodium hydroxide, 50% (caustic acid)	L	1.53	0.78
Sodium hydroxide, 30%	**L**	**1.33**	**0.84**
Soybean oil	L	0.92	0.24-0.33
Steel, mild @ 70	S	7.90	0.11
Steel, stainless, 300 series	**S**	**8.04**	**0.12**
Sucrose, 60% sugar syrup	L	1.29	0.74
Sucrose, 40% sugar syrup	L	1.18	0.66
Sugar, cane & beet	**S**	**1.66**	**0.30**
Sulfur	S	2.00	0.203
Sulfuric acid, 110% (fuming)	L		0.27
Sulfuric acid, 98%	**L**	**1.84**	**0.35**
Sulfuric acid, 60%	L	1.50	0.52
Sulfuric acid, 20%	L	1.14	0.84
Titanium (commercial)	**S**	**4.50**	**0.13**
Toluene	L	0.86	0.42
Trichloroethylene	L	1.62	0.215
Tetrachloride carbon	**L**	**1.58**	**0.21**
Turpentine, spirits of	L	0.86	0.42
Vegetables, fresh, average	S		0.73-0.94
Water	**L**	**1.00**	**1.00**
Wines, table, dessert, average	L	1.03	0.90
Woods, vary from	S	0.35-0.9	0.90
Wool	**S**	**1.32**	**0.325**
Zinc	S	7.05	0.095

Table CG-34. Physical Properties of Gases

	sp gr @ 60-70°F	spht@60°FBtu/lb-°F
Air	1.00	0.24
Ammonia	0.60	0.54
Benzene		**0.325**
Butane	2.00	0.455
Carbon dioxide	1.50	0.21
Carbon monoxide	**0.97**	**0.255**
Chlorine	2.50	0.118
Ethane	1.10	0.50
Ethylene	**0.97**	**0.45**
Freon - 12		0.16
Hydrogen	0.069	3.42
Hydrogen sulfide	**1.20**	**0.25**
Methane	0.55	0.60
Nitrogen	0.97	0.253
Oxygen	**1.10**	**0.225**
Propane	1.50	0.46
Sulfur dioxide		0.162
Water vapor (steam)	2.30	0.453

How to Size Condensate Return Lines

The sizing of condensate return lines presents several problems that differ from those of sizing steam or water lines. The most significant of these is the handling of flash steam. Although a return line must handle both water and flash steam, the volume of flash steam is many times greater than the volume of condensate. For the values in Chart CG-26 the volume of flash steam is 96% to 99% of the total volume. Consequently, only flash steam is considered in Chart CG-26.

Condensate return lines should be sized to have a reasonable velocity at an acceptable pressure drop. Chart CG-26 is based on having a constant velocity of 7,000 feet per minute or below, using Schedule 40 pipe. Additional factors that should also be considered—depending on water conditions—are dirt, fouling, corrosion and erosion.

For a given supply pressure to the trap and a return line pressure, along with an assumed pressure drop per 100 feet of pipe (ΔP/L) and knowing the condensate flow rate, the proper pipe diameter can be selected from Chart CG-26.

How to Use Chart CG-26

Example 1: A condensate system has the steam supply at 30 psig. The return line is non-vented and at 0 psig. The return line is to have the capacity for returning 2,000 lbs/hr of condensate. What must be the size of the return line?

Solution: Since the system will be throttling the condensate from 30 psig to 0 psig, there will be flash steam (assuming no subcooling), and the system will be a dry-closed (not completely full of liquid and not vented to atmosphere) return. The data in Chart CG-26 can be used. A pressure of 1/4 psig per 100 feet is selected. In Chart CG-26 for a 30 psig supply and a 0 psig return for ΔP/L = 1/4, a pipe size for the return line of 2" is selected.

Example 2: A condensate return system has the steam supply at 100 psig and the return line is non-vented and at 0 psig. The return line is horizontal and must have a capacity of 2,500 lbs/hr. What size pipe is required?

Solution: Since the system will be throttling non-subcooled condensate from 100 psig to 0 psig, there will be flash steam, and the system will be a dry-closed return. Selecting a pressure drop of 1 psi per 100 feet yields from Chart CG-26 a non-recommended situation (a). Select a pressure drop of 1/4 psi per 100 feet and then a 2-1/2" pipe can be used for this system.

Chart CG-26. Flow Rate (lbs/hr) for Dry-Closed Returns

ΔP/L psi/100'	Supply Pressure = 5 psig Return Pressure = 0 psig			Supply Pressure = 15 psig Return Pressure = 0 psig			Supply Pressure = 30 psig Return Pressure = 0 psig			Supply Pressure = 50 psig Return Pressure = 0 psig		
D, in	1/16	1/4	1	1/16	1/4	1	1/16	1/4	1	1/16	1/4	1
1/2	240	520	1,100	95	210	450	60	130	274	42	92	200
3/4	510	1,120	2,400	210	450	950	130	280	590	91	200	420
1	**1,000**	**2,150**	**4,540**	**400**	**860**	**1,820**	**250**	**530**	**1,120**	**180**	**380**	**800**
1-1/4	2,100	4,500	9,500	840	1,800	3,800	520	1,110	2,340	370	800	1,680
1-1/2	3,170	6,780	14,200	1,270	2,720	5,700	780	1,670	3,510	560	1,200	2,520
2	**6,240**	**13,300**	**a**	**2,500**	**5,320**	**a**	**1,540**	**3,270**	**a**	**1,110**	**2,350**	**a**
2-1/2	10,000	21,300	a	4,030	8,520	a	2,480	5,250	a	1,780	3,780	a
3	18,000	38,000	a	7,200	15,200	a	4,440	9,360	a	3,190	6,730	a
4	**37,200**	**78,000**	**a**	**14,900**	**31,300**	**a**	**9,180**	**19,200**	**a**	**6,660**	**13,800**	**a**
6	110,500	a	a	44,300	a	a	27,300	a	a	19,600	a	a
8	228,600	a	a	91,700	a	a	56,400	a	a	40,500	a	a

Chart CG-26. Flow Rate (lbs/hr) for Dry-Closed Returns

ΔP/L psi/100'	Supply Pressure = 100 psig Return Pressure = 0 psig			Supply Pressure = 150 psig Return Pressure = 0 psig			Supply Pressure = 100 psig Return Pressure = 15 psig			Supply Pressure = 150 psig Return Pressure = 15 psig		
D, in	1/16	1/4	1	1/16	1/4	1	1/16	1/4	1	1/16	1/4	1
1/2	28	62	133	23	51	109	56	120	260	43	93	200
3/4	62	134	290	50	110	230	120	260	560	93	200	420
1	**120**	**260**	**544**	**100**	**210**	**450**	**240**	**500**	**1,060**	**180**	**390**	**800**
1-1/4	250	540	1,130	200	440	930	500	1,060	2,200	380	800	1,680
1-1/2	380	810	1,700	310	660	1,400	750	1,600	3,320	570	1,210	2,500
2	**750**	**1,590**	**a**	**610**	**1,300**	**a**	**1,470**	**3,100**	**6,450**	**1,120**	**2,350**	**4,900**
2-1/2	1,200	2,550	a	980	2,100	a	2,370	5,000	10,300	1,800	3,780	7,800
3	2,160	4,550	a	1,760	3,710	a	4,230	8,860	a	3,200	6,710	a
4	**4,460**	**9,340**	**a**	**3,640**	**7,630**	**a**	**8,730**	**18,200**	**a**	**6,620**	**13,800**	**a**
6	13,200	a	a	10,800	a	a	25,900	53,600	a	19,600	40,600	a
8	27,400	a	a	22,400	a	a	53,400	110,300	a	40,500	83,600	a

[a] For these sizes and pressure losses the velocity is above 7,000 fpm. Select another combination of size and pressure loss.
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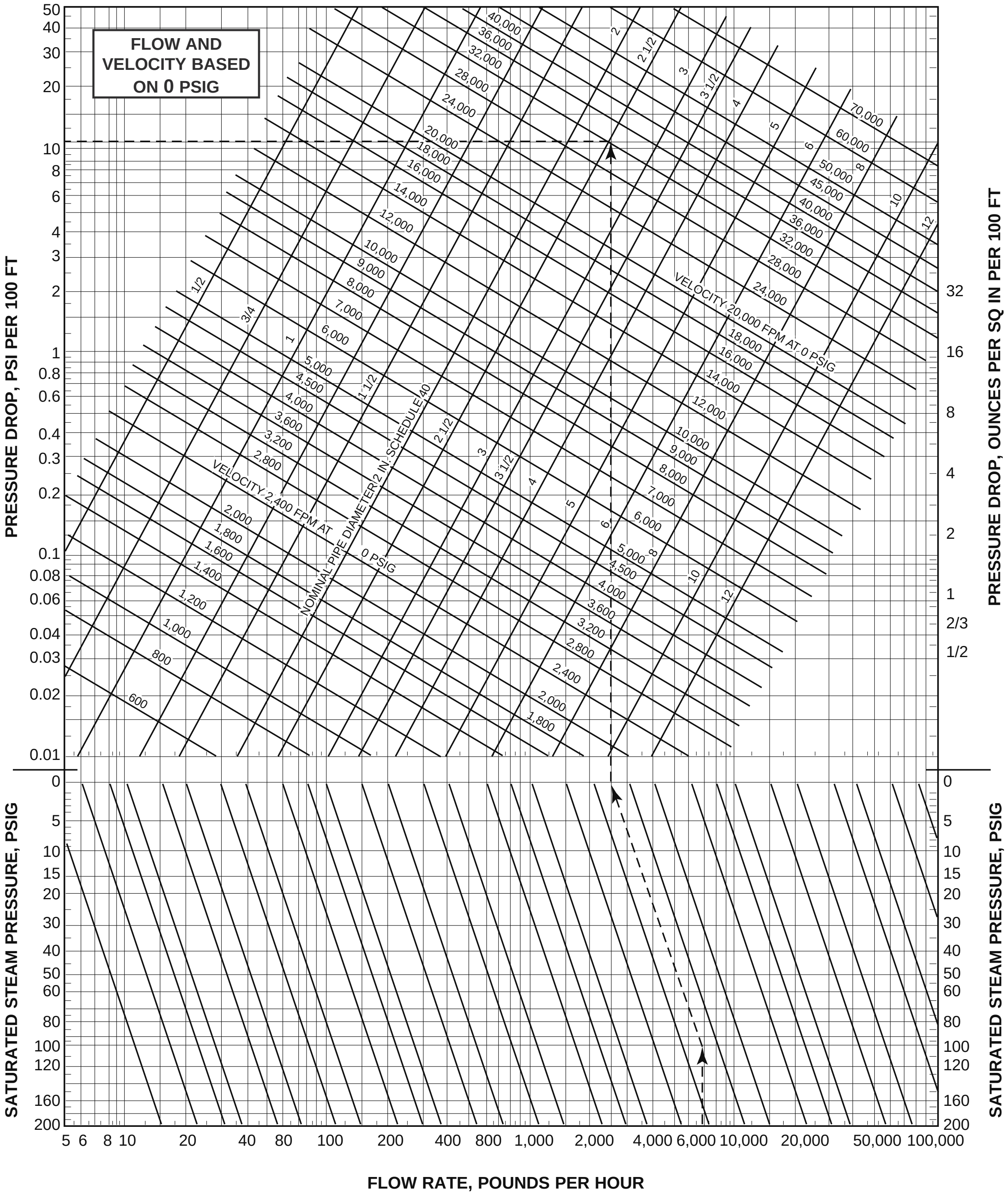
Pipe Sizing Steam Supply and Condensate Return Lines

Chart CG-25. Flow Rate and Velocity of Steam in Schedule 40 Pipe at Saturation Pressure of 0 psig



Pipe Sizing Steam Supply and Condensate Return Lines

Sizing Charts

Chart CG-25, page CG-51, is the basic chart for determining the flow rate and velocity of steam in Schedule 40 pipe for various values of pressure drop per 100 ft, based on 0 psig saturated steam. Using the multiplier chart (Chart CG-24), Chart CG-25 can be used at all saturation pressures between 0 and 200 psig (see Example).

These Charts are based on the Moody Friction Factor, which considers the Reynolds number and the roughness of the internal pipe surfaces.

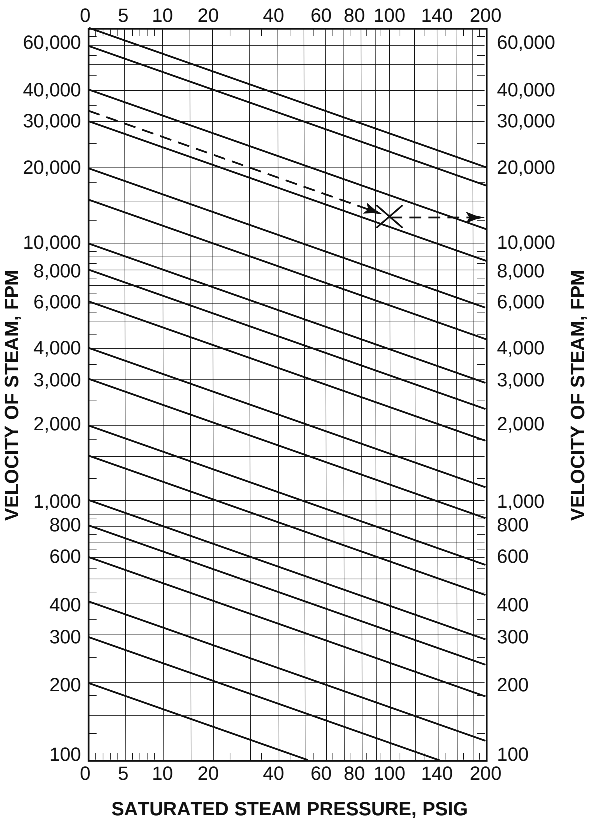
Notes: Based on Moody Friction Factor where flow of condensate does not inhibit the flow of steam. See Chart CG-24 for obtaining flow rates and velocities of all saturation pressures between 0 to 200 psig: see Example.

Pipe Sizing

Two principal factors determine pipe sizing in a steam system:

1. The initial pressure at the boiler and the allowable pressure drop of the total system. The total pressure drop in the system should not exceed 20% of the total maximum pressure at the boiler. This includes all drops—line loss, elbows, valves, etc. Remember, pressure drops are a loss of energy.
2. Steam velocity. Erosion and noise increase with velocity. Reasonable velocities for process steam are 6,000 to 12,000 fpm, but lower pressure heating systems normally have lower velocities. Another consideration is future expansion. Size your lines for the foreseeable future. If ever in doubt, you will have less trouble with oversized lines than with ones that are marginal.

Chart CG-24. Velocity Multiplier Chart for CG-25.



Use of Basic and Velocity Multiplier Charts

Example.

Given a flow rate of 6,700 lb/hr, an initial steam pressure of 100 psig, and a pressure drop of 11 psi/100 ft, find the size of Schedule 40 pipe required and the velocity of steam in the pipe.

Solution: The following steps are illustrated by the broken line on Chart CG-25 and Chart CG-24.

1. Enter Chart CG-25 at a flow rate of 6,700 lb/hr, and move vertically to the horizontal line at 100 psig.

2. Follow inclined multiplier line (upward and to the left) to horizontal 0 psig line. The equivalent mass flow at 0 psig is about 2,500 lb/hr.

3. Follow the 2,500 lb/hr line vertically until it intersects the horizontal line at 11 psi per 100 ft pressure drop. Nominal pipe size is 2-1/2 in. The equivalent steam velocity at 0 psig is about 32,700 fpm.

4. To find the steam velocity at 100 psig, locate the value of 32,700 fpm on the ordinate of the velocity multiplier chart (Chart CG-24) at 0 psig.

5. Move along the inclined multiplier line (downward and to the right) until it intersects the vertical 100 psig pressure line. The velocity as read from the right (or left) scale is about 13,000 fpm.

NOTE: Steps 1 through 5 would be rearranged or reversed if different data were given.

Condensate Pipe Sizing

The following is a very simple guide for condensate pipe sizing and is based on steel pipe. If Copper pipe is used you should go up a size.

There are many helpful charts on the internet for extremely accurate pipe sizing but the chart below will suffice for 99.99% of applications.

Pipe Size mm	15	20	25	32	40	50	65	80	100
Flow kg/hr	160	370	690	1500	2290	4390	8900	13,800	28,200

Nominal Size 15mm ($\frac{1}{2}$ in)

BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes	Diameter of raised face(3) iron	Diameter of raised face(3) steel	Height of raised face(3)	Thickness of flange			
									Grey cast iron	Copper alloy	Cast and forged steel	Ductile cast iron
PN 6	80	55	4	M10	11	38	40	2	12 (1)	-	12	-
PN 10	95	65	4	M12	14	46	45	2	14 (1)	-	16	14
PN 16	95	65	4	M12	14	46	45	2	14 (1)	6 (2)	16	14
PN 25	95	65	4	M12	14	46	45	2	16 (1)	8 (2)	16	14
PN 40	95	65	4	M12	14	46	45	2	-	9 (2)	16	16
PN 64	105	75	4	M12	14	-	45	2	-	-	20	-
ANSI												
Class 125/150	$3\frac{1}{2}$ (89)	$2\frac{3}{8}$ (60)	4	$\frac{1}{2}$ (13)	$\frac{5}{8}$ (16)	-	$1\frac{3}{8}$ (35)	$\frac{1}{16}$ (2)	-	$\frac{5}{16}$ (8)	$\frac{7}{16}$ (11)	-
Class 300	$3\frac{3}{4}$ (95)	$2\frac{5}{8}$ (67)	4	$\frac{1}{2}$ (13)	$\frac{5}{8}$ (16)	-	$1\frac{3}{8}$ (35)	$\frac{1}{16}$ (2)	-	$\frac{1}{2}$ (13)	$\frac{1}{2}$ (13)	-
Class 600	$3\frac{3}{4}$ (95)	$2\frac{5}{8}$ (67)	4	$\frac{1}{2}$ (13)	$\frac{5}{8}$ (16)	-	$1\frac{3}{8}$ (35)	$\frac{1}{4}$ (6)	-	-	$\frac{9}{16}$ (14)	-
Class 900	$4\frac{3}{4}$ (121)	$3\frac{1}{4}$ (83)	4	$\frac{3}{4}$ (19)	$\frac{7}{8}$ (22)	-	$1\frac{3}{8}$ (35)	$\frac{1}{4}$ (6)	-	-	$\frac{7}{8}$ (22)	-
Class 1500	$4\frac{3}{4}$ (121)	$3\frac{1}{4}$ (83)	4	$\frac{3}{4}$ (19)	$\frac{7}{8}$ (22)	-	$1\frac{3}{8}$ (35)	$\frac{1}{4}$ (6)	-	-	$\frac{7}{8}$ (22)	-
BS 10												
Table A	$3\frac{3}{4}$ (95)	$2\frac{5}{8}$ (67)	4	$\frac{1}{2}$ (13)	$\frac{9}{16}$ (14)	-	-	-	$\frac{1}{2}$ (13)	$\frac{1}{4}$ (6)	-	-
Table D	$3\frac{3}{4}$ (95)	$2\frac{5}{8}$ (67)	4	$\frac{1}{2}$ (13)	$\frac{9}{16}$ (14)	-	-	-	$\frac{1}{2}$ (13)	$\frac{1}{4}$ (6)	$\frac{3}{8}$ (10)	-
Table E	$3\frac{3}{4}$ (95)	$2\frac{5}{8}$ (67)	4	$\frac{1}{2}$ (13)	$\frac{9}{16}$ (14)	-	-	-	$\frac{1}{2}$ (13)	$\frac{1}{4}$ (6)	$\frac{3}{8}$ (10)	-
Table F	$3\frac{3}{4}$ (95)	$2\frac{5}{8}$ (67)	4	$\frac{1}{2}$ (13)	$\frac{9}{16}$ (14)	-	-	-	$\frac{1}{2}$ (13)	$\frac{5}{16}$ (8)	$\frac{3}{8}$ (10)	-
Table H	$4\frac{1}{2}$ (114)	$3\frac{1}{4}$ (83)	4	$\frac{5}{8}$ (16)	$\frac{11}{16}$ (17)	-	$2\frac{1}{4}$ (57)	$\frac{1}{16}$ (2)	$\frac{5}{8}$ (16)	$\frac{3}{8}$ (10)	$\frac{1}{2}$ (13)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2
(2) Flange thicknesses for copper alloy are from BS4504
(3) Copper alloy flanges are always flat-faced

Nominal Size 20mm (3/4in)

BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes	Diameter of raised face(3) iron	Diameter of raised face(3) steel	Height of raised face(3)	Thickness of flange: Grey cast iron	Copper alloy	Cast and forged steel	Ductile cast iron
PN 6	90	65	4	M10	11	48	50	2	14 (1)	-	14	-
PN 10	105	75	4	M12	14	56	58	2	16 (1)	-	18	16
PN 16	105	75	4	M12	14	56	58	2	16 (1)	6 (2)	18	16
PN 25	105	75	4	M12	14	56	58	2	18 (1)	8 (2)	18	16
PN 40	105	75	4	M12	14	56	58	2	-	9 (2)	18	18
PN 64	130	90	4	M16	18	-	58	2	-	-	22	-
PN 100	130	90	4	M16	18	-	58	2	-	-	22	-
ANSI												
Class 125/150	3 7/8 (98)	2 3/4 (70)	4	1/2 (13)	5/8 (16)	-	1 11/16 (43)	1/16 (2)	-	11/32 (9)	9/16 (14)	-
Class 300	4 5/8 (117)	3 1/4 (83)	4	5/8 (16)	3/4 (19)	-	1 11/16 (43)	1/16 (2)	-	17/32 (13)	5/8 (16)	-
Class 600	4 5/8 (117)	3 1/4 (83)	4	5/8 (16)	3/4 (19)	-	1 11/16 (43)	1/4 (6)	-	-	5/8 (16)	-
Class 900	5 1/8 (130)	3 1/2 (89)	4	3/4 (19)	7/8 (22)	-	1 11/16 (43)	1/4 (6)	-	-	1 (25)	-
Class 1500	5 1/8 (130)	3 1/2 (89)	4	3/4 (19)	7/8 (22)	-	1 11/16 (43)	1/4 (6)	-	-	1 (25)	-
BS 10												
Table A	4 (102)	2 7/8 (73)	4	1/2 (13)	9/16 (14)	-	-	-	1/2 (13)	1/4 (6)	-	-
Table D	4 (102)	2 7/8 (73)	4	1/2 (13)	9/16 (14)	-	-	-	1/2 (13)	1/4 (6)	3/8 (10)	-
Table E	4 (102)	2 7/8 (73)	4	1/2 (13)	9/16 (14)	-	-	-	1/2 (13)	1/4 (6)	3/8 (10)	-
Table F	4 (102)	2 7/8 (73)	4	1/2 (13)	9/16 (14)	-	-	-	1/2 (13)	5/16 (8)	3/8 (10)	-
Table H	4 1/2 (114)	3 1/4 (83)	4	5/8 (16)	11/16 (17)	-	2 1/4 (57)	1/16 (2)	5/8 (16)	3/8 (10)	1/2 (13)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2
(2) Flange thicknesses for copper alloy are from BS4504
(3) Copper alloy flanges are always flat-faced

Nominal Size 25mm (1in)

BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes	Diameter of raised face(3) iron	Diameter of raised face(3) steel	Height of raised face(3) iron	Height of raised face(3) steel	Thickness of flange			
										Grey cast iron	Copper alloy	Cast and forged steel	Ductile cast iron
PN 6	100	75	4	M10	11	58	60	3	2	14 (1)	-	14	-
PN 10	115	85	4	M12	14	65	68	3	2	16 (1)	-	18	16
PN 16	115	85	4	M12	14	65	68	3	2	16 (1)	8 (2)	18	16
PN 25	115	85	4	M12	14	65	68	3	2	18 (1)	9 (2)	18	16
PN 40	115	85	4	M12	14	65	68	3	2	-	11 (2)	18	18
PN 64	140	100	4	M16	18	-	68	-	2	-	-	24	-
PN 100	140	100	4	M16	18	-	68	-	2	-	-	24	-
ANSI													
Class 125/150	$4\frac{1}{4}$ (114)	$3\frac{1}{8}$ (79)	4	$\frac{1}{2}$ (13)	$\frac{5}{8}$ (16)	-	2 (51)	-	$\frac{1}{16}$ (2)	$\frac{7}{16}$ (11)	$\frac{3}{8}$ (10)	$\frac{7}{16}$ (11)	$\frac{9}{10}$ (14)
Class 300	$4\frac{7}{8}$ (124)	$3\frac{1}{2}$ (89)	4	$\frac{5}{8}$ (16)	$\frac{3}{4}$ (19)	-	2 (51)	-	$\frac{1}{16}$ (2)	-	$\frac{19}{32}$ (15)	$\frac{11}{16}$ (17)	-
Class 600	$4\frac{7}{8}$ (124)	$3\frac{1}{2}$ (89)	4	$\frac{5}{8}$ (16)	$\frac{3}{4}$ (19)	-	2 (51)	-	$\frac{1}{4}$ (6)	-	-	$\frac{11}{16}$ (17)	
Class 900	$5\frac{7}{8}$ (149)	4 (102)	4	$\frac{7}{8}$ (22)	1 (25)	-	2 (51)	-	$\frac{1}{4}$ (6)	-	-	$1\frac{1}{8}$ (29)	-
Class 1500	$5\frac{7}{8}$ (149)	4 (102)	4	$\frac{7}{8}$ (22)	1 (25)	-	2 (51)	-	$\frac{1}{4}$ (6)	-	-	$1\frac{1}{8}$ (29)	-
BS 10													
Table A	$4\frac{1}{2}$ (114)	$3\frac{1}{4}$ (83)	4	$\frac{1}{2}$ (13)	$\frac{9}{16}$ (14)	-	-	-	-	$\frac{1}{2}$ (13)	$\frac{5}{16}$ (8)	-	-
Table D	$4\frac{1}{2}$ (114)	$3\frac{1}{4}$ (83)	4	$\frac{1}{2}$ (13)	$\frac{9}{16}$ (14)	-	-	-	-	$\frac{1}{2}$ (13)	$\frac{5}{16}$ (8)	$\frac{3}{8}$ (10)	-
Table E	$4\frac{1}{2}$ (114)	$3\frac{1}{4}$ (83)	4	$\frac{1}{2}$ (13)	$\frac{9}{16}$ (14)	-	-	-	-	$\frac{1}{2}$ (13)	$\frac{5}{16}$ (8)	$\frac{3}{8}$ (10)	-
Table F	$4\frac{3}{4}$ (121)	$3\frac{7}{16}$ (87)	4	$\frac{5}{8}$ (16)	$\frac{11}{16}$ (17)	-	-	-	-	$\frac{1}{2}$ (13)	$\frac{3}{8}$ (10)	$\frac{3}{8}$ (10)	-
Table H	$4\frac{3}{4}$ (121)	$3\frac{7}{16}$ (87)	4	$\frac{5}{8}$ (16)	$\frac{11}{16}$ (17)	-	$2\frac{1}{2}$ (64)	-	$\frac{1}{16}$ (2)	$\frac{3}{4}$ (19)	$\frac{7}{16}$ (11)	$\frac{9}{16}$ (14)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2
(2) Flange thicknesses for copper alloy are from BS4504
(3) Copper alloy flanges are always flat-faced

Nominal Size 32mm ($1\frac{1}{4}$in)

BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes iron	Diameter of holes steel	Diameter of raised face(3) iron	Diameter of raised face(3) steel	Height of raised face(3) iron	Height of raised face(3) steel	Thickness of flange: Grey cast iron	Thickness of flange: Copper alloy	Thickness of flange: Cast and forged steel	Thickness of flange: Ductile cast iron
PN 6	120	90	4	M12	14	14	69	70	3	2	16 (1)	-	14	-
PN 10	140	100	4	M16	19	18	76	78	3	2	18 (1)	-	18	18
PN 16	140	100	4	M16	19	18	76	78	3	2	18 (1)	8 (2)	18	18
PN 25	140	100	4	M16	19	18	76	78	3	2	20 (1)	9 (2)	18	18
PN 40	140	100	4	M16	19	18	76	78	3	2	-	11 (2)	18	20
PN 64	155	110	4	M20	-	22	-	78	-	2	-	-	26	-
PN 100	155	110	4	M20	-	22	-	78	-	2	-	-	26	-
ANSI														
Class 125/150	$4\frac{5}{8}$ (117)	$3\frac{1}{2}$ (89)	4	$\frac{1}{2}$ (13)	$\frac{5}{8}$ (16)	$\frac{5}{8}$ (16)	-	$2\frac{1}{2}$ (64)	-	$\frac{1}{16}$ (2)	$\frac{1}{2}$ (13)	$\frac{13}{32}$ (10)	$\frac{1}{2}$ (13)	$\frac{5}{8}$ (16)
Class 300	$5\frac{1}{4}$ (133)	$3\frac{7}{8}$ (98)	4	$\frac{5}{8}$ (16)	-	$\frac{3}{4}$ (19)	-	$2\frac{1}{2}$ (64)	-	$\frac{1}{16}$ (2)	-	$\frac{5}{8}$ (16)	$\frac{3}{4}$ (19)	-
Class 600	$5\frac{1}{4}$ (133)	$3\frac{7}{8}$ (98)	4	$\frac{5}{8}$ (16)	-	$\frac{3}{4}$ (19)	-	$2\frac{1}{2}$ (64)	-	$\frac{1}{4}$ (6)	-	-	$\frac{13}{16}$ (21)	-
Class 900	$6\frac{1}{4}$ (159)	$4\frac{3}{8}$ (111)	4	$\frac{7}{8}$ (22)	-	1 (25)	-	$2\frac{1}{2}$ (64)	-	$\frac{1}{4}$ (6)	-	-	$1\frac{1}{8}$ (29)	-
Class 1500	$6\frac{1}{4}$ (159)	$4\frac{3}{8}$ (111)	4	$\frac{7}{8}$ (22)	-	1 (25)	-	$2\frac{1}{2}$ (64)	-	$\frac{1}{4}$ (6)	-	-	$1\frac{1}{8}$ (29)	-
BS 10														
Table A	$4\frac{3}{4}$ (121)	$3\frac{7}{16}$ (87)	4	$\frac{1}{2}$ (13)	$\frac{9}{16}$ (14)	$\frac{9}{16}$ (14)	-	-	-	-	$\frac{5}{8}$ (16)	$\frac{5}{16}$ (8)	-	-
Table D	$4\frac{3}{4}$ (121)	$3\frac{7}{16}$ (87)	4	$\frac{1}{2}$ (13)	$\frac{9}{16}$ (14)	$\frac{9}{16}$ (14)	-	-	-	-	$\frac{5}{8}$ (16)	$\frac{5}{16}$ (8)	$\frac{1}{2}$ (13)	-
Table E	$4\frac{3}{4}$ (121)	$3\frac{7}{16}$ (87)	4	$\frac{1}{2}$ (13)	$\frac{9}{16}$ (14)	$\frac{9}{16}$ (14)	-	-	-	-	$\frac{5}{8}$ (16)	$\frac{5}{16}$ (8)	$\frac{1}{2}$ (13)	-
Table F	$5\frac{1}{4}$ (133)	$3\frac{7}{8}$ (98)	4	$\frac{5}{8}$ (16)	$\frac{11}{16}$ (17)	$\frac{11}{16}$ (17)	-	-	-	-	$\frac{5}{8}$ (16)	$\frac{3}{8}$ (10)	$\frac{1}{2}$ (13)	-
Table H	$5\frac{1}{4}$ (133)	$3\frac{7}{8}$ (98)	4	$\frac{5}{8}$ (16)	$\frac{11}{16}$ (17)	$\frac{11}{16}$ (17)	-	3 (76)	-	$\frac{1}{16}$ (2)	$\frac{7}{8}$ (22)	$\frac{7}{16}$ (11)	$\frac{11}{16}$ (17)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2
(2) Flange thicknesses for copper alloy are from BS4504
(3) Copper alloy flanges are always flat-faced

Nominal Size 40mm (1 1/2in)

BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes iron	Diameter of holes steel	Diameter of raised face(3) iron	Diameter of raised face(3) steel	Height of raised face(3) iron	Height of raised face(3) steel	Thickness of flange: Grey cast iron	Thickness of flange: Copper alloy	Thickness of flange: Cast and forged steel	Thickness of flange: Ductile cast iron
PN 6	130	100	4	M12	14	14	78	80	3	2	16 (1)	-	14	-
PN 10	150	110	4	M16	19	18	84	88	3	2	18 (1)	-	18	19
PN 16	150	110	4	M16	19	18	84	88	3	2	18 (1)	9 (2)	18	19
PN 25	150	110	4	M16	19	18	84	88	3	2	20 (1)	11 (2)	18	19
PN 40	150	110	4	M16	19	18	84	88	3	2	-	13 (2)	18	19
PN 64	170	125	4	M20	-	22	-	88	-	2	-	-	28	-
PN 100	170	125	4	M20	-	22	-	88	-	2	-	-	28	-
ANSI														
Class 125/150	5 (127)	3 7/8 (98)	4	1/2 (13)	5/8 (16)	5/8 (16)	-	2 7/8 (73)	-	1/16 (2)	9/16 (14)	7/16 (11)	9/16 (14)	11/16 (17)
Class 300	6 1/8 (156)	4 1/2 (114)	4	3/4 (19)	-	7/8 (22)	-	2 7/8 (73)	-	1/16 (2)	-	11/16 (17)	13/16 (21)	-
Class 600	6 1/8 (156)	4 1/2 (114)	4	3/4 (19)	-	7/8 (22)	-	2 7/8 (73)	-	1/4 (6)	-	-	7/8 (22)	-
Class 900	7 (178)	4 7/8 (124)	4	1 (25)	-	1 1/8 (29)	-	2 7/8 (73)	-	1/4 (6)	-	-	1 1/4 (32)	-
Class 1500	7 (178)	4 7/8 (124)	4	1 (25)	-	1 1/8 (29)	-	2 7/8 (73)	-	1/4 (6)	-	-	1 1/4 (32)	-
BS 10														
Table A	5 1/4 (133)	3 7/8 (98)	4	1/2 (13)	9/16 (14)	9/16 (14)	-	-	-	-	5/8 (16)	3/8 (10)	-	-
Table D	5 1/4 (133)	3 7/8 (98)	4	1/2 (13)	9/16 (14)	9/16 (14)	-	-	-	-	5/8 (16)	3/8 (10)	1/2 (13)	-
Table E	5 1/4 (133)	3 7/8 (98)	4	1/2 (13)	9/16 (14)	9/16 (14)	-	-	-	-	5/8 (16)	3/8 (10)	1/2 (13)	-
Table F	5 1/2 (140)	4 1/8 (105)	4	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	5/8 (16)	7/16 (11)	1/2 (13)	-
Table H	5 1/2 (140)	4 1/8 (105)	4	5/8 (16)	11/16 (17)	11/16 (17)	-	3 1/4 (83)	-	1/16 (2)	7/8 (22)	1/2 (13)	11/16 (17)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2
(2) Flange thicknesses for copper alloy are from BS4504
(3) Copper alloy flanges are always flat-faced

Nominal Size 50mm (2in)

BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes iron	Diameter of holes steel	Diameter of raised face(3) iron	Diameter of raised face(3) steel	Height of raised face(3) iron	Height of raised face(3) steel	Thickness of flange: Grey cast iron	Thickness of flange: Copper alloy	Thickness of flange: Cast and forged steel	Thickness of flange: Ductile cast iron
PN 6	140	110	4	M12	14	14	88	90	3	2	16 (1)	-	14	-
PN 10	165	125	4	M16	19	18	99	102	3	2	20 (1)	-	18	19
PN 16	165	125	4	M16	19	18	99	102	3	2	20 (1)	11 (2)	18	19
PN 25	165	125	4	M16	19	18	99	102	3	2	22 (1)	11 (2)	20	19
PN 40	165	125	4	M16	19	18	99	102	3	2	-	13 (2)	20	19
PN 64	180	135	4	M20	-	22	-	102	-	2	-	-	26	-
PN 100	195	145	4	M24	-	26	-	102	-	2	-	-	30	-
ANSI														
Class 125/150	6 (152)	4 3/4 (121)	4	5/8 (16)	3/4 (19)	3/4 (19)	-	3 5/8 (92)	-	1/16 (2)	5/8 (16)	1/2 (13)	5/8 (16)	-
Class 300	6 1/2 (165)	5 (127)	8	5/8 (16)	-	3/4 (19)	-	3 5/8 (92)	-	1/16 (2)	-	3/4 (19)	7/8 (22)	-
Class 600	6 1/2 (165)	5 (127)	8	5/8 (16)	-	3/4 (19)	-	3 5/8 (92)	-	1/4 (6)	-	-	1 (25)	-
Class 900	8 1/2 (216)	6 1/2 (165)	8	7/8 (22)	-	1 (25)	-	3 5/8 (92)	-	1/4 (6)	-	-	1 1/2 (38)	-
Class 1500	8 1/2 (216)	6 1/2 (165)	8	7/8 (22)	-	1 (25)	-	3 5/8 (92)	-	1/4 (6)	-	-	1 1/2 (38)	-
BS 10														
Table A	6 (152)	4 1/2 (114)	4	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	5/8 (16)	3/8 (10)	-	-
Table D	6 (152)	4 1/2 (114)	4	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	11/16 (17)	3/8 (10)	9/16 (14)	-
Table E	6 (152)	4 1/2 (114)	4	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	3/4 (19)	3/8 (10)	9/16 (14)	-
Table F	6 1/2 (165)	5 (127)	4	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	3/4 (19)	7/16 (11)	5/8 (16)	-
Table H	6 1/2 (165)	5 (127)	4	5/8 (16)	11/16 (17)	11/16 (17)	-	4 (102)	-	1/16 (2)	1 (25)	1/2 (13)	3/4 (19)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2
(2) Flange thicknesses for copper alloy are from BS4504
(3) Copper alloy flanges are always flat-faced

Nominal Size 65mm (2 1/2in)

BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes iron	Diameter of holes steel	Diameter of raised face(4) iron	Diameter of raised face(4) steel	Height of raised face(4) iron	Height of raised face(4) steel	Thickness of flange: Grey cast iron	Thickness of flange: Copper alloy(3)	Thickness of flange: Cast and forged steel	Thickness of flange: Ductile cast iron
PN 6	160	130	4	M12	14	14	108	110	2	3	16 (1)	-	14	-
PN 10	185	145	4 (2)	M16	19	18	118	122	2	3	20 (1)	-	18	19
PN 16	185	145	4 (2)	M16	19	18	118	122	2	3	20 (1)	13	18	19
PN 25	185	145	8	M16	19	18	118	122	2	3	24 (1)	13	22	19
PN 40	185	145	8	M16	19	18	118	122	2	3	-	14	22	19
PN 64	205	160	8	M20	-	22	-	122	2	-	-	-	26	-
PN 100	220	170	8	M24	-	26	-	122	2	-	-	-	34	-
ANSI														
Class 125/150	7 (178)	5 1/2 (140)	4	5/8 (16)	3/4 (19)	3/4 (19)	-	4 1/8 (105)	-	1/16 (2)	11/16 (17)	9/16 (14)	11/16 (17)	-
Class 300	7 1/2 (191)	5 7/8 (149)	8	3/4 (19)	-	7/8 (22)	-	4 1/8 (105)	-	1/16 (2)	-	13/16 (21)	1 (25)	-
Class 600	7 1/2 (191)	5 7/8 (149)	8	3/4 (19)	-	7/8 (22)	-	4 1/8 (105)	-	1/4 (6)	-	-	1 1/8 (29)	-
Class 900	9 5/8 (244)	7 1/2 (191)	8	1 (25)	-	1 1/8 (29)	-	4 1/8 (105)	-	1/4 (6)	-	-	1 5/8 (41)	-
Class 1500	9 5/8 (244)	7 1/2 (191)	8	1 (25)	-	1 1/8 (29)	-	4 1/8 (105)	-	1/4 (6)	-	-	1 5/8 (41)	-
BS 10														
Table A	6 1/2 (165)	5 (127)	4	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	11/16 (17)	7/16 (11)	-	-
Table D	6 1/2 (165)	5 (127)	4	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	11/16 (17)	7/16 (11)	9/16 (14)	-
Table E	6 1/2 (165)	5 (127)	4	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	3/4 (19)	7/16 (11)	9/16 (14)	-
Table F	7 1/4 (184)	5 3/4 (146)	8	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	3/4 (19)	1/2 (13)	5/8 (16)	-
Table H	7 1/4 (184)	5 3/4 (146)	8	5/8 (16)	11/16 (17)	11/16 (17)	-	4 1/2 (114)	-	1/16 (2)	1 (25)	9/16 (14)	3/4 (19)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2
(2) Steel flanges in this DN and PN may be supplied with 8 holes. For compliance with these, equivalent cast iron flanges may be supplied with 8 holes as special order and after agreement between manufacturer and customer
(2) Flange thicknesses for copper alloy are from BS4504
(3) Copper alloy flanges are always flat-faced

Nominal Size 80mm (3in)

BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes iron	Diameter of holes steel	Diameter of raised face(3) iron	Diameter of raised face(3) steel	Height of raised face(3) iron	Height of raised face(3) steel	Thickness of flange: Grey cast iron	Thickness of flange: Copper alloy	Thickness of flange: Cast and forged steel	Thickness of flange: Ductile cast iron
PN 6	190	150	4	M16	19	18	124	128	3	2	18 (1)	-	16	-
PN 10	200	160	8	M16	19	18	132	138	3	2	22 (1)	-	20	19
PN 16	200	160	8	M16	19	18	132	138	3	2	22 (1)	13 (2)	20	19
PN 25	200	160	8	M16	19	18	132	138	3	2	26 (1)	14 (2)	24	19
PN 40	200	160	8	M16	19	18	132	138	3	2	-	16 (2)	24	19
PN 64	215	170	8	M20	-	22	-	138	-	2	-	-	28	-
PN100	230	180	8	M24	-	26	-	138	-	2	-	-	36	-
ANSI														
Class 125/150	7 1/2 (191)	6 (152)	4	5/8 (16)	3/4 (19)	3/4 (19)	-	5 (127)	-	1/16 (2)	3/4 (19)	5/8 (16)	3/4 (19)	-
Class 300	8 1/4 (210)	6 5/8 (168)	8	3/4 (19)	-	7/8 (22)	-	5 (127)	-	1/16 (2)	-	29/32 (23)	1 1/8 (29)	-
Class 600	8 1/4 (210)	6 5/8 (168)	8	3/4 (19)	-	7/8 (22)	-	5 (127)	-	1/4 (6)	-	-	1 1/4 (32)	-
Class 900	9 1/2 (241)	7 1/2 (192)	8	7/8 (22)	-	1 (25)	-	5 (127)	-	1/4 (6)	-	-	1 1/2 (38)	-
Class 1500	10 1/2 (267)	8 (203)	8	1 1/8 (29)	-	1 1/4 (32)	-	5 (127)	-	1/4 (6)	-	-	1 7/8 (48)	-
BS 10														
Table A	7 1/4 (184)	5 3/4 (146)	4	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	11/16 (17)	1/2 (13)	-	-
Table D	7 1/4 (184)	5 3/4 (146)	4	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	3/4 (19)	1/2 (13)	9/16 (14)	-
Table E	7 1/4 (184)	5 3/4 (146)	4	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	3/4 (19)	1/2 (13)	9/16 (14)	-
Table F	8 (203)	6 1/2 (165)	8	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	3/4 (19)	9/16 (14)	5/8 (16)	-
Table H	8 (203)	6 1/2 (165)	8	5/8 (16)	11/16 (17)	11/16 (17)	-	5 (127)	-	1/16 (2)	1 1/8 (29)	5/8 (16)	7/8 (22)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2
(2) Flange thicknesses for copper alloy are from BS4504
(3) Copper alloy flanges are always flat-faced

Nominal Size 100mm (4in)

BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes iron	Diameter of holes steel	Diameter of raised face(3) iron	Diameter of raised face(3) steel	Height of raised face(3) iron	Height of raised face(3) steel	Thickness of flange			
											Grey cast iron	Copper alloy	Cast and forged steel	Ductile cast iron
PN 6	210	170	4	M16	19	18	144	148	3	2	18 (1)	-	16	-
PN 10	220	180	8	M16	19	18	156	158	3	2	24 (1)	-	20	19
PN16	220	180	8	M16	19	18	156	158	3	2	24 (1)	16 (2)	20	19
PN 25	235	190	8	M20	23	22	156	162	3	2	28 (1)	17 (2)	24	19
PN 40	235	190	8	M20	23	22	156	162	3	2	-	19 (2)	24	19
PN 64	250	200	8	M24	-	26	-	162	-	2	-	-	30	-
PN 100	265	210	8	M27	-	30	-	162	-	2	-	-	40	-
ANSI														
Class 125/150	9 (229)	7 1/2 (191)	8	5/8 (16)	3/4 (19)	3/4 (19)	-	6 3/16 (157)	-	1/16 (2)	15/16 (24)	11/16 (17)	15/16 (24)	-
Class 300	10 (254)	7 7/8 (200)	8	3/4 (19)	-	7/8 (22)	-	6 3/16 (157)	-	1/16 (2)	-	1 1/16 (27)	1 1/4 (32)	-
Class 600	10 3/4 (273)	8 1/2 (216)	8	7/8 (22)	-	1 (25)	-	6 3/16 (157)	-	1/4 (6)	-	-	1 1/2 (38)	-
Class 900	11 1/2 (292)	9 1/4 (235)	8	1 1/8 (29)	-	1 1/4 (32)	-	6 3/16 (157)	-	1/4 (6)	-	-	1 3/4 (44)	-
Class 1500	12 1/4 (311)	9 1/2 (241)	8	1 1/4 (32)	-	1 3/8 (35)	-	6 3/16 (157)	-	1/4 (6)	-	-	2 1/8 (54)	-
BS 10														
Table A	8 1/2 (216)	7 (178)	4	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	3/4 (19)	5/8 (16)	-	-
Table D	8 1/2 (216)	7 (178)	4	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	3/4 (19)	5/8 (16)	11/16 (17)	-
Table E	8 1/2 (216)	7 (178)	8	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	7/8 (22)	5/8 (16)	11/16 (17)	-
Table F	9 (229)	7 1/2 (191)	8	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	7/8 (22)	11/16 (17)	3/4 (19)	-
Table H	9 (229)	7 1/2 (191)	8	5/8 (16)	11/16 (17)	11/16 (17)	-	6 (152)	-	1/16 (2)	1 1/4 (32)	3/4 (19)	1 (25)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2
(2) Flange thicknesses for copper alloy are from BS4504
(3) Copper alloy flanges are always flat-faced

Nominal Size 125mm (5in)

BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes iron	Diameter of holes steel	Diameter of raised face(2) iron	Diameter of raised face(2) steel	Height of raised face(2) iron	Height of raised face(2) steel	Thickness of flange: Grey cast iron	Thickness of flange: Copper alloy	Thickness of flange: Cast and forged steel	Thickness of flange: Ductile cast iron
PN 6	240	200	8	M16	19	18	174	178	3	2	20 (1)	-	18	-
PN 10	250	210	8	M16	19	18	184	188	3	2	26 (1)	-	22	19
PN 16	250	210	8	M16	19	18	184	188	3	2	26 (1)	-	22	19
PN 25	270	220	8	M24	28	26	184	188	3	2	30 (1)	-	26	19
PN 40	270	220	8	M24	28	26	184	188	3	2	-	-	26	23.5
PN 64	295	240	8	M27	-	30	-	188	-	2	-	-	34	-
PN 100	315	250	8	M30	-	33	-	188	-	2	-	-	40	-
ANSI														
Class 125/150	10 (254)	8 1/2 (216)	8	3/4 (19)	7/8 (22)	7/8 (22)	-	7 5/16 (186)	-	1/16 (2)	15/16 (24)	3/4 (19)	15/16 (24)	-
Class 300	11 (279)	9 1/4 (235)	8	3/4 (19)	-	7/8(22)	-	7 5/16 (186)	-	1/16 (2)	-	1 1/8 (29)	1 3/8 (35)	-
Class 600	13 (330)	10 1/2 (267)	8	1 (25)	-	1 1/8 (29)	-	7 5/16 (186)	-	1/4 (6)	-	-	1 3/4 (44)	-
Class 900	13 3/4 (349)	11 (279)	8	1 1/4 (32)	-	1 3/8 (35)	-	7 5/16 (186)	-	1/4 (6)	-	-	2 (51)	-
Class 1500	14 3/4 (375)	11 1/2 (292)	8	1 1/2 (38)	-	1 5/8 (41)	-	7 5/16 (186)	-	1/4 (6)	-	-	2 7/8 (73)	-
BS 10														
Table A	10 (254)	8 1/4 (210)	4	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	3/4 (19)	11/16 (17)	-	-
Table D	10 (254)	8 1/4 (210)	8	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	13/16 (21)	11/16 (17)	11/16 (17)	-
Table E	10 (254)	8 1/4 (210)	8	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	7/8 (22)	11/16 (17)	11/16 (17)	-
Table F	11 (279)	9 1/4 (235)	8	3/4 (19)	7/8 (22)	7/8 (22)	-	-	-	-	1 (25)	3/4 (19)	7/8 (22)	-
Table H	11 (279)	9 1/4 (235)	8	3/4 (19)	7/8 (22)	7/8 (22)	-	7 (178)	-	1/16 (2)	1 3/8 (35)	7/8 (22)	1 1/8 (29)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2
(2) Copper alloy flanges are always flat-faced

Nominal Size 150mm (6in)

BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes iron	Diameter of holes steel	Diameter of raised face(2) iron	Diameter of raised face(2) steel	Height of raised face(2) iron	Height of raised face(2) face	Thickness of flange: Grey cast iron	Copper alloy	Cast and forged steel	Ductile cast iron
PN 6	265	225	8	M16	19	18	199	202	3	2	20 (1)	-	18	-
PN 10	285	240	8	M20	23	22	211	212	3	2	26 (1)	-	22	19
PN 16	285	240	8	M20	23	22	211	212	3	2	26 (1)	-	22	19
PN 25	300	250	8	M24	28	26	211	218	3	2	34 (1)	-	28	20
PN 40	300	250	8	M24	28	26	211	218	3	2	-	-	28	26
PN 64	345	280	8	M30	-	33	-	218	-	2	-	-	36	-
PN 100	355	290	12	M30	-	33	-	218	-	2	-	-	44	-
ANSI														
Class 125/150	11 (279)	$9\frac{1}{2}$ (241)	8	$\frac{3}{4}$ (19)	$\frac{7}{8}$ (22)	$\frac{7}{8}$ (22)	-	$8\frac{1}{2}$ (216)	-	$\frac{1}{16}$ (2)	1 (25)	$\frac{13}{16}$ (21)	1 (25)	-
Class 300	$12\frac{1}{2}$ (318)	$10\frac{5}{8}$ (270)	12	$\frac{3}{4}$ (19)	-	$\frac{7}{8}$ (22)	-	$8\frac{1}{2}$ (216)	-	$\frac{1}{16}$ (2)	-	$1\frac{3}{16}$ (30)	$1\frac{7}{16}$ (37)	-
Class 600	14 (356)	$11\frac{1}{2}$ (292)	12	1 (25)	-	$1\frac{1}{8}$ (29)	-	$8\frac{1}{2}$ (216)	-	$\frac{1}{4}$ (6)	-	-	$1\frac{7}{8}$ (48)	-
Class 900	15 (381)	$12\frac{1}{2}$ (318)	12	$1\frac{1}{8}$ (29)	-	$1\frac{1}{4}$ (32)	-	$8\frac{1}{2}$ (216)	-	$\frac{1}{4}$ (6)	-	-	$2\frac{3}{16}$ (56)	-
Class 1500	$15\frac{1}{2}$ (394)	$12\frac{1}{2}$ (318)	12	$1\frac{3}{8}$ (35)	-	$1\frac{1}{2}$ (38)	-	$8\frac{1}{2}$ (216)	-	$\frac{1}{4}$ (6)	-	-	$3\frac{1}{4}$ (83)	-
BS 10														
Table A	11 (279)	$9\frac{1}{4}$ (235)	4	$\frac{5}{8}$ (16)	$\frac{11}{16}$ (17)	$\frac{11}{16}$ (17)	-	-	-	-	$\frac{13}{16}$ (21)	$\frac{11}{16}$ (17)	-	-
Table D	11 (279)	$9\frac{1}{4}$ (235)	8	$\frac{5}{8}$ (16)	$\frac{11}{16}$ (17)	$\frac{11}{16}$ (17)	-	-	-	-	$\frac{13}{16}$ (21)	$\frac{11}{16}$ (17)	$\frac{11}{16}$ (17)	-
Table E	11 (279)	$9\frac{1}{4}$ (235)	8	$\frac{3}{4}$ (19)	$\frac{7}{8}$ (22)	$\frac{7}{8}$ (22)	-	-	-	-	$\frac{7}{8}$ (22)	$\frac{11}{16}$ (17)	$\frac{11}{16}$ (17)	-
Table F	12 (305)	$10\frac{1}{4}$ (260)	12	$\frac{3}{4}$ (19)	$\frac{7}{8}$ (22)	$\frac{7}{8}$ (22)	-	-	-	-	1 (25)	$\frac{7}{8}$ (22)	$\frac{7}{8}$ (22)	-
Table H	12 (305)	$10\frac{1}{4}$ (260)	12	$\frac{3}{4}$ (19)	$\frac{7}{8}$ (22)	$\frac{7}{8}$ (22)	-	$8\frac{1}{4}$ (210)	-	$\frac{1}{16}$ (2)	$1\frac{3}{8}$ (35)	1 (25)	$1\frac{1}{8}$ (29)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2

(2) Copper alloy flanges are always flat-faced

Nominal Size 200 mm (8 in)

BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes iron	Diameter of holes steel	Diameter of raised face(2) iron	Diameter of raised face(2) steel	Height of raised face(2) iron	Height of raised face(2) steel	Thickness of flange: Grey cast iron	Thickness of flange: Copper alloy	Thickness of flange: Cast and forged steel	Thickness of flange: Ductile cast iron
PN 6	320	280	8	M16	19	18	254	258	3	2	22 (1)	-	20	-
PN 10	340	295	8	M20	23	22	266	268	3	2	26 (1)	-	24	20
PN 16	340	295	12	M20	23	22	266	268	3	2	30 (1)	-	24	20
PN 25	360	310	12	M24	28	26	274	278	3	2	34 (1)	-	30	22
PN 40	375	320	12	M27	31	30	284	285	3	2	-	-	34	30
PN 64	415	345	12	M33	-	36	-	285	-	2	-	-	42	-
PN 100	430	360	12	M33	-	36	-	285	-	2	-	-	52	-
ANSI														
Class 125/150	13 1/2 (343)	11 3/4 (298)	8	3/4 (19)	7/8 (22)	7/8 (22)	-	10 5/8 (270)	-	1/16 (2)	1 1/8 (29)	15/16 (24)	1 1/8(29)	-
Class 300	15 (381)	13 (330)	12	7/8 (22)	-	1 (25)	-	10 5/8 (270)	-	1/16 (2)	-	1 3/8 (35)	1 5/8 (41)	-
Class 600	16 1/2 (419)	13 3/4 (349)	12	1 1/8 (29)	-	1 1/4 (32)	-	10 5/8 (270)	-	1/4 (6)	-	-	2 3/16 (56)	-
Class 900	18 1/2 (470)	15 1/2 (394)	12	1 3/8 (35)	-	1 1/2 (38)	-	10 5/8 (270)	-	1/4 (6)	-	-	2 1/2 (64)	-
Class 1500	19 (438)	15 1/2 (394)	12	1 5/8 (41)	-	1 3/4 (44)	-	10 5/8 (270)	-	1/4 (6)	-	-	3 5/8 (92)	-
BS 10														
Table A	13 1/4 (337)	11 1/2 (292)	8	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	7/8 (22)	3/4 (19)	1/2 (13)	-
Table D	13 1/4 (337)	11 1/2 (292)	8	5/8 (16)	11/16 (17)	11/16 (17)	-	-	-	-	7/8 (22)	3/4 (19)	3/4 (19)	-
Table E	13 1/4 (337)	11 1/2 (292)	8	3/4 (19)	7/8 (22)	7/8 (22)	-	-	-	-	1 (25)	3/4 (19)	3/4 (19)	-
Table F	14 1/2 (368)	12 3/4 (324)	12	3/4 (19)	7/8 (22)	7/8 (22)	-	-	-	-	1 1/8 (29)	1 (25)	1 (25)	-
Table H	14 1/2 (368)	12 3/4 (324)	12	3/4 (19)	7/8 (22)	7/8 (22)	-	10 1/4 (260)	-	1/16 (2)	1 1/2 (38)	1 1/4 (32)	1 1/4 (32)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2

(2) Copper alloy flanges are always flat-faced

Nominal Size 250 mm (10 in)

BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes iron	Diameter of holes steel	Diameter of raised face(3) iron	Diameter of raised face(3) steel	Height of raised face(3) iron	Height of raised face(3) steel	Thickness of flange: Grey cast iron	Copper alloy	Cast and forged steel	Ductile cast iron
PN 6	375	335	12	M16	19	18	309	312	3	2	24 (1)	-	22	-
PN 10	395 (2)	350	12	M20	23	22	319	320	3	2	28 (1)	-	26	22
PN 16	405 (2)	355	12	M24	28	26	319	320	3	2	32 (1)	-	26	22
PN 25	425	370	12	M27	31	30	330	335	3	2	-	-	32	24.5
PN 40	450	385	12	M30	34	33	345	345	3	2	-	-	38	34.5
PN 64	470	400	12	M33	-	36	-	345	-	2	-	-	46	-
PN 100	505	430	12	M36	-	39	-	345	-	2	-	-	60	-
ANSI														
Class 125/150	16 (406)	$14\frac{1}{4}$ (362)	12	$\frac{7}{8}$ (22)	1 (25)	1 (25)	-	$12\frac{3}{4}$ (324)	-	$\frac{1}{16}$ (2)	$\frac{13}{16}$ (30)	1 (25)	$\frac{13}{16}$ (30)	-
Class 300	$17\frac{1}{2}$ (445)	$15\frac{1}{4}$ (387)	16	1 (25)	-	$1\frac{1}{8}$ (29)	-	$12\frac{3}{4}$ (324)	-	$\frac{1}{16}$ (2)	-	-	$1\frac{7}{8}$ (41)	-
Class 600	20 (508)	17 (432)	16	$1\frac{1}{4}$ (32)	-	$1\frac{3}{8}$ (35)	-	$12\frac{3}{4}$ (324)	-	$\frac{1}{4}$ (6)	-	-	$2\frac{1}{2}$ (64)	-
Class 900	$21\frac{1}{2}$ (546)	$18\frac{1}{2}$ (470)	16	$1\frac{3}{8}$ (35)	-	$1\frac{1}{2}$ (38)	-	$12\frac{3}{4}$ (324)	-	$\frac{1}{4}$ (6)	-	-	$2\frac{3}{4}$ (70)	-
Class 1500	23 (584)	19 (483)	12	$1\frac{7}{8}$ (41)	-	2 (51)	-	$12\frac{3}{4}$ (324)	-	$\frac{1}{4}$ (6)	-	-	$4\frac{1}{4}$ (108)	-
BS 10														
Table A	16 (406)	14 (356)	8	$\frac{3}{4}$ (19)	$\frac{7}{8}$ (22)	$\frac{7}{8}$ (22)	-	-	-	-	$\frac{15}{16}$ (24)	$\frac{3}{4}$ (19)	-	-
Table D	16 (406)	14 (356)	8	$\frac{3}{4}$ (19)	$\frac{7}{8}$ (22)	$\frac{7}{8}$ (22)	-	-	-	-	1 (25)	$\frac{3}{4}$ (19)	$\frac{3}{4}$ (19)	-
Table E	16 (406)	14 (356)	12	$\frac{3}{4}$ (19)	$\frac{7}{8}$ (22)	$\frac{7}{8}$ (22)	-	-	-	-	1 (25)	$\frac{7}{8}$ (22)	$\frac{7}{8}$ (22)	-
Table F	17 (432)	15 (381)	12	$\frac{7}{8}$ (22)	1 (25)	1 (25)	-	-	-	-	$1\frac{1}{8}$ (29)	1 (25)	1 (25)	-
Table H	17 (432)	15 (381)	12	$\frac{7}{8}$ (22)	1 (25)	1 (25)	-	$12\frac{1}{4}$ (311)	-	$\frac{1}{16}$ (2)	$1\frac{5}{8}$ (41)	$1\frac{3}{8}$ (35)	$1\frac{3}{8}$ (35)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2
(2) For ductile iron pipes and fittings the outside diameters shall be:
- for PN 10, D = 400 mm
- for PN 16, D = 400mm

(3) Copper alloy flanges are always flat-faced

Nominal Size 300 mm (12 in)

BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes iron	Diameter of holes steel	Diameter of raised face(3) iron	Diameter of raised face(3) steel	Height of raised face(3) iron	Height of raised face(3) steel	Thickness of flange: Grey cast iron	Copper alloy	Cast and forged steel	Ductile cast iron
PN 6	440	395	12	M20	23	22	363	365	4	2	24 (1)	-	22	-
PN 10	445 (2)	400	12	M20	23	22	370	370	4	2	28 (1)	-	26	24.5
PN 16	460 (2)	410	12	M24	28	26	370	378	4	2	32 (1)	-	28	24.5
PN 25	485	430	16	M27	31	30	389	395	4	2	40 (1)	-	34	27.5
PN 40	515	450	16	M30	34	33	409	410	4	2	-	-	42	39.5
PN 64	530	460	16	M33	-	36	-	410	-	2	-	-	52	-
PN 100	585	500	16	M39	-	42	-	410	-	2	-	-	68	-
ANSI														
Class 125/150	19 (483)	17 (432)	12	7/8 (22)	1 (25)	1 (25)	-	15 (381)	-	1/16 (2)	1 1/4 (32)	1 1/16 (27)	1 1/4 (32)	-
Class 300	20 1/2 (521)	17 3/4 (451)	16	1 1/8 (29)	-	1 1/4 (32)	-	15 (381)	-	1/16 (2)	-	-	2 (51)	-
Class 600	22 (559)	19 1/4 (489)	20	1 1/4 (32)	-	1 3/8 (35)	-	15 (381)	-	1/4 (6)	-	-	2 5/8 (67)	-
Class 900	24 (610)	21 (533)	20	1 3/8 (35)	-	1 1/2 (38)	-	15 (381)	-	1/4 (6)	-	-	3 1/8 (80)	-
Class 1500	26 1/2 (673)	22 1/2 (571)	16	2 (51)	-	21/8 (54)	-	15 (381)	-	1/4 (6)	-	-	4 7/8 (124)	-
BS 10														
Table A	18 (457)	16 (406)	8	3/4 (19)	7/8 (22)	7/8 (22)	-	-	-	-	15/16 (24)	7/8 (22)	-	-
Table D	18 (457)	16 (406)	12	3/4 (19)	7/8 (22)	7/8 (22)	-	-	-	-	1 (25)	7/8 (22)	7/8 (22)	-
Table E	18 (457)	16 (406)	12	7/8 (22)	1 (25)	1 (25)	-	-	-	-	1 1/8 (29)	1 (25)	1 (25)	-
Table F	19 1/4 (489)	17 1/4 (438)	16	7/8 (22)	1 (25)	1 (25)	-	-	-	-	1 1/4 (32)	1 1/8 (29)	1 1/8 (29)	-
Table H	19 1/4 (489)	17 1/4 (438)	16	7/8 (22)	1 (25)	1 (25)	-	14 1/4 (362)	-	1/16 (2)	1 3/4 (44)	1 1/2 (38)	1 1/2 (38)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2
(2) For ductile iron pipes and fittings the outside diameter shall be:
- for PN 10, D = 455 mm
- for PN 16, D = 455 mm
(3) Copper alloy flanges are always flat-faced

Nominal Size 350 mm (14 in)

BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes iron	Diameter of holes steel	Diameter of raised face(2) iron	Diameter of raised face(2) steel	Height of raised face(2) iron	Height of raised face(2) steel	Thickness of flange: Grey cast iron	Thickness of flange: Copper alloy	Thickness of flange: Cast and forged steel	Thickness of flange: Ductile cast iron
PN 6	490	445	12	M20	23	22	413	415	4	2	26 (1)	-	22	-
PN 10	505	460	16	M20	23	22	429	430	4	2	30 (1)	-	26	24.5
PN 16	520	470	16	M24	28	26	429	438	4	2	36 (1)	-	30	26.5
PN 25	555	490	16	M30	34	33	448	450	4	2	44 (1)	-	38	30
PN 40	580	510	16	M33	37	36	465	465	4	2	-	-	46	44
PN 64	600	525	16	M36	-	39	-	465	-	2	-	-	56	-
PN 100	655	560	16	M45	-	48	-	465	-	2	-	-	74	-
ANSI														
Class 125/150	21 (533)	$18\frac{3}{4}$ (476)	12	1 (25)	$1\frac{1}{8}$ (29)	$1\frac{1}{8}$ (29)	-	$16\frac{1}{4}$ (413)	-	$\frac{1}{16}$ (2)	$1\frac{3}{8}$ (35)	-	$1\frac{3}{8}$ (35)	-
Class 300	23 (584)	$20\frac{1}{4}$ (514)	20	$1\frac{1}{8}$ (29)	-	$1\frac{1}{4}$ (32)	-	$16\frac{1}{4}$ (413)	-	$\frac{1}{16}$ (2)	-	-	$2\frac{1}{8}$ (54)	-
Class 600	$23\frac{3}{4}$ (603)	$20\frac{3}{4}$ (527)	20	$1\frac{3}{8}$ (35)	-	$1\frac{1}{2}$ (38)	-	$16\frac{1}{4}$ (413)	-	$\frac{1}{4}$ (6)	-	-	$2\frac{3}{4}$ (70)	-
Class 900	$25\frac{1}{4}$ (641)	22 (559)	20	$1\frac{1}{2}$ (38)	-	$1\frac{5}{8}$ (41)	-	$16\frac{1}{4}$ (413)	-	$\frac{1}{4}$ (6)	-	-	$3\frac{3}{8}$ (86)	-
Class 1500	$29\frac{1}{2}$ (749)	25 (635)	16	$2\frac{1}{4}$ (57)	-	$2\frac{3}{8}$ (60)	-	$16\frac{1}{4}$ (413)	-	$\frac{1}{4}$ (6)	-	-	$5\frac{1}{4}$ (133)	-
BS 10														
Table A	$20\frac{3}{4}$ (527)	$18\frac{1}{2}$ (470)	8	$\frac{7}{8}$ (22)	1 (25)	1 (25)	-	-	-	-	1 (25)	1 (25)	-	-
Table D	$20\frac{3}{4}$ (527)	$18\frac{1}{2}$ (470)	12	$\frac{7}{8}$ (22)	1 (25)	1 (25)	-	-	-	-	$1\frac{1}{8}$ (29)	1 (25)	1 (25)	-
Table E	$20\frac{3}{4}$ (527)	$18\frac{1}{2}$ (470)	12	$\frac{7}{8}$ (22)	1 (25)	1 (25)	-	-	-	-	$1\frac{1}{4}$ (32)	1 (25)	1 (25)	-
Table F	$21\frac{3}{4}$ (552)	$19\frac{1}{2}$ (495)	16	1 (25)	$1\frac{1}{8}$ (29)	$1\frac{1}{8}$ (29)	-	-	-	-	$1\frac{3}{8}$ (35)	$1\frac{1}{4}$ (32)	$1\frac{1}{4}$ (32)	-
Table H	$21\frac{3}{4}$ (552)	$19\frac{1}{2}$ (495)	16	1 (25)	$1\frac{1}{8}$ (29)	$1\frac{1}{8}$ (29)	-	$16\frac{1}{2}$ (419)	-	$\frac{1}{16}$ (2)	$1\frac{7}{8}$ (48)	$1\frac{5}{8}$ (41)	$1\frac{5}{8}$ (41)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2

(2) Copper alloy flanges are always flat-faced

Nominal Size 400 mm (16in)

BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes iron	Diameter of holes steel	Diameter of raised face(2) iron	Diameter of raised face(2) steel	Height of raised face(2) iron	Height of raised face(2) steel	Thickness of flange: Grey cast iron	Thickness of flange: Copper alloy	Thickness of flange: Cast and forged steel	Thickness of flange: Ductile cast iron
PN 6	540	495	16	M20	23	22	463	465	4	2	28 (1)	-	22	-
PN 10	565	515	16	M24	28	26	480	482	4	2	32 (1)	-	26	24.5
PN 16	580	525	16	M27	31	30	480	490	4	2	38 (1)	-	32	28
PN25	620	550	16	M33	37	36	503	505	4	2	48 (1)	-	40	32
PN 40	660	585	16	M36	41	39	535	535	4	2	-	-	50	48
PN 64	670	585	16	M39	-	42	-	535	-	2	-	-	60	-
PN 100	715	620	16	M45	-	48	-	535	-	2	-	-	78	-
ANSI														
Class 125/150	23 1/2 (597)	21 1/4 (540)	16	1 (25)	1 1/8 (29)	1 1/8 (29)	-	18 1/2 (470)	-	1/16 (2)	1 7/16 (37)	-	1 7/16 (37)	-
Class 300	25 1/2 (648)	22 1/2 (572)	20	1 1/4 (32)	-	1 3/8 (35)	-	18 1/2 (470)	-	1/16 (2)	-	-	2 1/4 (57)	-
Class 600	27 (686)	23 3/4 (603)	20	1 1/2 (38)	-	1 5/8 (41)	-	18 1/2 (470)	-	1/4 (6)	-	-	3 (76)	-
Class 900	27 3/4 (705)	24 1/4 (616)	20	1 5/8 (41)	-	1 3/4 (44)	-	18 1/2 (470)	-	1/4 (6)	-	-	3 1/2 (89)	-
Class 1500	32 1/2 (826)	27 3/4 (705)	16	2 1/2 (64)	-	2 5/8 (67)	-	18 1/2 (470)	-	1/4 (6)	-	-	5 3/4 (146)	-
BS 10														
Table A	22 3/4 (578)	20 1/2 (521)	12	7/8 (22)	1 (25)	1 (25)	-	-	-	-	1 1/16 (27)	1 (25)	-	-
Table D	22 3/4 (578)	20 1/2 (521)	12	7/8 (22)	1 (25)	1 (25)	-	-	-	-	1 1/8 (29)	1 (25)	1 (25)	-
Table E	22 3/4 (578)	20 1/2 (521)	12	7/8 (22)	1 (25)	1 (25)	-	-	-	-	1 1/4 (32)	1 (25)	1 (25)	-
Table F	24 (610)	21 3/4 (552)	20	1 (25)	1 1/8 (29)	1 1/8 (29)	-	-	-	-	1 3/8 (35)	1 1/4 (32)	1 1/4 (32)	-
Table H	24 (610)	21 3/4 (552)	20	1 (25)	1 1/8 (29)	1 1/8 (29)	-	19 (483)	-	1/16 (2)	2 (51)	1 3/4 (44)	1 3/4 (44)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2
(2) Copper alloy flanges are always flat-faced

Nominal Size 450 mm (18 in)

BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes iron	Diameter of holes steel	Diameter of raised face(2) iron	Diameter of raised face(2) steel	Height of raised face(2) iron	Height of raised face(2) steel	Thickness of flange: Grey cast iron	Thickness of flange: Copper alloy	Thickness of flange: Cast and forged steel	Thickness of flange: Ductile cast iron
PN 6	595	550	16	M20	23	22	518	520	4	2	28 (1)	-	22	-
PN 10	615	565	20	M24	28	26	530	532	4	2	32 (1)	-	28	25.5
PN 16	640	585	20	M27	31	30	548	550	4	2	40 (1)	-	40	30
PN 25	670	600	20	M33	37	36	548	555	4	2	50 (1)	-	46	34.5
PN 40	685	610	20	M36	41	39	560	560	4	2	-	-	57	49
PN 64	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PN 100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANSI														
Class 125/150	25 (635)	22 3/4 (578)	16	1 1/8 (29)	1 1/4 (32)	1 1/4 (32)	-	21 (533)	-	1/16 (2)	1 9/16 (40)	-	1 9/16 (40)	-
Class 300	28 (711)	24 3/4 (629)	24	1 1/4 (32)	-	1 3/8 (35)	-	21 (533)	-	1/16 (2)	-	-	2 3/8 (60)	-
Class 600	29 1/4 (743)	25 3/4 (654)	20	1 5/8 (41)	-	1 3/4 (44)	-	21 (533)	-	1/4 (6)	-	-	3 1/4 (83)	-
Class 900	31 (787)	27 (686)	20	1 7/8 (48)	-	2 (51)	-	21 (533)	-	1/4 (6)	-	-	4 (102)	-
Class 1500	36 (914)	30 1/2 (775)	16	2 3/4 (70)	-	2 7/8 (73)	-	21 (533)	-	1/4 (6)	-	-	6 3/8 (162)	-
BS 10														
Table A	25 1/4 (641)	23 (584)	12	7/8 (22)	-	1 (25)	-	-	-	-	1 1/16 (27)	1 1/16 (27)	-	-
Table D	25 1/4 (641)	23 (584)	12	7/8 (22)	-	1 (25)	-	-	-	-	1 1/4 (32)	1 1/8 (29)	1 1/8 (29)	-
Table E	25 1/4 (641)	23 (584)	16	7/8 (22)	-	1 (25)	-	-	-	-	1 3/8 (35)	1 1/8 (29)	1 1/8 (29)	-
Table F	26 1/2 (673)	24 (610)	20	1 1/8 (29)	-	1 1/4 (32)	-	-	-	-	1 1/2 (38)	1 3/8 (35)	1 3/8 (35)	-
Table H	26 1/2 (673)	24 (610)	20	1 1/8 (29)	-	1 1/4 (32)	-	21 (533)	-	1/16 (2)	2 1/8 (54)	1 7/8 (48)	1 7/8 (48)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2
(2) Copper alloy flanges are always flat-faced

Nominal Size 500 mm (20 in)

BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes iron	Diameter of holes steel	Diameter of raised face(3) iron	Diameter of raised face(3) steel	Height of raised face(3) iron	Height of raised face(3) steel	Thickness of flange: Grey cast iron	Thickness of flange: Copper alloy	Thickness of flange: Cast and forged steel	Thickness of flange: Ductile cast iron
PN 6	645	600	20	M20	23	22	568	570	4	2	30 (1)	-	24 (2)	-
PN 10	670	620	20	M24	28	26	582	585	4	2	34 (1)	-	28 (2)	26.5
PN 16	715	650	20	M30	34	33	609	610	4	2	42 (1)	-	44 (2)	31.5
PN 25	730	660	20	M33	37	36	609	615	4	2	52 (1)	-	48 (2)	36.5
PN 40	755	670	20	M39	44	42	615	615	4	2	-	-	57 (2)	52
PN 64	800	705	20	M45	-	48	-	615	-	2	-	-	68 (2)	-
PN 100	870	760	20	M52	-	56	-	615	-	2	-	-	94 (2)	-
ANSI														
Class 125/150	27 1/2 (699)	25 (635)	20	1 1/8 (29)	1 1/4 (32)	1 1/4 (32)	-	23 (584)	-	1/16 (2)	1 11/16 (43)	-	1 11/16 (43)	-
Class 300	30 1/2 (775)	27 (686)	24	1 1/4 (32)	-	1 3/8 (35)	-	23 (584)	-	1/16 (2)	-	-	2 1/2 (64)	-
Class 600	32 (813)	28 1/2 (724)	24	1 5/8 (41)	-	1 3/4 (44)	-	23 (584)	-	1/4 (6)	-	-	3 1/2 (89)	-
Class 900	33 3/4 (857)	29 1/2 (749)	20	2 (51)	-	2 1/8 (54)	-	23 (584)	-	1/4 (6)	-	-	4 1/4 (108)	-
Class 1500	38 3/4 (984)	32 3/4 (832)	16	3 (76)	-	3 1/8 (79)	-	23 (584)	-	1/4 (6)	-	-	7 (178)	-
BS 10														
Table A	27 3/4 (705)	25 1/4 (641)	12	7/8 (22)	1 (25)	1 (25)	-	-	-	-	1 1/8 (29)	1 1/8 (29)	-	-
Table D	27 3/4 (705)	25 1/4 (641)	16	7/8 (22)	1 (25)	1 (25)	-	-	-	-	1 1/4 (32)	1 1/4 (32)	-	-
Table E	27 3/4 (705)	25 1/4 (641)	16	7/8 (22)	1 (25)	1 (25)	-	-	-	-	1 1/2 (38)	1 1/4 (32)	1 1/4 (32)	-
Table F	29 (737)	26 1/2 (673)	24	1 1/8 (29)	1 1/4 (32)	1 1/4 (32)	-	-	-	-	1 5/8 (41)	1 1/2 (38)	1 1/2 (38)	-
Table H	29 (737)	26 1/2 (673)	24	1 1/8 (29)	1 1/4 (32)	1 1/4 (32)	-	23 1/2 (597)	-	1/16 (2)	2 1/4 (57)	2 (51)	2 (51)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2

(2) These flange thicknesses are changed substantially as a result of the flange calculation method used in BS EN 1092-1

(3) Copper alloy flanges are always flat-faced

Nominal Size 600 mm (24 in)

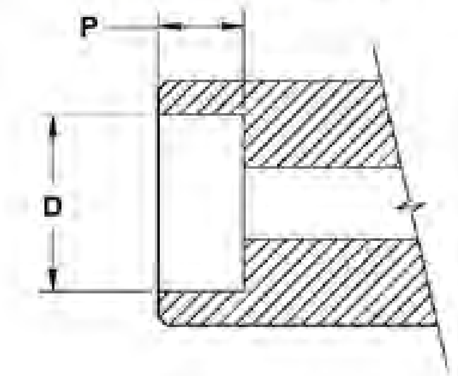
BS EN 1092	Diameter of flange	Bolt circle diameter	Number of bolts	Diameter of bolts	Diameter of holes iron	Diameter of holes steel	Diameter of raised face(3) iron	Diameter of raised face(3) steel	Height of raised face(3) iron	Height of raised face(3) steel	Thickness of flange: Grey cast iron	Thickness of flange: Copper alloy	Thickness of flange: Cast and forged steel	Thickness of flange: Ductile cast iron
PN 6	755	705	20	M24	28	26	667	670	5	2	30 (1)	-	30	-
PN 10	780	725	20	M27	31	30	682	685	5	2	36 (1)	-	34	30
PN 16	840	770	20	M33	37	36	720	725	5	2	48 (1)	-	54	36
PN 25	845	770	20	M36	41	39	720	720	5	2	-	-	58	42
PN 40	890	795	20	M45	50	48	735	735	5	2	-	-	72	58
PN 64	930	820	20	M52	-	56	-	735	-	2	-	-	76	-
ANSI														
Class 125/150	32 (813)	$29\frac{1}{2}$ (749)	20	$1\frac{1}{4}$ (32)	$1\frac{3}{8}$ (35)	$1\frac{3}{8}$ (35)	-	$27\frac{1}{4}$ (692)	-	$\frac{1}{16}$ (2)	$1\frac{7}{8}$ (48)	-	$1\frac{7}{8}$ (48)	-
Class 300	36 (914)	32 (813)	24	$1\frac{1}{2}$ (38)	-	$1\frac{5}{8}$ (41)	-	$27\frac{1}{4}$ (692)	-	$\frac{1}{16}$ (2)	-	-	$2\frac{3}{4}$ (70)	-
Class 600	37 (940)	33 (838)	24	$1\frac{7}{8}$ (48)	-	2 (51)	-	$27\frac{1}{4}$ (692)	-	$\frac{1}{4}$ (6)	-	-	4 (102)	-
Class 900	41 (1041)	$35\frac{1}{2}$ (902)	20	$2\frac{1}{2}$ (64)	-	$2\frac{5}{8}$ (67)	-	$27\frac{1}{4}$ (692)	-	$\frac{1}{4}$ (6)	-	-	$5\frac{1}{2}$ (140)	-
Class 1500	46 (1168)	39 (991)	16	$3\frac{1}{2}$ (89)	-	$3\frac{5}{8}$ (92)	-	$27\frac{1}{4}$ (692)	-	$\frac{1}{4}$ (6)	-	-	8 (203)	-
BS 10														
Table A	$32\frac{1}{2}$ (826)	$29\frac{3}{4}$ (756)	12	1 (25)	$1\frac{1}{8}$ (29)	$1\frac{1}{8}$ (29)	-	-	-	-	$1\frac{3}{16}$ (30)	$1\frac{3}{16}$ (30)	-	-
Table D	$32\frac{1}{2}$ (826)	$29\frac{3}{4}$ (756)	16	1 (25)	$1\frac{1}{8}$ (29)	$1\frac{1}{8}$ (29)	-	-	-	-	$1\frac{3}{8}$ (35)	$1\frac{3}{8}$ (35)	$1\frac{3}{8}$ (35)	-
Table E	$32\frac{1}{2}$ (826)	$29\frac{3}{4}$ (756)	16	$1\frac{1}{8}$ (29)	$1\frac{1}{4}$ (32)	$1\frac{1}{4}$ (32)	-	-	-	-	$1\frac{5}{8}$ (41)	$1\frac{1}{2}$ (38)	$1\frac{1}{2}$ (38)	-
Table F	$33\frac{1}{2}$ (851)	$30\frac{3}{4}$ (781)	24	$1\frac{1}{4}$ (32)	$1\frac{1}{4}$ (32)	$1\frac{3}{8}$ (35)	-	-	-	-	$1\frac{3}{4}$ (44)	$1\frac{5}{8}$ (41)	$1\frac{5}{8}$ (41)	-
Table H	$33\frac{1}{2}$ (851)	$30\frac{3}{4}$ (781)	24	$1\frac{1}{4}$ (32)	$1\frac{3}{8}$ (35)	$1\frac{3}{8}$ (35)	-	$27\frac{1}{2}$ (699)	-	$\frac{1}{16}$ (2)	$2\frac{1}{2}$ (64)	$2\frac{1}{4}$ (57)	$2\frac{1}{4}$ (57)	-

(1) These flange thicknesses are also valid for ductile iron flanges type 21-2

(2) These flange thicknesses are changed substantially as a result of the flange calculation method used in BS EN 1092-1

(3) Copper alloy flanges are always flat-faced

SOCKET WELD END DIMENSIONS
ASME B 16.11



DN		D	P
IN	MM		
3/8	10	17.5	10
1/2	15	21.8	10
3/4	20	27.0	13
1	25	33.8	13
1-1/4	32	42.5	13
1-1/2	40	48.6	13
2	50	61.1	16

METRIC UNITS

The following pressure-temperature charts are derived from ASME B16.34 - 2004 version. It will cover the most commonly used body and bonnet materials in the industry. All Pacific valves are designed to operate through pressure and temperature ranges shown in these P-T charts for a particular ASME Class Rating and ASTM Material. Hydrostatic Shell Testing at a minimum 1.5 times and Hydrostatic Seat Testing at a minimum of 1.1 times the Maximum Cold Working Pressure of an ASME Class Rating.

ASTM A216 GR. WCB

°C	STANDARD CLASS B16.34 - 2004							SPECIAL CLASS B16.34 - 2004						
	MAXIMUM NON-SHOCK WORKING PRESSURE, Bar							MAXIMUM NON-SHOCK WORKING PRESSURE, Bar						
	150	300	600	900	1500	2500	4500	150	300	600	900	1500	2500	4500
-29 to 38	19.6	51.1	102.1	153.2	255.3	425.5	765.9	19.8	51.7	103.4	155.1	258.6	430.9	775.7
50	19.2	50.1	100.2	150.4	250.6	417.7	751.9	19.8	51.7	103.4	155.1	258.6	430.9	775.7
100	17.7	46.6	93.2	139.8	233.0	388.3	699.0	19.8	51.6	103.3	154.9	258.2	430.3	774.5
150	15.8	45.1	90.2	135.2	225.4	375.6	676.1	19.6	51.0	102.1	153.1	255.2	425.3	765.5
200	13.8	43.8	87.6	131.4	219.0	365.0	657.0	19.4	50.6	101.1	151.7	252.9	421.4	758.6
250	12.1	41.9	83.9	125.8	209.7	349.5	629.1	19.4	50.5	101.1	151.6	252.6	421.1	757.9
300	10.2	39.8	79.6	119.5	199.1	331.8	597.3	19.4	50.5	101.1	151.6	252.6	421.1	757.9
325	9.3	38.7	77.4	116.1	193.6	322.6	580.7	19.2	50.1	100.2	150.3	250.6	417.6	751.7
350	8.4	37.6	75.1	112.7	187.8	313.0	563.5	18.7	48.9	97.8	146.7	244.6	407.6	733.7
375	7.4	36.4	72.7	109.1	181.8	303.1	545.5	18.1	47.1	94.2	141.3	235.5	392.5	706.5
400	6.5	34.7	69.4	104.2	173.6	289.3	520.8	16.6	43.4	86.8	130.2	217.0	361.7	651.0
425	5.5	28.8	57.5	86.3	143.8	239.7	431.5	13.8	36.0	71.9	107.9	179.8	299.6	539.3
450	4.6	23.0	46.0	69.0	115.0	191.7	345.1	11.0	28.8	57.5	86.3	143.8	239.6	431.4
475	3.7	17.4	34.9	52.3	87.2	145.3	261.5	8.4	21.8	43.6	65.4	109.0	181.6	326.9
500	2.8	11.8	23.5	35.3	58.8	97.9	176.3	5.6	14.7	29.4	44.1	73.5	122.4	220.4
538	1.4	5.9	11.8	17.7	29.5	49.2	88.6	2.8	7.4	14.8	22.2	36.9	61.6	110.8

Note: Upon prolonged exposure to temperatures above 425°C, the carbide phase of steel may be converted to graphite. Permissible, but not recommended for prolonged usage above 425°C.

ASTM A216 GR. WCC

°C	STANDARD CLASS B16.34 - 2004							SPECIAL CLASS B16.34 - 2004						
	MAXIMUM NON-SHOCK WORKING PRESSURE, Bar							MAXIMUM NON-SHOCK WORKING PRESSURE, Bar						
	150	300	600	900	1500	2500	150	300	600	900	1500	2500		
-29 to 38	19.8	51.7	103.4	155.0	258.6	430.9	775.7	20.0	51.7	103.4	155.1	258.6	430.9	775.7
50	19.5	51.7	103.4	155.1	258.6	430.9	775.7	20.0	51.7	103.4	155.1	258.6	430.9	775.7
100	17.7	51.5	103.0	154.6	257.6	429.4	773.0	20.0	51.7	103.4	155.1	258.6	430.9	775.7
150	15.8	50.2	100.3	150.5	250.8	418.1	752.6	20.0	51.7	103.4	155.1	258.6	430.9	775.7
200	13.8	48.6	97.2	145.8	243.2	405.4	729.7	20.0	51.7	103.4	155.1	258.6	430.9	775.7
250	12.1	46.3	92.7	139.0	231.8	386.2	694.8	20.0	51.7	103.4	155.1	258.6	430.9	775.7
300	10.2	42.9	85.7	128.6	214.4	357.1	642.6	20.0	51.7	103.4	155.1	258.6	430.9	775.7
325	9.3	41.4	82.6	124.0	206.6	344.3	619.6	20.0	51.7	103.4	155.1	258.6	430.9	775.7
350	8.4	40.0	80.0	120.1	200.1	333.5	600.3	19.8	51.1	102.2	153.3	255.5	425.8	766.4
375	7.4	37.8	75.7	113.5	189.2	315.3	567.5	19.3	48.4	96.7	145.1	241.9	403.1	725.6
400	6.5	34.7	69.4	104.2	173.6	289.3	520.8	19.3	43.4	86.8	130.2	217.0	361.7	651.0
425	5.5	28.8	57.5	86.3	143.8	239.7	431.5	18.0	36.0	71.9	107.9	179.8	299.6	539.3
450	4.6	23.0	46.0	69.0	115.0	191.7	345.1	14.4	28.8	57.5	86.3	143.8	239.6	431.4
475	3.7	17.1	34.2	51.3	85.4	142.4	256.3	10.7	21.4	42.7	64.1	106.8	178.0	320.4
500	2.8	11.6	23.2	34.7	57.9	96.5	173.7	7.2	14.5	29.0	43.4	72.4	120.7	217.2
538	1.4	5.9	11.8	17.7	29.5	49.2	88.6	3.7	7.4	14.8	22.2	36.9	61.6	110.8

Note: Upon prolonged exposure to temperatures above 455°C, the carbide phase of steel may be converted to graphite. Permissible, but not recommended for prolonged usage above 425°C.

ASTM A352, GR. LCB

°C	STANDARD CLASS B16.34 - 2004							SPECIAL CLASS B16.34 - 2004						
	MAXIMUM NON-SHOCK WORKING PRESSURE, Bar							MAXIMUM NON-SHOCK WORKING PRESSURE, Bar						
	150	300	600	900	1500	2500	4500	150	300	600	900	1500	2500	4500
-29 to 38	18.4	48.0	96.0	144.1	240.1	400.1	720.3	20.0	48.0	96.0	144.1	240.1	400.1	720.3
50	18.2	47.5	94.9	142.4	237.3	395.6	712.0	20.0	48.0	96.0	144.1	240.1	400.1	720.3
100	17.4	45.3	90.7	136.0	226.7	377.8	680.1	20.0	48.0	96.0	144.1	240.1	400.1	720.3
150	15.8	43.9	87.9	131.8	219.7	366.1	659.1	20.0	48.0	96.0	144.1	240.1	400.1	720.3
200	13.8	42.5	85.1	127.6	212.7	354.4	638.0	20.0	48.0	96.0	144.1	240.1	400.1	720.3
250	12.1	40.8	81.6	122.3	203.9	339.8	611.7	20.0	48.0	96.0	144.1	240.1	400.1	720.3
300	10.2	38.7	77.4	116.1	193.4	322.4	580.3	20.0	48.0	96.0	144.1	240.1	400.1	720.3
325	9.3	37.6	75.2	112.7	187.9	313.1	563.7	20.0	48.0	95.9	143.9	239.8	399.6	719.3
350	8.4	36.4	72.8	109.2	182.0	303.3	545.9	19.8	47.3	94.6	141.9	236.5	394.1	709.4
375	7.4	35.0	69.9	104.9	174.9	291.4	524.6	19.3	44.9	89.9	134.8	224.7	374.6	674.2
400	6.5	32.6	65.2	97.9	163.1	271.9	489.3	19.3	40.8	81.6	122.3	203.9	339.8	611.7
425	5.5	27.3	54.6	81.9	136.5	227.5	409.5	17.1	34.1	68.3	102.4	170.6	284.4	511.9
450	4.6	21.6	43.2	64.8	107.9	179.9	323.8	13.5	27.0	54.0	81.0	134.9	224.9	404.8
475	3.7	15.7	31.3	47.0	78.3	130.6	235.0	9.8	19.6	39.2	58.8	97.9	163.2	293.8
500	2.8	11.1	22.1	33.2	55.4	92.3	166.1	6.9	13.8	27.7	41.5	69.2	115.3	207.6
538	1.4	5.9	11.8	17.7	29.5	49.2	88.6	3.7	7.4	14.8	22.2	36.9	61.6	110.8

ASTM A217 GR. WC6

°C	STANDARD CLASS B16.34 - 2004 MAXIMUM NON-SHOCK WORKING PRESSURE, Bar							SPECIAL CLASS B16.34 - 2004 MAXIMUM NON-SHOCK WORKING PRESSURE, Bar						
	150	300	600	900	1500	2500	4500	150	300	600	900	1500	2500	4500
-29 to 38	19.8	51.7	103.4	155.1	258.6	430.9	775.7	19.8	51.7	103.4	155.1	258.6	430.9	775.7
50	19.5	51.7	103.4	155.1	258.6	430.9	775.7	19.8	51.7	103.4	155.1	258.6	430.9	775.7
100	17.7	51.5	103.0	154.4	257.4	429.0	772.2	19.8	51.7	103.4	155.1	258.6	430.9	775.7
150	15.8	49.7	99.5	149.2	248.7	414.5	746.2	19.8	51.7	103.4	155.1	258.6	430.9	775.7
200	13.8	48.0	95.9	143.9	239.8	399.6	719.4	19.8	51.7	103.4	155.1	258.6	430.9	775.7
250	12.1	46.3	92.7	139.0	231.8	386.2	694.8	19.8	51.7	103.4	155.1	258.6	430.9	775.7
300	10.2	42.9	85.7	128.6	214.4	357.1	642.6	19.8	51.7	103.4	155.1	258.6	430.9	775.7
325	9.3	41.4	82.6	124.0	206.6	344.3	619.6	19.8	51.7	103.4	155.1	258.6	430.9	775.7
350	8.4	40.3	80.4	120.7	201.1	335.3	603.3	19.8	51.5	102.8	154.3	257.1	428.6	771.4
375	7.4	38.9	77.6	116.5	194.1	323.2	581.8	19.3	50.6	101.0	151.5	252.5	420.9	757.4
400	6.5	36.5	73.3	109.8	183.1	304.9	548.5	19.3	50.3	100.6	150.6	251.2	418.3	753.2
425	5.5	35.2	70.0	105.1	175.1	291.6	524.7	19.0	49.6	99.3	148.9	248.2	413.7	744.6
450	4.6	33.7	67.7	101.4	169.0	281.8	507.0	18.1	47.3	94.4	141.4	235.8	393.1	707.6
475	3.7	31.7	63.4	95.1	158.2	263.9	474.8	16.4	42.8	85.5	128.2	213.7	356.3	641.3
500	2.8	25.7	51.5	77.2	128.6	214.4	385.9	12.3	32.2	64.3	96.5	160.8	268.0	482.4
538	1.4	14.9	29.8	44.7	74.5	124.1	223.4	7.1	18.6	37.2	55.8	93.1	155.1	279.2
550	1.4(a)	12.7	25.4	38.1	63.5	105.9	190.6	6.1	15.9	31.8	47.7	79.4	132.4	238.3
575	1.4(a)	8.8	17.6	26.4	44.0	73.4	132.0	4.2	11.0	22.0	33.0	55.0	91.7	165.1
600	1.4(a)	6.1	12.2	18.3	30.5	50.9	91.6	2.9	7.6	15.3	22.9	38.2	63.6	114.5
625	1.4(a)	4.3	8.5	12.8	21.3	35.5	63.9	2.0	5.3	10.6	16.0	26.6	44.4	79.9
650	1.1(a)	2.8	5.7	8.5	14.2	23.6	42.6	1.4	3.5	7.1	10.6	17.7	29.5	53.2

Note: Use normalized and tempered material only. Not to be used over 595°C. (a) Flanged end valve ratings terminate at 538°C.

ASTM A217 GR. WC9

°C	STANDARD CLASS B16.34 - 2004 MAXIMUM NON-SHOCK WORKING PRESSURE, Bar							SPECIAL CLASS B16.34 - 2004 MAXIMUM NON-SHOCK WORKING PRESSURE, Bar						
	150	300	600	900	1500	2500	4500	150	300	600	900	1500	2500	4500
-29 to 38	19.8	51.7	103.4	155.1	258.6	430.9	775.7	19.8	51.7	103.4	155.1	258.6	430.9	775.7
50	19.5	51.7	103.4	155.1	258.6	430.9	775.7	19.8	51.7	103.4	155.1	258.6	430.9	775.7
100	17.7	51.5	103.0	154.6	257.6	429.4	773.0	19.8	51.7	103.4	154.9	258.1	430.2	774.3
150	15.8	50.3	100.3	150.6	250.8	418.2	752.8	19.5	51.0	101.9	152.9	254.8	424.6	764.3
200	13.8	48.6	97.2	145.8	243.4	405.4	729.8	19.3	50.2	100.4	150.7	251.1	418.5	753.4
250	12.1	46.3	92.7	139.0	231.8	386.2	694.8	19.2	50.0	100.0	149.9	249.9	416.5	749.7
300	10.2	42.9	85.7	128.6	214.4	357.1	642.6	19.1	49.8	99.6	149.3	248.9	414.8	746.7
325	9.3	41.4	82.6	124.0	206.6	344.3	619.6	19.0	49.6	99.2	148.8	248.0	413.3	743.9
350	8.4	40.3	80.4	120.7	201.1	335.3	603.3	18.9	49.2	98.4	147.6	246.0	410.0	738.1
375	7.4	38.9	77.6	116.5	194.1	323.2	581.8	18.7	48.8	97.5	146.3	243.8	406.3	731.3
400	6.5	36.5	73.3	109.8	183.1	304.9	548.5	18.7	48.8	97.5	146.3	243.8	406.3	731.3
425	5.5	35.2	70.0	105.1	175.1	291.6	524.7	18.7	48.8	97.5	146.3	243.8	406.3	731.3
450	4.6	33.7	67.7	101.4	169.0	281.8	507.0	18.1	47.3	94.4	141.4	235.8	393.1	707.6
475	3.7	31.7	63.4	95.1	158.2	263.9	474.8	16.4	42.8	85.5	128.2	213.7	356.3	641.3
500	2.8	28.2	56.5	84.7	140.9	235.0	423.0	13.7	35.6	71.5	107.1	178.6	297.5	535.4
538	1.4	18.4	36.9	55.3	92.2	153.7	276.6	8.8	23.0	46.1	69.1	115.2	192.1	345.7
550	1.4(a)	15.6	31.3	46.9	78.2	130.3	234.5	7.5	19.5	39.1	58.6	97.7	162.8	293.1
575	1.4(a)	10.5	21.1	31.6	52.6	87.7	157.9	5.0	13.2	26.3	39.5	65.8	109.7	197.4
600	1.4(a)	6.9	13.8	20.7	34.4	57.4	103.3	3.3	8.6	17.2	25.8	43.0	71.7	129.1
625	1.4(a)	4.5	8.9	13.4	22.3	37.2	66.9	2.1	5.6	11.2	16.7	27.9	46.5	83.7
650	1.1(a)	2.8	5.7	8.5	14.2	23.6	42.6	1.4	3.5	7.1	10.6	17.7	29.5	53.2

Note: Use normalized and tempered material only. Not be used over 595°C. (a) Flanged end valve ratings terminate at 538°C.

ASTM A217 GR. C5

°C	STANDARD CLASS B16.34 - 2004							SPECIAL CLASS B16.34 - 2004						
	MAXIMUM NON-SHOCK WORKING PRESSURE, Bar							MAXIMUM NON-SHOCK WORKING PRESSURE, Bar						
	150	300	600	900	1500	2500	4500	150	300	600	900	1500	2500	4500
-29 to 38	20.0	51.7	103.4	155.1	258.6	430.9	775.7	20.0	51.7	103.4	155.1	258.6	430.9	775.7
50	19.5	51.7	103.4	155.1	258.6	430.9	775.7	20.0	51.7	103.4	155.1	258.6	430.9	775.7
100	17.7	51.5	103.0	154.6	257.6	429.4	773.0	20.0	51.7	103.4	155.1	258.6	430.9	775.7
150	15.8	5.03	100.3	150.6	250.8	418.2	752.8	20.0	51.7	103.4	155.1	258.6	430.9	775.7
200	13.8	48.6	97.2	145.8	243.4	405.4	729.8	20.0	51.7	103.4	155.1	258.6	430.9	775.7
250	12.1	46.3	92.7	139.0	231.8	386.2	694.8	20.0	51.7	103.4	155.1	258.6	430.9	775.7
300	10.2	42.9	85.7	128.6	214.4	357.1	642.6	20.0	51.7	103.4	155.1	258.6	430.9	775.7
325	9.3	41.4	82.6	124.0	206.6	344.3	619.6	20.0	51.7	103.4	155.1	258.6	430.9	775.7
350	8.4	40.3	80.4	120.7	201.1	335.3	603.3	19.8	51.5	102.8	154.3	257.1	428.6	771.4
375	7.4	38.9	77.6	116.5	194.1	323.2	581.8	19.3	50.6	101.0	151.5	252.5	420.9	757.4
400	6.5	36.5	73.3	109.8	183.1	304.9	548.5	19.3	50.3	100.6	150.6	251.2	418.3	753.2
425	5.5	35.2	70.0	105.1	175.1	291.6	524.7	19.0	49.6	99.3	148.9	248.2	413.7	744.6
450	4.6	33.7	67.7	101.4	169.0	281.8	507.0	18.1	45.2	90.3	135.5	225.9	376.5	677.6
475	3.7	27.9	55.7	83.6	139.3	232.1	417.8	16.4	34.8	69.6	104.5	174.1	290.2	522.3
500	2.8	21.4	42.8	64.1	106.9	178.2	320.7	13.4	26.7	53.4	80.2	133.6	222.7	400.9
538	1.4	13.7	27.4	41.1	68.6	114.3	205.7	8.6	17.1	34.3	51.4	85.7	142.8	257.1
550	1.4(a)	12.0	24.1	36.1	60.2	100.4	180.7	7.5	15.1	30.1	45.2	75.3	125.5	225.9
575	1.4(a)	8.9	17.8	26.7	44.4	74.0	133.3	5.6	11.1	22.2	33.3	55.5	92.5	166.6
600	1.4(a)	6.2	12.5	18.7	31.2	51.9	93.5	3.9	7.8	15.6	23.4	38.9	64.9	116.8
625	1.4(a)	4.0	8.0	12.0	20.0	33.3	59.9	2.5	5.0	10.0	15.0	24.9	41.6	74.8
650	0.9(a)	2.4	4.7	7.1	11.8	19.7	35.5	1.5	3.0	5.9	8.9	14.8	24.6	44.3

Note: Use normalized and tempered material only. (a) Flanged end valve ratings terminate at 538°C.

ASTM A217 GR. C12

°C	STANDARD CLASS B16.34 - 2004							SPECIAL CLASS B16.34 - 2004						
	MAXIMUM NON-SHOCK WORKING PRESSURE, Bar							MAXIMUM NON-SHOCK WORKING PRESSURE, Bar						
	150	300	600	900	1500	2500	4500	150	300	600	900	1500	2500	4500
-29 to 38	20.0	51.7	103.4	155.1	258.6	430.9	775.7	20.0	51.7	103.4	155.1	258.6	430.9	775.7
50	19.5	51.7	103.4	155.1	258.6	430.9	775.7	20.0	51.7	103.4	155.1	258.6	430.9	775.7
100	17.7	51.5	103.0	154.6	257.6	429.4	773.0	20.0	51.7	103.4	155.1	258.6	430.9	775.7
150	15.8	50.3	100.3	150.6	250.8	418.2	752.8	20.0	51.7	103.4	155.1	258.6	430.9	775.7
200	13.8	48.6	97.2	145.8	243.4	405.4	729.8	20.0	51.7	103.4	155.1	258.6	430.9	775.7
250	12.1	46.3	92.7	139.0	231.8	386.2	694.8	20.0	51.7	103.4	155.1	258.6	430.9	775.7
300	10.2	42.9	85.7	128.6	214.4	357.1	642.6	20.0	51.7	103.4	155.1	258.6	430.9	775.7
325	9.3	41.4	82.6	124.0	206.6	344.3	619.6	20.0	51.7	103.4	155.1	258.6	430.9	775.7
350	8.4	40.3	80.4	120.7	201.1	335.3	603.3	19.8	51.5	102.8	154.3	257.1	428.6	771.4
375	7.4	38.9	77.6	116.5	194.1	323.2	581.8	19.3	50.6	101.0	151.5	252.5	420.9	757.4
400	6.5	36.5	73.3	109.8	183.1	304.9	548.5	19.3	50.3	100.6	150.6	251.2	418.3	753.2
425	5.5	35.2	70.0	105.1	175.1	291.6	524.7	19.0	49.6	99.3	148.9	248.2	413.7	744.6
450	4.6	33.7	67.7	101.4	169.0	281.8	507.0	18.1	47.3	94.4	141.4	235.8	393.1	707.6
475	3.7	31.7	63.4	95.1	158.2	263.9	474.8	16.4	42.8	85.5	128.2	213.7	356.3	641.3
500	2.8	28.2	56.5	84.7	140.9	235.0	423.0	13.7	35.6	71.5	107.1	178.6	297.5	535.4
538	1.4	17.5	35.0	52.5	87.5	145.8	262.4	8.4	21.9	43.7	65.6	109.3	182.2	328.0
550	1.4(a)	15.0	30.0	45.0	75.0	125.0	225.0	7.2	18.7	37.5	56.2	93.7	156.2	281.2
575	1.4 (a)	10.5	20.9	31.4	52.3	87.1	156.8	5.0	13.1	26.1	39.2	65.3	108.9	196.0
600	1.4 (a)	7.2	14.4	21.5	35.9	59.8	107.7	3.4	9.0	17.9	26.9	44.9	74.8	134.6
625	1.4 (a)	5.0	9.9	14.9	24.8	41.4	74.5	2.4	6.2	12.4	18.6	31.1	51.8	93.2
650	1.4 (a)	3.5	7.1	10.6	17.7	29.5	53.2	1.7	4.4	8.9	13.3	22.2	36.9	66.5

Note: Use normalized and tempered material only. (a) Flanged end valve ratings terminate at 538°C.

ASTM A351 GR. CF8M

°C	STANDARD CLASS B16.34 - 2004 MAXIMUM NON-SHOCK WORKING PRESSURE, Bar							SPECIAL CLASS B16.34 - 2004 MAXIMUM NON-SHOCK WORKING PRESSURE, Bar						
	150	300	600	900	1500	2500	4500	150	300	600	900	1500	2500	4500
-29 to 38	19.0	49.6	99.3	148.9	248.2	413.7	744.6	19.8	51.7	103.4	155.1	258.6	430.9	775.7
50	18.4	48.1	92.6	144.3	240.6	400.9	721.7	19.5	50.8	101.6	152.5	254.1	423.5	762.3
100	16.2	42.2	84.4	126.6	211.0	351.6	632.9	18.1	47.1	94.2	141.3	235.5	392.4	706.4
150	14.8	38.5	77.0	115.5	192.5	320.8	577.4	16.5	43.0	85.9	128.9	214.8	358.0	644.4
200	13.7	35.7	71.3	107.0	178.3	297.2	534.9	15.3	39.8	79.6	119.4	199.0	331.7	597.0
250	12.1	33.4	66.8	100.1	166.9	278.1	500.6	14.3	37.3	74.5	111.8	186.3	310.4	558.8
300	10.2	31.6	63.2	94.9	158.1	263.5	474.3	13.5	35.3	70.6	105.9	176.4	294.1	529.3
325	9.3	30.9	61.8	92.7	154.4	257.4	463.3	13.2	34.5	68.9	103.4	172.3	287.2	517.0
350	8.4	30.3	60.7	91.0	151.6	252.7	454.9	13.0	33.8	67.7	101.5	169.2	282.1	507.7
375	7.4	29.9	59.8	89.6	149.4	249.0	448.2	12.8	33.3	66.7	100.0	166.7	277.9	500.2
400	6.5	29.4	58.9	88.3	147.2	245.3	441.6	12.6	32.9	65.7	98.6	164.3	273.8	492.9
425	5.5	29.1	58.3	87.4	145.7	242.9	437.1	12.5	32.5	65.1	97.6	162.6	271.1	487.9
450	4.6	28.8	57.7	86.5	144.2	240.4	432.7	12.3	32.2	64.4	96.6	161.0	268.3	482.9
475	3.7	28.7	57.3	86.0	143.4	238.9	430.1	12.3	32.0	64.0	96.0	160.0	266.6	480.0
500	2.8	28.2	56.5	84.7	140.9	235.0	423.0	12.2	31.7	63.4	95.1	158.6	264.3	475.7
538	1.4	25.2	50.0	75.2	125.5	208.9	375.8	11.0	29.0	57.9	86.9	145.1	241.7	435.1
550	1.4(a)	25.0	49.8	74.8	124.9	208.0	374.2	11.0	29.0	57.9	86.9	145.1	241.7	435.1
575	1.4(a)	24.0	47.9	71.8	119.7	199.5	359.1	10.9	28.6	57.1	85.7	143.0	238.3	428.8
600	1.4(a)	19.9	39.8	59.7	99.5	165.9	298.6	9.5	24.9	49.8	74.6	124.4	207.3	373.2
625	1.4(a)	15.8	31.6	47.4	79.1	131.8	237.2	7.6	19.8	39.5	59.3	98.8	164.7	296.5
650	1.4(a)	12.7	25.3	38.0	63.3	105.5	189.9	6.1	15.8	31.7	47.5	79.1	131.9	237.4
675	1.4(a)	10.3	20.6	31.0	51.6	86.0	154.8	4.9	12.9	25.8	38.7	64.5	107.5	193.5
700	1.4(a)	8.4	16.8	25.1	41.9	69.8	125.7	4.4	11.4	22.8	34.3	57.1	95.2	171.3
725	1.4(a)	7.0	14.0	21.0	34.9	58.2	104.8	3.7	9.5	19.1	28.6	47.7	79.5	143.0
750	1.4(a)	5.9	11.7	17.6	29.3	48.9	87.9	2.8	7.4	14.8	22.1	36.7	61.2	110.3
775	1.4(a)	4.6	9.0	13.7	22.8	38.0	68.4	2.2	5.8	11.4	17.2	28.5	47.6	85.6
800	1.2(a)	3.5	7.0	10.5	17.4	29.2	52.6	1.8	4.4	8.8	13.2	22.0	36.6	65.6
816	1.0(a)	2.8	5.9	8.6	14.1	23.8	42.7	1.4	3.4	7.2	10.7	17.9	29.6	53.1

Note: At temperatures over 538°C, use only when the carbon content is 0.04% or higher. (a) Flanged end valve ratings terminate at 538°C.

ASTM A351 GR. CF8C

°C	STANDARD CLASS B16.34 - 2004 MAXIMUM NON-SHOCK WORKING PRESSURE, Bar							SPECIAL CLASS B16.34 - 2004 MAXIMUM NON-SHOCK WORKING PRESSURE, Bar						
	150	300	600	900	1500	2500	4500	150	300	600	900	1500	2500	4500
-29 to 38	19.0	49.6	99.3	148.9	248.2	413.7	744.6	19.8	51.7	103.4	155.1	258.6	430.9	775.7
50	18.7	48.8	97.5	146.3	243.8	406.4	731.5	19.6	51.2	102.4	153.6	256.0	426.7	768.1
100	17.4	45.3	90.6	135.9	226.5	377.4	679.4	18.8	48.9	97.9	146.8	244.7	407.8	734.1
150	15.8	42.5	84.9	127.4	212.4	353.9	637.1	17.4	45.4	90.8	136.1	226.9	378.2	680.7
200	13.8	39.9	79.9	119.8	199.7	332.8	599.1	16.5	43.1	86.1	129.2	215.3	358.8	645.8
250	12.1	37.8	75.6	113.4	189.1	315.1	567.2	16.0	41.6	83.3	124.9	208.2	347.0	624.5
300	10.2	36.1	72.2	108.3	180.4	300.7	541.3	15.4	40.2	80.3	120.5	200.9	334.8	602.6
325	9.3	35.4	70.7	106.1	176.8	294.6	530.3	15.1	39.5	78.9	118.4	197.3	328.8	591.8
350	8.4	34.8	69.5	104.3	173.8	289.6	521.3	14.9	38.8	77.6	116.4	194.0	323.3	581.9
375	7.4	34.2	68.4	102.6	171.0	285.1	513.1	14.6	38.2	76.4	114.5	190.9	318.1	572.7
400	6.5	33.9	67.8	101.7	169.5	282.6	508.6	14.5	37.8	75.7	113.5	189.2	315.4	567.7
425	5.5	33.6	67.2	100.8	168.1	280.1	504.2	14.4	37.5	75.0	112.5	187.6	312.6	562.7
450	4.6	33.5	66.9	100.4	167.3	278.8	501.8	14.3	37.3	74.7	112.0	186.7	311.1	560.0
475	3.7	31.7	63.4	95.1	158.2	263.9	474.8	14.3	37.3	74.6	111.9	186.5	310.9	559.6
500	2.8	28.2	56.5	84.7	140.9	235.0	423.0	13.7	35.6	71.5	107.1	178.6	297.5	535.4
538	1.4	25.2	50.0	75.2	125.5	208.9	375.8	11.0	29.0	57.9	86.9	145.1	241.7	435.1
550	1.4(a)	25.0	49.8	74.8	124.9	208.0	374.2	11.0	29.0	57.9	86.9	145.1	241.7	435.1
575	1.4(a)	24.0	47.9	71.8	119.7	199.5	359.1	10.9	28.6	57.1	85.7	143.0	238.3	428.8
600	1.4(a)	19.8	39.6	59.4	99.0	165.1	297.1	9.5	24.8	49.5	74.3	123.8	206.4	371.4
625	1.4(a)	13.9	27.7	41.6	69.3	115.5	207.9	6.6	17.3	34.6	52.0	86.6	144.3	259.8
650	1.4(a)	10.3	20.6	30.9	51.5	85.8	154.5	4.9	12.9	25.7	38.6	64.4	107.3	193.1
675	1.4(a)	8.0	15.9	23.9	39.8	66.3	119.4	3.8	9.9	19.9	29.8	49.7	82.9	149.2
700	1.4(a)	5.6	11.2	16.8	28.1	46.8	84.2	3.1	8.2	16.4	24.5	40.9	68.2	122.7
725	1.4(a)	4.0	8.0	11.9	19.9	33.1	59.6	2.3	5.9	11.8	17.7	29.5	49.2	88.5
750	1.2(a)	3.1	6.2	9.3	15.5	25.8	46.4	1.6	4.1	8.2	12.2	20.4	34.0	61.2
775	0.9(a)	2.5	4.9	7.4	12.3	20.4	36.8	1.2	3.1	6.2	9.3	15.5	25.8	46.4
800	0.8(a)	2.0	4.0	6.1	10.1	16.9	30.4	1.0	2.7	5.3	8.0	13.3	22.2	40.0
816	0.7(a)	1.9	3.8	5.7	9.5	15.8	28.4	0.9	2.4	4.7	7.1	11.8	19.7	35.5

Note: At temperatures over 538°C, use only when the carbon content is 0.04% or higher. (a) Flanged end valve ratings terminate at 538°C.

METRIC UNITS

Pressure Temperature Ratings for modified 9Cr-1Mo-V Cast Material equivalent to ASTM A182, GR. F91 are not currently listed in ASME B-16.34 - 2004 version. Allowable stress values for this material at elevated temperatures were published in ASME Code Case 2192, March 1995. Using the allowable stress valves in Code Case 2192, and the methods outlined in ASME B16.34, Annex F, the calculated values for Pressure-Temperature Ratings ASTM A217, GR. C12A are tabulated below.

ASTM A217 GR. C12A

°C	STANDARD CLASS MAXIMUM NON-SHOCK WORKING PRESSURE, Bar							SPECIAL CLASS MAXIMUM NON-SHOCK WORKING PRESSURE, Bar						
	150	300	600	900	1500	2500	4500	150	300	600	900	1500	2500	4500
-29 to 38	20.0	51.7	103.4	155.1	258.6	430.9	775.7	20.0	51.7	103.4	155.1	258.6	430.9	775.7
50	19.5	51.7	103.4	155.1	258.6	430.9	775.7	20.0	51.7	103.4	155.1	258.6	430.9	775.7
100	17.7	51.5	103.0	154.6	257.6	429.4	773.0	20.0	51.7	103.4	155.1	258.6	430.9	775.7
150	15.8	50.3	100.3	150.6	250.8	418.2	752.8	20.0	51.7	103.4	155.1	258.6	430.9	775.7
200	13.8	48.6	97.2	145.8	243.4	405.4	729.8	20.0	51.7	103.4	155.1	258.6	430.9	775.7
250	12.1	46.3	92.7	139.0	231.8	386.2	694.8	20.0	51.7	103.4	155.1	258.6	430.9	775.7
300	10.2	42.9	85.7	128.6	214.4	357.1	642.6	20.0	51.7	103.4	155.1	258.6	430.9	775.7
325	9.3	41.4	82.6	124.0	206.6	344.3	619.6	20.0	51.7	103.4	155.1	258.6	430.9	775.7
350	8.4	40.3	80.4	120.7	201.1	335.3	603.3	19.8	51.5	102.8	154.3	257.1	428.6	771.4
375	7.4	38.9	77.6	116.5	194.1	323.2	581.8	19.3	50.6	101.0	151.5	252.5	420.9	757.4
400	6.5	36.5	73.3	109.8	183.1	304.9	548.5	19.3	50.3	100.6	150.6	251.2	418.3	753.2
425	5.5	35.2	70.0	105.1	175.1	291.6	524.7	19.0	49.6	99.3	148.9	248.2	413.7	744.6
450	4.6	33.7	67.7	101.4	169.0	281.8	507.0	18.1	47.3	94.4	141.4	235.8	393.1	707.6
475	3.7	31.7	63.4	95.1	158.2	263.9	474.8	16.4	42.8	85.5	128.2	213.7	356.3	641.3
500	2.8	28.2	56.5	84.7	140.9	235.0	423.0	13.7	35.6	71.5	107.1	178.6	297.5	535.4
538	1.4	25.2	50.0	75.2	125.5	208.9	375.8	11.0	29.0	57.9	86.9	145.1	241.7	435.1
550	1.4(a)	25.0	49.8	74.8	124.9	208.0	374.2	11.0	29.0	57.9	86.9	145.1	241.7	435.1
575	1.4(a)	24.0	47.9	71.8	119.7	199.5	359.1	10.9	28.6	57.1	85.7	143.0	238.3	428.8
600	1.4(a)	19.5	39.0	58.5	97.5	162.5	292.5	9.3	24.4	48.7	73.1	121.9	203.1	365.6
625	1.4(a)	14.6	29.2	43.8	73.0	121.7	219.1	7.0	18.3	36.5	54.8	91.3	152.1	273.8
650	1.4(a)	9.9	19.9	29.8	49.6	82.7	148.9	4.8	12.4	24.8	37.2	62.1	103.4	186.2

Note: (a) Flanged end valve ratings terminate at 538°C.

THREADS AT A GLANCE

The following tables have been prepared to show information relating to the thread form of both ends of a tube connection fitting - tube end and pipe end.

TABLE 1. PIPE THREADS

	British Pipe Thread					American Pipe Thread				
	BSP (G Series)			BSP (R Series)		NPS - National Pipe Straight			NPT - National Pipe Taper	
	Threads		BSP	BSP		Threads		NPS	NPT	
Nom. Size	T.P.I	Angle	O.D. (mm)	Min. Dia. (mm)	Max. Dia. (mm)	T.P.I	Angle	O.D. (mm)	Min. Dia. (mm)	Max. Dia. (mm)
1/8	28	55	9.62	9.51	9.73	27	60	10.29	10.27	10.29
1/4	19	55	13.03	12.91	13.16	18	60	13.77	13.69	13.77
3/8	19	55	16.54	16.41	16.66	18	60	17.15	17.07	17.15
1/2	14	55	20.82	20.67	20.96	14	60	21.34	21.26	21.34
3/4	14	55	26.30	26.16	26.44	14	60	26.67	26.59	26.67
1"	11	55	33.07	32.89	33.25	11.5	60	33.40	33.31	33.40
1 1/4	11	55	41.73	41.55	41.91	11.5	60	42.16	42.07	42.16
1 1/2	11	55	47.62	47.44	47.80	11.5	60	48.26	48.17	48.26
2"	11	55	59.44	59.25	59.62	11.5	60	60.33	60.24	60.33

PIPE THREADS

A 'Pipe Thread' is a 'universal' thread that enables port connection via a common thread form. With the addition of a tube connection fitting, pipe threads can be used to connect tube to the port of a piece of equipment or allow adaptation, both sizing and/or configuration, to satisfy a given situation. However, depending upon the place of manufacture or the industry in which you are working, different 'universal' pipe threads may be specified.

In Australia, most specifications will demand either BSP (British Standard Pipe - Taper or Parallel) or NPT/NPS (American Pipe Taper/Straight). The fundamental difference with these two 'universal' threads is the pitch or threads per inch (T.P.I.) and the thread angle. For further information, refer to the drawings below and/or Table 1.

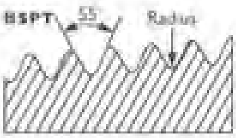
Pipe thread sizes are determined by the 'nominal bore' of pipe and, as such, can be very confusing when ordered. Confusion is often encountered because the wall thickness of the pipe is not included in the calculation for BSPT, BSPP, NPT or NPS thread specifications. The easiest way to determine the size you require is to use the 'Tube and Thread Profile' drawings on page 7-2.

EXAMPLE BSPT/BSPP

1/8" BSP - 28 threads per inch & 55° thread angle

1/8" BSPT

BSPT

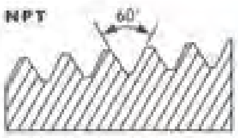


EXAMPLE NPT/NPS

1/8" NPT - 27 threads per inch & 60° thread angle

1/8" NPT

NPT



AS 1722.1 SEALING THREADS OF WHITWORTH FORM (R SERIES)

Commonly termed BSPT, gas thread, sealing thread, dry seal thread or engineering thread. AS1722.1 require mating threads, including a combination of parallel and tapered sealing ends, to effect a seal without the aid of any form of thread sealant or gasket. Generally longer and more bulky than the AS1722.2 equivalents, pipe threads manufactured to meet AS1722.1 have a limited working life if continually disassembled and re-made.

AS 1722.2 FASTENING THREADS OF WHITWORTH FORM (G SERIES)

Commonly termed BSP, M.I., F.I or plumbing thread, the thread will require a sealing aid to effect a positive seal. The sealing agent may take the form of a gasket, o-ring, thread tape, hemp or thread paste. Threads manufactured to AS1722.2 are used extensively in the Plumbing Industry. If used in the correct manner, threads manufactured to AS1722.2 can be disassembled and re-made many times over.

TABLE 2. TUBE THREADS A 'tube thread' is a generic term used for identifying the thread form, of the tube end, of a tube connection fitting and not a specific thread.

Tube O.D.	Standard Compression	Internal Compression	Solder-On	SAE 45 Flare	SAE 45 Inverted Flare	Nicox Air Brake
1/8	5/16 x 24UNF	9/32 x 26brass	5/16 x 26brass	5/16 x 24UNF	5/16 x 28UNS	1/4 x 28UNF
3/16	3/8 x 24UNF	3/8 x 24UNF	1/8 x 28BSP	3/8 x 24UNF	3/8 x 24UNF	3/8 x 24UNF
1/4	7/16 x 24UNS	7/16 x 24UNS	7/16 x 20UNF	7/16 x 20UNF	7/16 x 24UNS	7/16 x 20UNF
5/16	1/2 x 24UNS	1/2 x 24UNS	1/4 x 19BSP	1/2 x 20UNF	1/2 x 20UNF	1/2 x 20UNF
3/8	9/16 x 24UNEF	9/16 x 24UNEF	3/8 x 19BSP	5/8 x 18UNF	5/8 x 18UNF	9/16 x 18UNF
1/2	11/16 x 20UN	3/4 x 24UNS	1/2 x 14BSP	3/4 x 16UNF	3/4 x 18UNS	3/4 x 16UNF
5/8	n/a	7/8 x 20UNEF	n/a	7/8 x 14UNF	n/a	n/a
3/4	n/a	1,025 x 18UNS	n/a	11/16 x 14UNF	n/a	n/a
4mm	5/16 x 24UNF	n/a	n/a	n/a	n/a	n/a
6mm	7/16 x 24UNS	n/a	n/a	n/a	n/a	n/a
8mm	1/2 x 24UNS	n/a	n/a	n/a	n/a	n/a
10mm	9/16 x 24UNEF	n/a	n/a	n/a	n/a	n/a
12mm	11/16 x 20UN	n/a	n/a	n/a	n/a	n/a

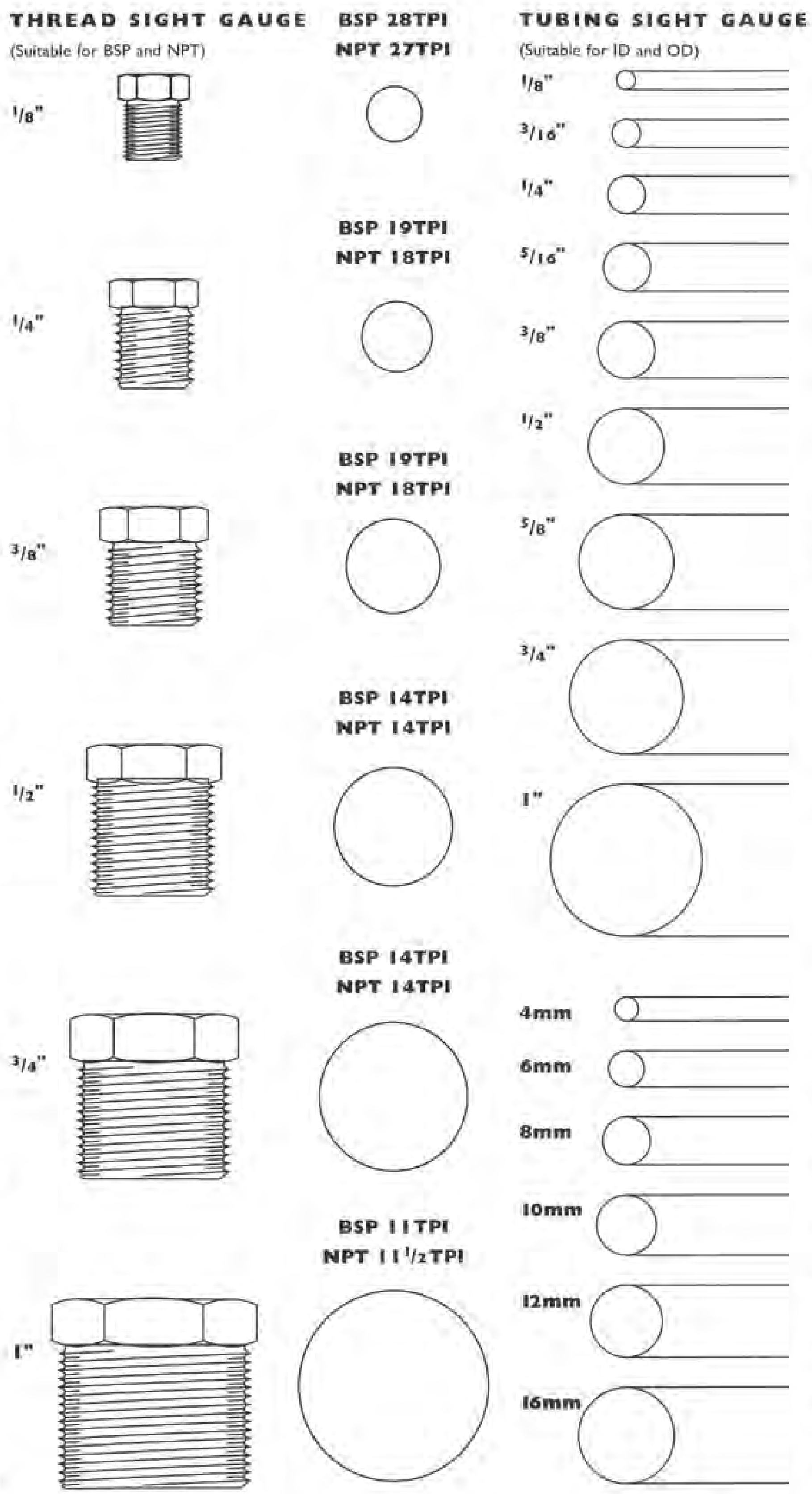
n/a = not available

THREAD ABBREVIATIONS AND DEFINITIONS

The thread types listed below are referenced throughout this catalogue and are representative of some of the common threads and terms used in general industry.

ANP	American National Pipe
ANPT	American National Pipe Taper
AS	Australian Standard
Brass Thread	Fine thread common to brass machining and always 26TPI regardless of major diameter (whitworth form)
BS	British Standard
BSP	British Standard Pipe
BSPP	British Standard Pipe Parallel
BSPT	British Standard Pipe Tapered
Dry Seal	A generic term referring to a thread that seals without the aid of a thread sealant or washer
Engineering Thread	A term referring to a thread capable of sealing without the aid of a thread sealant or washer
F.I.	Female Iron (BSP Female – common in the Plumbing Industry)
GAS	A term referring to BSPT or NPT thread (common in Automotive and Plumbing Industry)
ISO	International Standards Organisation
J.I.C.	Joint Industries Conference or J.I. Case
M.I.	Male Iron (BSP Male – common in the Plumbing Industry)
NPS	National Pipe Straight (American pipe thread)
NPT	National Pipe Taper (American pipe thread)
NPTF	National Pipe Taper Fuel (Internal, straight, American pipe thread)
TPI	Threads per inch
Pipe Thread	A term referring to BSPT/BSPP or NPT/NPS thread
Plumbing Thread	A term referring to a BSP fastening thread
P.T.	Sealing, tapered, pipe thread of whitworth form
SAE	Society of Automotive Engineers
Sealing Thread	A term referring to a thread capable of sealing without the aid of a thread sealant or washer
PSIG	Pounds per square inch gauge
Tube Thread	Thread used on the tube end of a tube connection fitting
UN	Unified National (not standard UNF)
UNEF	Unified National Extra Fine
UNF	Unified National Fine (formerly SAE)
UNS	Unified National Special (not standard UNF)

TUBE & THREAD PROFILE CHART



Useful Information

COMMON ABBREVIATIONS IN THE VALVE INDUSTRY

- **VALVE MATERIAL TEMPERATURE LIMITS**
- **MATERIAL COMPARISON FOR CAST AND FORGED STEEL PRODUCTS**
- **BUTTWELDING END DETAILS**
- **MATERIAL COMPOSITION**
- **PIPE DIMENSIONS**

COMMON ABBREVIATIONS IN THE VALVE INDUSTRY			
ORGANISATIONS/SOCIETIES			
ANSI	American National Standards Institute	**API**	American Petroleum Institute
ASME	American Society of Mechanical Engineers	**ASTM**	American Society for Testing Materials
BS	British Standards	**DIN**	Deutsche Industrie - Normen
BVQI	Bureau Veritas Quality International	**ISO**	International Standards Organisation
VALVE MATERIALS			
Br	Bronze	**A.I.**	All Iron
C.I.	Cast Iron	**M.I.**	Malleable Iron
N.I.	Nickel Iron	**D.I.**	Ductile Iron
C.S.	Cast Steel/Carbon Steel	**F.S.**	Forged Steel
S.S.	Stainless Steel	**PVC**	Polyvinyl Chloride
N	Nickel	**M**	Monel Metal
Mo	Molybdenum	**Al**	Aluminium
Cr	Chromium	**Tef**	Teflon
13% Cr	Type 410 Stainless Steel	**HF**	Hard Face (Stellite Face)
OPERATING MECHANISMS			
O.S. & Y	Outside Screw & Yoke	**N.R.S.**	Non Rising Stem
R.S.	Rising Stem		
END CONNECTIONS			
F.E.	Flanged Ends	**S.E.**	Screwed Ends
F.F.D.	Flanged, Faced & Drilled	**B.W.**	Butt Welding Ends
S.W.	Socket Welding Ends	**Scr.**	Screwed Ends
Flg.	Flanged Ends	**S.J.**	Solder Ends

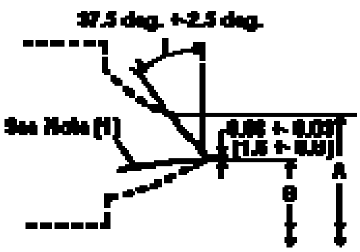
VALVE MATERIAL TEMPERATURE LIMITS		
		DEGREES F
VALVE BODY MATERIAL		
MATERIAL	**LOWER**	**UPPER**
Cast Iron	-20	410
Ductile Iron	-20	650
Carbon Steel - Grade WCB	-20	1000
Carbon Steel - Grade LCB	-50	650
Carbon Moly - Grade WC1	-20	850
1 1/4 Cr - 1/2 Mo - Grade WC6	-20	1000
2 1/4 Cr - 1 Mo - Grade WC9	-20	1050
5 Cr - 1/2 Mo - Grade C5	-20	1100
9 Cr. - 1 Mo - Grade C12	-20	1100
Type 304 SS - Grade CF8	-425	1500
Type 347 SS - Grade CF8C	-425	1500
Type 316 SS - Grade CF8M	-425	1500
3 1/2 Ni - Grade LC3	-150	650
Aluminium	-325	400
Bronze	-325	550
Inconel	-325	1200
Monel	-325	900
Hastelloy B	-325	700
Hastelloy C	-325	1000
Titanium		600
Nickel	-325	500
Alloy 20	-50	300
VALVE TRIM MATERIAL		
Type 304 SS	450	600
Type 316 SS	450	600
Hastelloy B		700
Hastelloy C		1000
Alloy 20	-50	600
Type 416 410 SS 40 RC	-20	800
TFE	-450	450
Neoprene	-40	180

MATERIAL COMPARISON FOR CAST AND FORGED PRODUCTS				
GENERAL CLASSIFICATION	CASTINGS		FORGINGS	
	ASTM	BS	ASTM	BS
Cast Iron	A126 - Class A	1452 - 14	-	-
	A126 - Class B	1452 - 17	-	-
	A126 - Class C	1452 - 20	-	-
Malleable Iron	A197	310 - B18/6	-	-
	A 47 - 32510	- B22/14	-	-
	A 47 - 35018	-	-	-
Ductile Iron	A395	-	-	-
	A536	-	-	-
Carbon Steel	A216 - WCA	-	A105	1503 - 161B
	-	1504 - 161	-	-
	A216 - WCB	1504 - B	A105	1503 - 161C
	A216 - WCC	-	-	-
	-	1504 - C	-	-
Carbon - 1/2 Mo	A217 - WC1	1504 - 240	A182 - F1	1503 - 240B
1/2 Cr - 1/2 Mo - 1/2 Ni	- WC4	-	-	-
1 Cr - 1/2 Mo - 1/2 Ni	A217 - WC5	-	A182 - F12	1503 - 620
1 1/4 Cr - 1/2 Mo	- WC6	1504 - 621	- F11	-
2 1/4 Cr - 1 Mo	- WC9	- 622	- F22	1503 - 622
3 Cr - 1 Mo			- F21	
5 Cr - 1/2 Mo (C0.15)	.	.	- F5	.
5 Cr - 1/2 Mo (C0.25)	A217 - C5	1504 - 625	- F5a	1503 - 625
9 Cr - 1 Mo	A217 - C12	- 629	- F9	.
Carbon Steel for Low Temp.	A352 - LCB	4242 - GRA	A350 - LF1	
13 Cr	A217 - CA15	.	A182 - F6	1503 - 713
18 Cr - 8 Ni (C0.03)	A351 - CF3		- F304L	
18 Cr - 8 Ni (C0.08)	- CF8	.	- F304	- 801
18 Cr - 8 Ni - 2 Mo (C0.03)	A351 - CF3M		- F316L	
18 Cr - 8 Ni - 2 Mo (C0.08)	- CF8M	1632 - GRC	- F316	- 8453
18 Cr - 8 Ni - Cb (C0.08)	A351 - CF8C		- F347	- 821Nb
22 Cr - 12 Ni (C0.08)	- CH18	.	.	.
22 Cr - 12 Ni (C0.10)	- CH10			
22 Cr - 12 Ni (C0.20)	- CH20	.	.	.
23 Cr - 19 Ni (C0.20)	- CK20			
23 Cr - 19 Ni (C0.35)	- HK30	.	.	.
23 Cr - 19 Ni (C0.45)	- HK40			

13 Cr - 33 Ni - Mo (C0.35)	- HT30	.	.	.
15 Cr - 13 Ni - 2 Mo - Cb (C0.10)	CF - 10MC			
19 Cr - 27 Ni - 2 Mo - 3 Cu (C0.07)	- CN7M	.	.	.
8 Cr - 20 Ni (C0.20)			A182 - F10	
HASTELLOY.B	A494 - N - 12MV	.	.	.

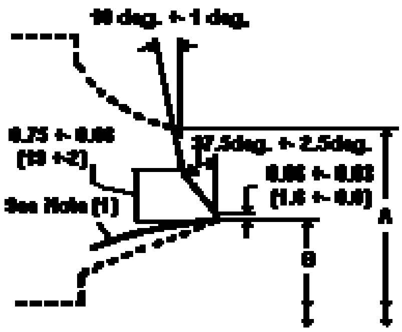
BUTTWELDING END DETAILS

ASME B16.25 - 1997



Welding end detail for joint without backing ring

Welding end details intended for use on 0.88 in. (22 mm) and thinner nominal wall thicknesses



Welding end detail for joint with backing ring

Welding end details intended for use on nominal wall thicknesses greater than 0.88 in. (22 mm)

NOTE: Internal surface may be re-formed or machined for dimensions B at root face. Contour within the envelope is manufacturer's option unless otherwise specifically ordered.

		Pipe Schedule No.	Nominal Pipe Size (inch)						
			2.1/2	3	4	5	6	8	10
A	inch	ALL	2.96	3.95	4.62	5.69	6.78	8.78	10.94
	mm		75	91	117	144	172	223	278
B	inch	40	2.469	3.068	4026	5.047	6.065	7.981	10.020
	mm		63	78	102	128	154	203	255
	inch	60						7.813	9.750
	mm							198	247
	inch	80	2.323	2.900	3.826	4.813	5.761	7.625	9.562
	mm		59	74	97	122	146	194	242
	inch	100						7.437	9.312
	mm							189	237
	inch	120			3.624	4.563	5.501	7.187	9.062
	mm				92	116	140	183	230
	inch	100						7.001	8.750
	mm							178	222
	inch	160	2.125	2.624	3.438	4.313	5.187	6.813	8.500
	mm		54	67	87	110	132	173	216
	inch	XXS	1.771	2.300	3.152	4.063	4.897	6.875	
	mm		45	58	80	103	124	175	

		Pipe Schedule No.	Nominal Pipe Size (inch)						
			12	14	16	18	20	24	
A	inch	ALL	12.97	14.25	16.25	18.28	20.31	24.38	
	mm		329	362	413	464	516	619	
B	inch	STD	12.000	13.250	15.250	17.250	19.250	23.250	
	mm		305	337	387	438	489	591	
	inch	XS	11.750	13.000		17.000	19.000	23.000	
	mm		298	330		432	483	584	
	inch	30						22.876	
	mm							581	
	inch	40	11.938	13.124	15.000	16.876	18.812	22.624	
	mm		303	333	381	429	478	575	
	inch	60	11.626	12.812	14.688	16.500	18.376	22.062	
	mm		295	325	373	419	467	560	
	inch	80	11.374	12.500	14.312	16.124	17.938	21.562	
	mm		289	318	364	410	456	584	
	inch	100	11.062	12.124	13.938	15.688	17.438	20.938	
	mm		281	308	354	398	443	532	
	inch	120	10.750	11.812	13.562	15.250	17.000	20.376	
	mm		273	300	344	387	432	518	
	inch	140	10.500	11.500	13.124	14.876	16.500	19.876	
	mm		267	292	333	378	419	505	
	inch	160	10.126	11.188	12.812	14.438	16.062	19.312	
	mm		257	284	325	367	408	491	

MATERIAL COMPOSITION FOR CAST MATERIAL

	CARBON STEEL			ALLOY STEEL		
ASTM Designation & Grade Identifcation / Elements % by weight	A216 WCB	A352 LCB	A252 LCC	A217 WC6	A217 WC9	A217 CA15
Carbon	0.30 $	0.30 $	0.25	0.05-0.20	0.05-0.18	0.15
Manganese	1.00	1.00	1.20	0.50 - 0.80	0.40 - 0.70	1.00
Phosphorus	0.04	0.04	0.04	0.04	0.04	0.040
Sulphur	0.045	0.045	0.045	0.045	0.045	0.040
Silicon	0.60	0.60	0.60	0.60	0.60	1.50
Copper	0.30 *	0.30 *	0.30 *	0.50 *	0.50 *	
Nickel	0.50 *	0.50 *	0.50 *	0.50 *	0.50 *	1.00
Chromium	0.50 *	0.50 *	0.50 *	1.00 - 1.50	2.00 - 2.75	11.5 - 14.0
Molybdenum	0.20 *	0.20 *	0.20 *	0.45 - 0.65	0.90 - 1.20	0.50
Vanadium	0.03 *	0.03 *	0.03 *			
Tungsten				0.10 *	0.10 *	

* These are residual elements, total content of these shall not exceed 1%.
$ Standard at AIL is 0.25 Max.
Values indicated are maximum except when range is given.

Material / Elements	ASTM A194 Gr. B7	ASTM A320 Gr. L7	ASTM A194 Gr. 2H	ASTM A194 Gr. 7	Hardfacing Stellite 6	ASTM A182 Gr. F6A	ASTM A276 Type 316
Carbon	0.37 - 0.49	0.38 - 0.48	0.40 min	0.37 - 0.49	0.90 - 1.40	0.150	0.80
Manganese	0.65 - 1.10	0.75 - 1.00	1.00	0.65 - 1.10	1.00	1.000	2.000
Phosphorus	0.350	0.035	0.040	0.040		0.040	0.045
Sulphur	0.040	0.040	0.050	0.040		0.030	0.030
Silicon	0.15 - 0.35	0.15 - 0.35	0.40	0.15 - 0.35	2.00	1.000	1.000
Chromium	0.75 - 1.20	0.80 - 1.10		0.75 - 1.20	26.0 - 32.0	11.5 - 13.5	16.0 - 18.0
Molybdenum	0.15 - 0.25	0.15 - 0.25		0.15 - 0.25	1.00		2.0 - 3.0
Nickel					3.00	0.50	10.0 - 14.0
Cobalt					balance		
Tungsten					3.0 - 6.0		
Iron					3.00		
Nitrogen							

A ASTM cross reference material specification of fittings, flanges, unions and cast and forged valves can be found in the table below:

Material	Forgings	Castings	Wrought Fittings
Carbon Steel Cold Temperature Service	A105 A350-LF2	A216-WCB	A234-WPB A420-WPL6
Carbon-1/2 Molybdenum Alloy Steel High Temperature Service	A182-F1	A217-WC1 A352-LC1	A234-WP1
3-1/2 Nickel Alloy Steel Low Temperature Service	A350-LF3	A352-LC3	A420-WPL3
1/2 Cr-1/2 Mo Alloy Steel 1/2 Cr-1/2 Mo-1 Ni Alloy 3/4 Cr-1 Mo-3/4 Ni Alloy Steel 1 Cr-1/2 Mo Alloy Steel	A182-F2 A182-F12 CL2	A217-WC4 A217-WC5	A234-WP12 CL2
1-1/4 Cr-1/2 Mo Alloy Steel 2-1/4 Cr-1 Mo Alloy Steel 5 Cr-1/2 Mo Alloy Steel 5 Cr-1/2 Mo Alloy Steel 9 Cr-1 Mo Alloy Steel 13 Cr Alloy Steel	A182-F11 CL2 A182-F22 CL3 A182-F5 A182-F5a A182-F9 A182-F6	A217-WC6 A217-WC9 A217-C5 A217-C12 A743-CA15	A234-WP11 CL2 A234-WP22 CL3 A234-WP5 A234-WP9

Material	Forgings	Castings	Wrought Fittings
Type 304 Stainless Steel (18 Cr-8 Ni) Standard Low Carbon High Temperature Service	A182-F304 A182-F304L A182-F304H	A351-CF3 A351-CF8	A403-WP304 A403-WP304L A403-WP304H
Type 310 Stainless Steel (25 Cr-20 Ni)	A182-F310H	A351-CK20	A403-WP310
Type 316 Stainless Steel (16 Cr-12 Ni-2 Mo) Standard Low Carbon High Temperature	A182-F316 A182-F316L A182-F316H	A351-CF3M A351-CF8M	A403-WP316 A403-WP316L A403-WP316H
Type 317 Stainless Steel (18 Cr-13 Ni-3 Mo) Type 321 Stainless Steel (18 Cr-10 Ni-Ti) Standard High Temperature Service	A182-F321 A182-F321H		A403-WP317 A403-WP321 A403-WP321H
Type 347 Stainless Steel (18 Cr-10 Ni-Cb) Standard High Temperature Service	A182-F347 A182-F347H	A351-CF8C	A403-WP347 A403-WP347H
Type 348 Stainless Steel (18 Cr-10 Ni-Cb) Standard High Temperature Service	A182-F348 A182-F348H		A403-WP348 A403-WP438H

What is differences between Casting valve material ASTM A352 LCB and A352 LCC, we request in our material requsition for casting valve body in Low Temperature ASTM A352 LCB while Vendor quotation offer ASTM A352 LCC.

The tensile strength of LCB is 450 - 620 N/mm2
The tensile strength of LCC is 485 - 655 N/mm2

The yield of LCB is min. 240 N/mm2
The yield of LCC is min. 275 N/mm2

All other properties are identical. This means that LCC is a better grade than LCB and normally automatically qualifies in case LCB is requested.

The American National Standard for rating valves is ANSI/ASME B16.34 and the rating tables are based on the material yield strength at various temperatures. Below is a comparison for Class 600 valves:

ASTM A352,LCB @100F, 1390 psig, @500F, 1165 psig
ASTM A352,LCC @100F, 1500 psig, @ 500F, 1330 psig

LCC is rated higher based on the increased strength and is generally accepted as a substitute for LCB

Unless my specs are well out of date the main difference I see is that the carbon content of LCB is 0.3% max and LCC is 0.25% max. Consequently LCC is better if welding is a consideration. My normal response is that LCC is basically a subset of LCB, that is all LCC will comply with the requirements of LCB but not the reverse. ASME B16.34 gives differing MOP for LCB and LCC (LCC > LCB), in line with the min tensile properties noted in the above replies. The same holds true for WCB and WCC. The max Manganese content of the "C" is higher than the "B" but in the notes the "B" allows more Manganese the lower the Carbon is relative to the maximum allowance to such an extent that if you have WCB/LCB with Carbon 0.25% (i.e. as per WCC/LCC limits) the max allowable Manganese is as per WCC/LCC!

I have seen WCB/LCB specified with a max Carbon of 0.25%, why the specifying engineer did not just specify WCC/LCC is beyond me.

Cross-Reference of ASTM Material Specifications
Covering Cast and Forged Valves, Fittings, Flanges and Unions

Material	Forgings	Castings	Wrought Fittings
Carbon Steel Cold Temperature Service	A105 A350-LF2	A216-WCB	A234-WPB A420-WPL6
Carbon-1/2 Moly Alloy Steel High Temperature Service	A182-F1	A217-WC1 A352-LC1	A234-WP1
3-1/2 Nickel Alloy Steel Low Temperature Service	A350-LF3	A352-LC3	A420-WPL3
1/2 Cr-1/2 Mo Alloy Steel 1/2 Cr-1/2 Mo-1 Ni Alloy Steel 3/4 Cr-1 Mo-3/4 Ni Alloy Steel 1 Cr-1/2 Mo Alloy Steel	A182-F2 A182-F12 CL2	A217-WC4 A217-WC5	A234-WP12 CL2
1-1/4 Cr-1/2 Mo Alloy Steel 2-1/4 Cr-1 Mo Alloy Steel 5 Cr-1/2 Mo Alloy Steel 5 Cr-1/2 Mo Alloy Steel 9 Cr-1 Mo Alloy Steel 13 Cr Alloy Steel	A182-F11 CL2 A182-F22 CL3 A182-F5 A182-F5a A182-F9 A182-F6	A217-WC6 A217-WC9 A217-C5 A217-C12 A743-CA15	A234-WP11 CL2 A234-WP22 CL3 A234-WP5 A234-WP9
Type 304 Stainless Steel (18 Cr-8 Ni) Standard Low Carbon High Temperature Service	A182-F304 A182-F304L A182-F304H	A351-CF3 A351-CF8	A403-WP304 A403-WP304L A403-WP304H
Type 310 Stainless Steel (25 Cr-20 Ni) Type 316 Stainless Steel (16 Cr-12 Ni-2 Mo) Standard Low Carbon High Temperature	A182-F310H A182-F316 A182-F316L A182-F316H	A351-CK20 A351-CF3M A351-CF8M	A403-WP310 A403-WP316 A403-WP316L A403-WP316H
Type 317 Stainless Steel (18 Cr-13 Ni-3 Mo) Type 321 Stainless Steel (18 Cr-10 Ni-Ti) Standard High Temperature Service	A182-F321 A182-F321H		A403-WP317 A403-WP321 A403-WP321H
Type 347 Stainless Steel (18 Cr-10 Ni-Cb) Standard High Temperature Service	A182-F347 A182-F321H	A351-CF8C	A403-WP347 A403-WP347H
Type 348 Stainless Steel (18 Cr-10 Ni-Cb) Standard High Temperature Service	A182-F348 A182-F348H		A403-WP348 A403-WP348H

Forging Materials

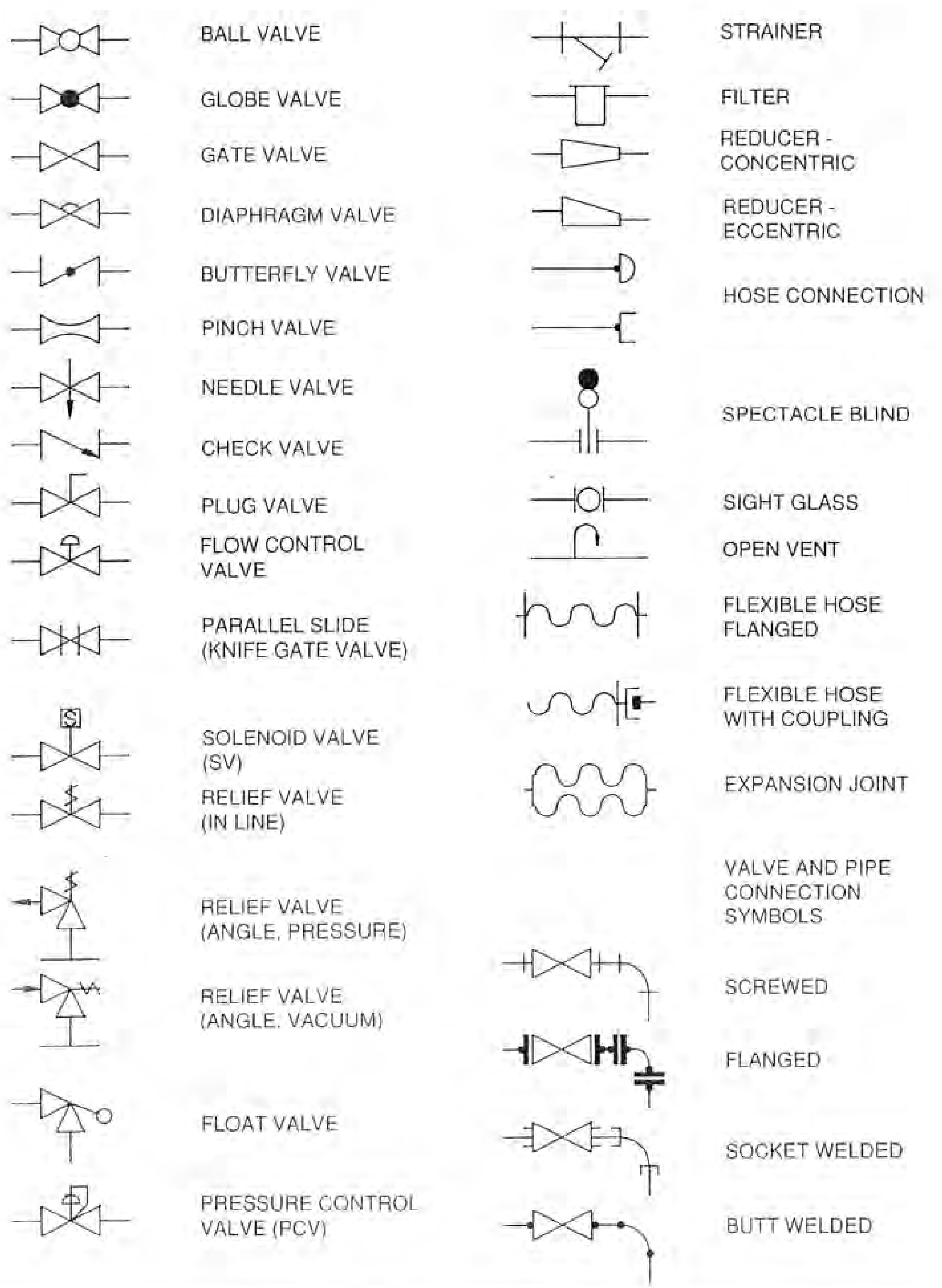
Chemistry Element – % Composition	Mechanical Properties		Chemistry Element – % Composition	Mechanical Properties	
ASTM A105 Carbon Steel Where temperatures are moderate and corrosion resistance is not critical.			**ASTM A182, Grade 5 – 4-6% Chromium 1/2% Molybdenum** With moderately corrosive fluids and in oil refineries where high temperature stability and oxidation resistance of the lower alloy steels are inadequate.		
C 0.20 - 0.24 Mn 1.00 - 1.35 Si 0.15 - 0.30 P .030 Max. S 0.015 - 0.040 Cr 0.20 Ni 0.20 Mo 0.06 V 0.02 Cb 0.02 Cu 0.20 Pb 0.02 Total Residuals = 0.50	TS Min. psi(MPa) YS Min. psi(MPa) EL (2” Min.) RA Min. Hardness, Bhn	70,000(485) 36,000(250) 22% 30% Max. 187	C 0.15 Max. Mn 0.30 - 0.60 P .030 Max. S 0.015 - 0.035 Si 0.50 Max Ni 0.50 Max Cr 4.00 - 6.00 Mo 0.44 - 0.65	TS Min. psi(MPa) YS Min. psi(MPa) EL (2” Min.) RA Min. Hardness, Bhn	70,000(485) 40,000(275) 20% 35% 143-217
ASTM A350, LF2 Where cold temperature (-50°F) impact strength is essential.			**ASTM A182, Grade F9 – 9% Chromium** For services where the higher chrome alloys are preferred and where high temperature stability and oxidation resistance of the lower alloy steels are inadequate.		
C 0.20 - 0.24 Mn 1.00 - 1.35 Si 0.15 - 0.30 P .030 Max. S 0.015 - 0.040 Cr 0.20 Ni 0.20 Mo 0.06 V 0.02 Cb 0.02 Cu 0.20 Pb 0.02 Total Residuals = 0.50	TS Min. psi(MPa) YS Min. psi(MPa) EL (2” Min.) RA Min. Hardness, Bhn -50°F Charpy Energy (Ft./Lb.) Average of Each Set of 3 Specimen For One Specimen	70,000(485) 36,000(250) 22% 30% Max. 197 Min. Impact (J) 15(20) 12(16)	C 0.15 Max. Mn 0.30 - 0.60 P .030 Max. S 0.030 Max Si 0.50 - 1.00 Cr 8.00 - 10.00 Mo 0.90 - 1.10	TS Min. psi(MPa) YS Min. psi(MPa) EL (2” Min.) RA Min. Hardness, Bhn	85,000(585) 55,000(380) 20% 40% 179-217
ASTM A182, Grade F11, Class 2 – 1 1/4% Chromium 1/2% Molybdenum To minimize graphitization encountered with carbon and carbon moly steels at high temperatures.			**ASTM A182, Grade F316. Grade F316L – 18% Chromium 8% Nickel 2-3% Molybdenum** For corrosion resistance applications where high temperature strength is required. Has restricted carbon level to minimize sensitization. Do not use for service temperatures above 1000°F.		
C 0.10 - 0.15 Mn 0.30 - 0.80 P .040 Max. S 0.015 - 0.035 Si 0.50 - 1.00 Cr 1.00 - 1.50 Mo 0.44 - 0.65	TS Min. psi(MPa) YS Min. psi(MPa) EL (2” Min.) RA Min. Hardness, Bhn	70,000(485) 40,000(275) 20% 30% 143-207	C 0.035 Max. Mn 2.00 Max. P .040 Max. S 0.020 - 0.030 Si 1.00 Max Ni 10.00 - 14.00 Cr 16.00 - 18.00 Mo 2.00 - 3.00	TS Min. psi(MPa) YS Min. psi(MPa) EL (2” Min.) RA Min.	75,000(515) 30,000(205) 30% 30%
ASTM A182, Grade F22, Class 3 – 2 1/4% Chromium 1% Molybdenum Where elevated temperature, surface stability, and greater strength than F11 are needed.			**ASTM A182, Grade F316H – 18% Chromium 8% Nickel 2-3% Molybdenum** For corrosion resistance applications where extreme high temperature service is expected. Has a restricted carbon range for high temperature strength above 1000°F.		
C 0.15 Max. Mn 0.30 - 0.60 P .040 Max. S 0.015 - 0.035 Si 0.50 Max Cr 2.00 - 2.50 Mo 0.87 - 1.13	TS Min. psi(MPa) YS Min. psi(MPa) EL (2” Min.) RA Min. Hardness, Bhn	75,000(515) 40,000(310) 20% 30% 156-207	C 0.04 - 0.10 Mn 2.00 Max. P .040 Max. S 0.020 - 0.030 Si 1.00 Max Ni 10.00 - 14.00 Cr 16.00 - 18.00 Mo 2.00 - 3.00	TS Min. psi(MPa) YS Min. psi(MPa) EL (2” Min.) RA Min.	75,000(515) 30,000(205) 30% 30%

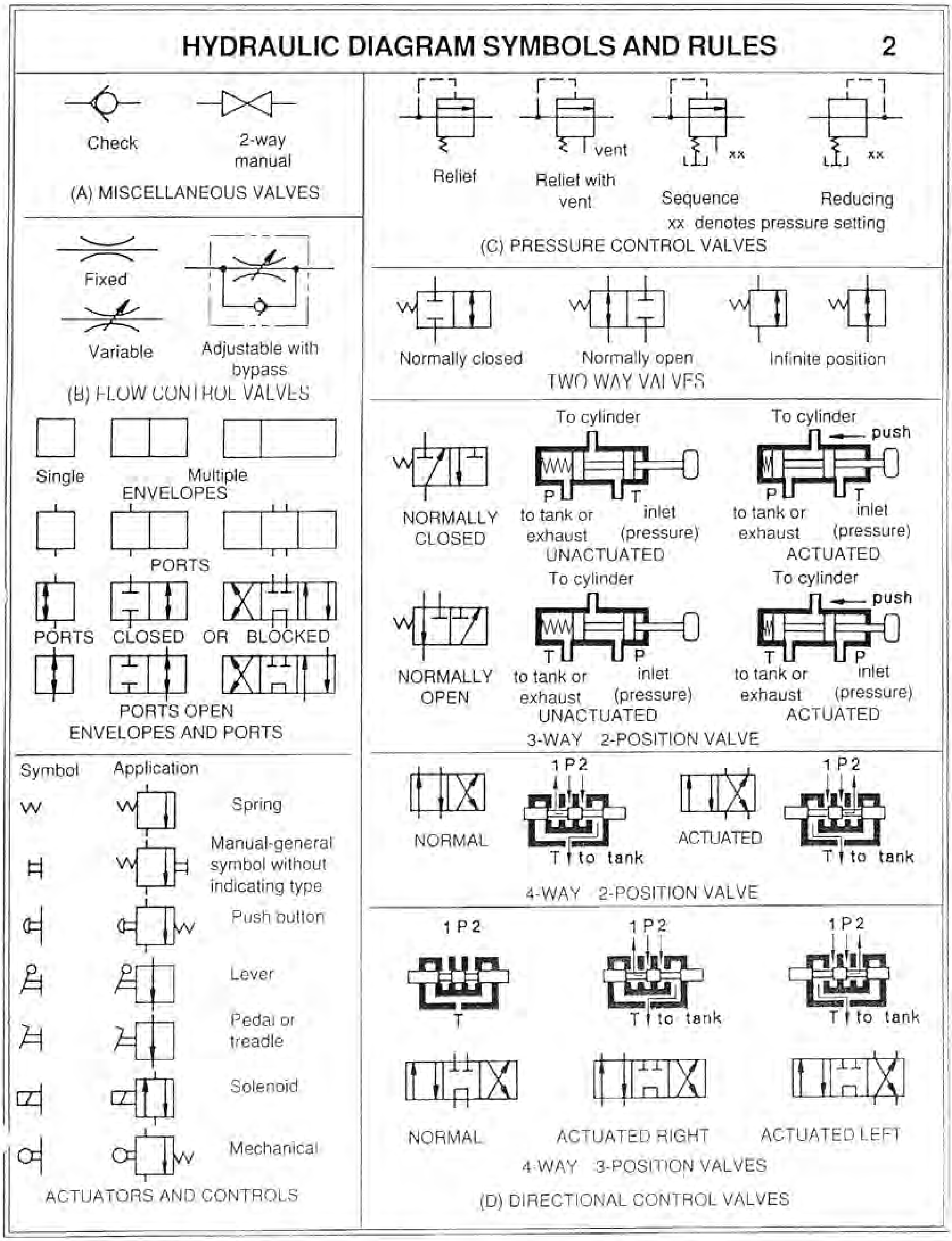
Valve Trim Materials

Description & General Use	Chemistry Element % Composition	Description & General Use	Chemistry Element % Composition
13% Chromium Stainless Steel Type 410 ASTM A479 This stainless steel material lends itself readily to hardening by heat treatment and is excellent for contacting parts such as stems, gates, and discs.	C 0.10- 0.15 Mn .60 Max. P .040 Max. S .030 Max. Si 1.00 Max Cr 12 - 13.5	**Cobalt Base and Nickel Base Hard Facing Materials ASME SFA 5.13** Hard facing materials, when used on seating surfaces of Gate, Globe, and Check Valves, give extended service life and troublefree operation.	– Cobalt, Chromium and Tungsten Alloy – Nickel, Chromium and Boron Alloy
13% Chromium Stainless Steel Type 416 ASTM A582 High quality stainless steel yoke nut material having excellent anti-galling characteristic for better operating threads.	C 0.11- 0.14 Mn .60 Max. P .060 Max. S 0.25 - 0.35 Si 1.00 Max Cr 12.00 - 14.00 Ni .60 Max.	**Nickel-Moly-Chromium ASTM B574, Grade N 10276 Hastelloy C-276** A high nickel alloy with exceptional resistance to corrosive attack by chlorine gas.	C .02 Max. Fe 4.00 - 7.00 Ni Balance Si 0.08 Max Co 2.5 Max. Mn 1.00 Max. Cr 14.50 - 16.50 V .35 Max. Mo 15.00 - 17.00 P .04 Max. W 3.00 - 4.50 S .03 Max.
18% Chromium 8% Nickel, 2% Molybdenum Stainless Steel Type 316 Type 316L ASTM A182 Provides excellent resistance to corrosive media at high temperatures and toughness for service at low temperatures.	C .035 Max. Mn 2.00 Max. P .040 Max. S 0.020 - .030 Si 1.00 Max Cr 16.00 - 18.00 Ni 10.00 - 14.00 Mo 2.00 - 3.00	**Precipitation Hardened Stainless Steel A564, Gr. 630 17-4 PH** Provides corrosion resistance and high strength for stems in NACE applications.	C 0.07 Max Cr 15.00 - 17.50 Mn 1.00 Max. Ni 3.00 - 5.00 P .04 Max. Cu 3.00 - 5.00 S .03 Max. Cb 0.15 - 0.45 Si 1.00 Max +Ta
Nickel-Copper Monel Alloy K500 FED-SPEC QQ-N-286F Class A This wrought material is precipitation hardened and possesses excellent corrosion resistance, high strength properties and hardness for internal valve components.	C .25 Max. Mn 1.50 Max. S 0.010 Max. Ni 63.00 - 70.00 Si .50 Max Fe 2.00 Max Al 2.3 - 3.15 Ti .35 - .85 Cu 27.0 - 33.0 P 0.020 Zn 0.020	**S-Monel ASTM A-494, Grade M-25S** Material used for Monel castings.	C .25 Max. Ni .03 Mn 1.50 Fe Balance Si 3.5 - 4.5 Cu 3.5 P .03 27.00 - 33.00

	Pb 0.006 Sn 0.006		
Monel Alloy 400 ASTM B164 (N0400) Non hardened alloy, except by work hardened, that has high strength and toughness over a wide temperature range. Has excellent corrosion resistance in chlorine and alkylation service.	C .030 Max. Mn 2.00 Max. S .024 Max. Si 0.50 Max Ni 63.00 - 70.00 Fe 2.50 Max Cu 27.0 - 33.0	**ASTM A-743, Grade CA-15** Material used for 13 CR castings, the cast equivalent to type 410 Stainless Steel.	C .15 Max. S .040 Max. Mn 1.00 Cr 11.50 - 14.00 Si 1.50 Max. Ni 1.0 Max. P .040 Mo .50 Max.
		Cast Cobalt ASME-SFA–5.13 RCoCr-A Material used for Cobalt castings, the cast equivalent to Stellite #6.	C 0.9-1.4 Mo 1.0 Mn 1.0 W 3.5 - 5.5 Si 1.5 Fe 3.0 Ni 3.0 Others .50 Cr 27.0 - 31.0 Co Balance
		ASTM A351 Grade CF8M Material used for 18-8 castings, the cast equivalent to type 316 stainless steel.	C 08 Max Cr 18.0-21.0 Mn 1.50 Max P .040 Max Ni 9.0-12.0 S .040 Max Si 1.50 Max Mo 2.0-3.0

SCHEMATIC VALVE AND PIPING SYMBOLS




HYDRAULIC DIAGRAM SYMBOLS AND RULES 2
Check
2-way manual
(A) MISCELLANEOUS VALVES
Fixed
Variable
Adjustable with bypass
(B) FLOW CONTROL VALVES
Single
Multiple
ENVELOPES
PORTS
PORTS CLOSED OR BLOCKED
PORTS OPEN
ENVELOPES AND PORTS
Symbol
Application
Spring
Manual-general symbol without indicating type
Push button
Lever
Pedal or treadle
Solenoid
Mechanical
ACTUATORS AND CONTROLS
Relief
vent
Relief with vent
Sequence
Reducing
xx denotes pressure setting
(C) PRESSURE CONTROL VALVES
Normally closed
Normally open
Infinite position
TWO WAY VALVES
To cylinder
push
NORMALLY CLOSED
to tank or exhaust
inlet (pressure)
UNACTUATED
ACTUATED
NORMALLY OPEN
3-WAY 2-POSITION VALVE
NORMAL
ACTUATED
T to tank
4-WAY 2-POSITION VALVE
ACTUATED RIGHT
ACTUATED LEFT
4-WAY 3-POSITION VALVES
(D) DIRECTIONAL CONTROL VALVES

Boiler Blowdown

A blowdown of the boiler is a routine operation necessary due to the increased concentration of **Total Dissolved Solids –TDS** in the boiler during the steam production.

The blow down rate of a boiler depends on

- **Steam consumption (steam used in the process and not returned as condensate to the boiler)**
- **Concentration of impurities in the feed water**
- **Maximum allowable TDS in the boiler**

The blowdown rate can be calculated as

$q_{BD} = q_S f_c / (b_c - f_c)$ (1)

where

q_{BD} = blowdown rate (kg/h)

q_S = steam consumption (kg/h)

f_c = Total Dissolved Solids - TDS - in the feed water (ppm)

b_c = maximum allowable Total Dissolved Solids - TDS - in the boiler water (ppm)

Common Formula / Rule of Thumb

1 Boiler MW = 100HP = 1,000kW = 1,595 kg/hr (from & at 100°C at atmospheric pressure).

A lift of 1 metre imposes a back pressure of 10kPa.

The pressure in the condensate line generally will be 10% of the steam pressure.

If 1 litre of condensate is discharged to atmosphere, 10 % will flash off to steam.

Steam Trap Selection

For process applications –use a float or bucket type with inbuilt air vent

For main steam lines –use a thermodynamic

For Hospital Sterilisers –Use a balanced pressure type with near to steam element

For heat tracing –Use a bimetallic

Control Valve Sizing

For closed loop systems –size the valve with 20% pressure drop

For direct injection systems –size the valve with a 35% pressure drop

Tank Heating Steam Loads kg/hr

1a –If heating through a coil

$$\text{Steam Flow per hour} = \frac{4.19 \times \text{litres} \times (T1 - T2)}{\text{Latent Heat of Steam}}$$

1b –If direct injection

$$\text{Steam Flow per hour} = \frac{4.19 \times \text{litres} \times (T1 - T2)}{\text{Total Heat of Steam}}$$

Note – if heat up time was 30min, multiply above by 2, if 15mins multiply by 4 etc. if heat up time was 2 hours, divide above by 2 etc.

Tank Volume

Circular Tank Volume in litres = 3.14 x r2x h x 1000
(Note, r and h are in metres)

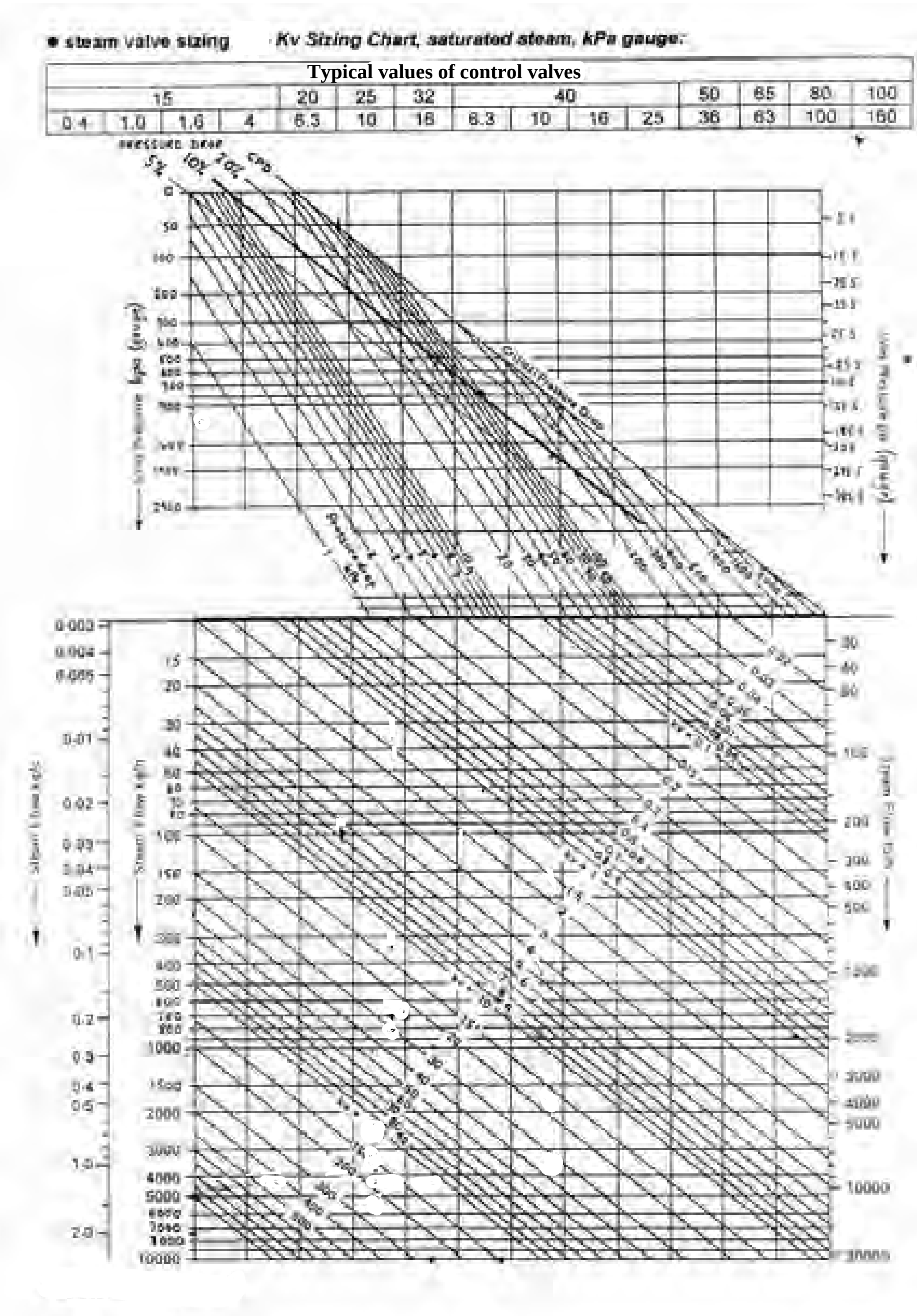
Heat Exchanger Steam Loads kg/hr

$$\text{Steam Flow per hour} = \frac{4.19 \times \text{litres/hr} \times (T1 - T2)}{\text{Latent Heat of Steam}}$$

Pipe Expansion

The table below can be used to calculate the expansion of steam pipes at different operating temperatures.

Steam Temperature (°C)	Expansion pr. 100m Pipe (mm)
66	63
93	96
121	136
149	166
177	203
204	246
232	279
260	323


● steam valve sizing
Kv Sizing Chart, saturated steam, kPa gauge:
Typical values of control valves
15 | 20 | 25 | 32 | 40 | 50 | 65 | 80 | 100
0.4 | 1.0 | 1.6 | 4 | 6.3 | 10 | 16 | 6.3 | 10 | 16 | 25 | 36 | 63 | 100 | 160
PRESSURE DROP
5% 10% 20% CPD
Critical Pressure Drop
Steam Flow kg/s
Steam Flow kg/h

Boiler output is always stated 'from & at 0kPag and fed with water at 100°C. The actual capacity uses the correction factor below for the actual boiler operating pressure and the actual feedwater temperature. The correction factor is divided into the 'from & at 'rating.

Gauge Pressure kPa

Water Temp°C	70	140	350	500	700	1000	1200	1500	1800
4	1.18	1.19	1.21	1.21	1.21	1.22	1.22	1.23	1.23
10	1.17	1.18	1.2	1.2	1.21	1.21	1.21	1.22	1.22
16	1.16	1.17	1.18	1.19	1.2	1.2	1.2	1.21	1.21
27	1.14	1.15	1.16	1.17	1.18	1.18	1.18	1.19	1.19
38	1.12	1.13	1.14	1.15	1.15	1.16	1.16	1.17	1.17
49	1.1	1.11	1.12	1.13	1.13	1.14	1.14	1.15	1.15
60	1.08	1.09	1.1	1.11	1.11	1.12	1.12	1.13	1.13
71	1.06	1.07	1.08	1.09	1.09	1.1	1.1	1.1	1.11
82	1.04	1.05	1.06	1.07	1.07	1.08	1.08	1.08	1.09
93	1.02	1.03	1.04	1.05	1.05	1.06	1.06	1.06	1.07
99	1.01	1.02	1.03	1.04	1.04	1.05	1.05	1.05	1.06

Pressure (bar)	Nominal Pipe Size (mm)											
	50	65	80	100	125	150	200	250	300	350	400	450
1	11	17	22.5	32	43	56.5	87	120	160	188	246	310
	9	11	14	17	20.5	26	32	40	46	50	56	62
2	12.5	20	26	38	50	65	98	140	184	216	284	358
	11	12	15	19	23	27	36	44	52	56	64	70
3	14	22	28.5	41	52	72	108	158	202	240	312	394
	12.5	14.5	17	22	28	32	40.5	50	60	64.5	54.5	80.5
4	15	24	31	44.5	60	79	118	166	220	262	340	430
	14	18	19	24.5	32.5	37	45	56	67	73	84.5	91
5	16.5	26	34	48	65	84.5	127	140	238	284	370	466
	14.5	18	21	26.5	34.5	40	48.5	61	72.5	80	91	99
6	17	27	35	50	67.5	86.5	132	187	248	294	398	484
	15	19	23	28	36	42.5	52.5	65.5	80	86	100	105
7	17.5	27.5	36	51.5	70	90.5	136	194	256	302	406	500
	16.5	20.5	24.5	30	38	45	56	70	84	92	104	112
8	18	29	38	54	73.5	95	142	201.5	268	316	414	522
	17	21.5	27	32	40	48	60	74	88	98	114	122
9	19	30	40	56	76	99	148	210	278	328	432	544
	18.5	22.5	28	33	41	49	63	78	93	103	120	128
10	20	31	40.5	58.5	80	102.5	154	218	288	342	448	564
	20.5	24	29	34	43	50	66	82	98	108	124	134

Blue highlighted row is condensation rate in kg/hr over a length of 100 metres
White rows are the warm-up load in kg (not kg/hr) over a length of 100 metres

Pressure (bar)	Nominal Pipe Size (mm)											
	50	65	80	100	125	150	200	250	300	350	400	450
12	21	33	43	61.5	84	108	162	230	304	360	472	496
	20.8	26	31.5	35.5	45	52	72	90	106	118	134	146
14	22	34.5	45	64	87	113	170	240	320	378	494	622
	22	28	34	41	51	60	78	98	116	128	146	158
16	26	37	48.5	69	93	121	183	256	344	406	530	668
	24	29.5	36.5	46	55	68	84	104	124	136	156	170
18	33	46.5	62	89.5	124	165	254	374	510	610	786	984
	27	32	39	48	60	71	88	110	132	144	164	180
20	34	52	70	102	142	194	296	440	604	724	930	1164
	29	34	41	50	62	74	92	116	138	152	172	188
25	38	58	78	112.5	156.5	214.5	328	486	666	800	1066	1284
	32.5	38	46	56.5	70	84	104	122	156	172	198	212
30	41	63	82.5	123	171	234	358	530	730	874	1142	1404
	34	42	50.5	63	78	94	108	146	174	192	216	236
40	44.5	68	91.5	134	194	254	388	574	790	946	1216	1504
	41	48	60	75	92.5	112	140.5	174.5	208	228	260	284
50	49	74.5	100	146	202	280	424	628	864	1036	1330	1668
	47	58.5	68.5	87.5	108	130	164	204	242	266	302	330
60	53	81	108.5	159	270	362	610	890	1252	1504	1920	2436
	52	78	77	100	124	147	190	238	280	310	354	400

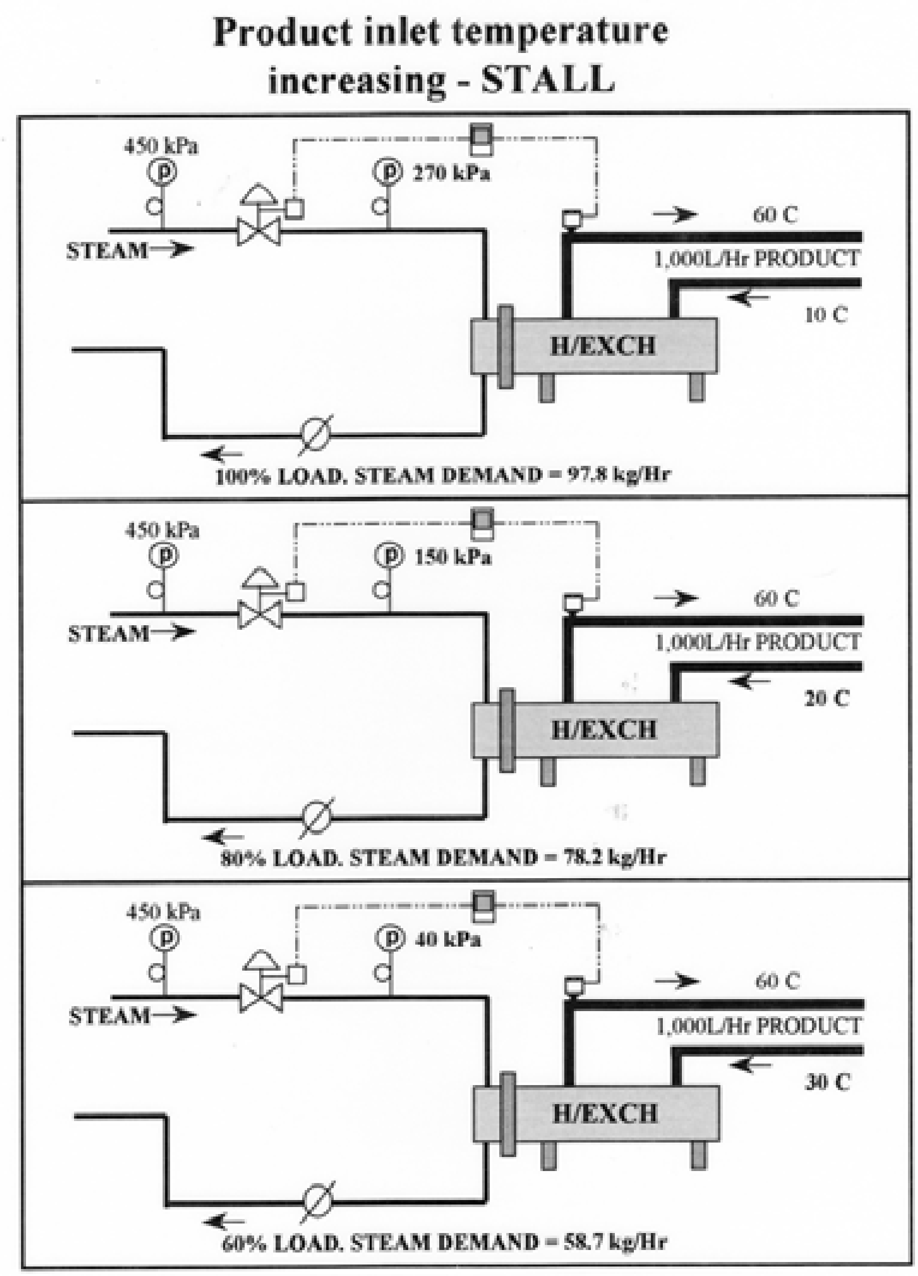
Blue highlighted row is condensation rate in kg/hr over a length of 100 metres
White rows are the warm-up load in kg (not kg/hr) over a length of 100 metres

Industry	Application	Operating Pressure		Consumption production		Consumption maximum	
		psig	*bar*	*lb/h*	*kg/h*	*lb/h*	*kg/h*
Bakeries	Dough room trough, 8 ft long	10	1	5	2		
	Proof Boxes, 500 cu ft capacity	10	1	10	5		
	Ovens		0		0		
	White bread, 120 sq ft surface	10	1	30	14		
	Rye bread, 10 sq ft surface	10	1	60	27		
Breweries	Bottle washing, normal size 100 bottles/min	5	0.3	300	136		
Candy and Chocolate	Candy cooking, 30 gal cooker, 1 hour	70	5	45	20		
	Chocolate melting, jacketed, 24 inch diameter	70	5	30	14		
	Candy kettle per sq ft of jacket	70	5		0	60	27
Creameries and Dairies	Milk quarts per 100 cases per hr	5	0.3	60	27		
	Creamery cans 3 per min	50	3	300	136		
	Pasteurizer per 100 gal heated 20 min	50	3	250	113		

Industry	Application	Operating Pressure		Consumption Production		Consumption Max	
		psig	*bar*	*lb/h*	*kg/h*	*lb/h*	*kg/h*
Hospitals	tills per 100 gal distilled water	50	3	100	45		
	Sterilizers bed pan	50	3	5	2		
	Sterilizers instruments per 100 cu inch	50	3	5	2		
	Sterilizers water per 10 gal	50	3	5	2		
	Disinfecting ovens 100 cu ft, per 10 cu ft	50	3	25	11		
Laundry	Vacuum stills per 10 gal	100	7	15	7		
	Spotting board	100	7	30	14		
	Jacket, dress finisher	100	7	50	23		
	Steam Irons	100	7	5	2		
	Flat iron worker, 48" * 120"	100	7	300	136		
Plastic Molding	12 to 15 sq ft platen surface	125	9	30	14		

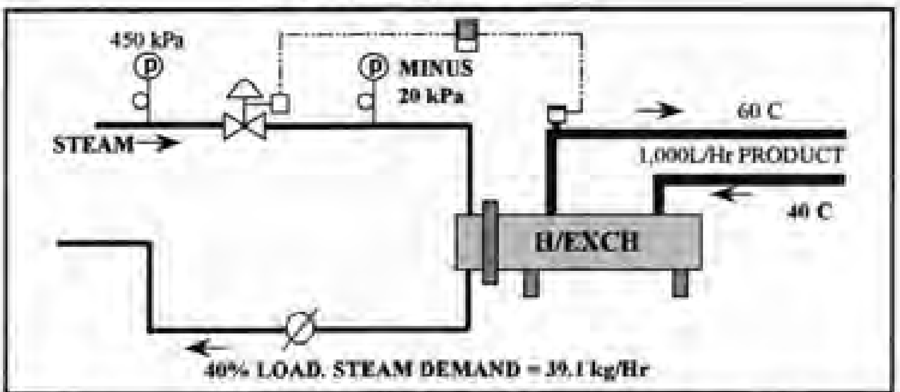
Industry	Application	Operating Pressure		Consumption Production		Consumption Max	
		psig	*bar*	*lb/h*	*kg/h*	*lb/h*	*kg/h*
Paper Production	Corrugators per 1000 sq ft	175	12	30	14		
	Wood pulp paper per 10 lb paper	50	3	400	181		
Restaurants	Dishwasher	20	1	70	32		
	Standard steam tables per ft length	20	1	40	18		
	Bain Marie per ft length 30 " wide	20	1	15	7		
	Oyster steamers	20	1	15	7		
	Clam and lobster steamer	20	1	30	14		
	Steam jacket kettle 10 gal	20	1	15	7	100	45
	Steam jacket kettle 60 gal	20	1	60	27	200	91
	Plate and dish warmers per 100 sq ft	20	1	60	27		
	Warming ovens per 20 cu ft	20	1	30	14		
	Vegetable steamer	20	1	30	14		
	Potato Steamer	20	1	30	14		
Tire Shops	Truck molds	100	7	90	41		
	Passenger molds	100	7	30	14		

Control Valve – Effect of the product inlet temperature increasing (Page 1/2)



Control Valve – Effect of the product inlet temperature increasing (Page 2/2)

Product inlet temperature increasing - STALL



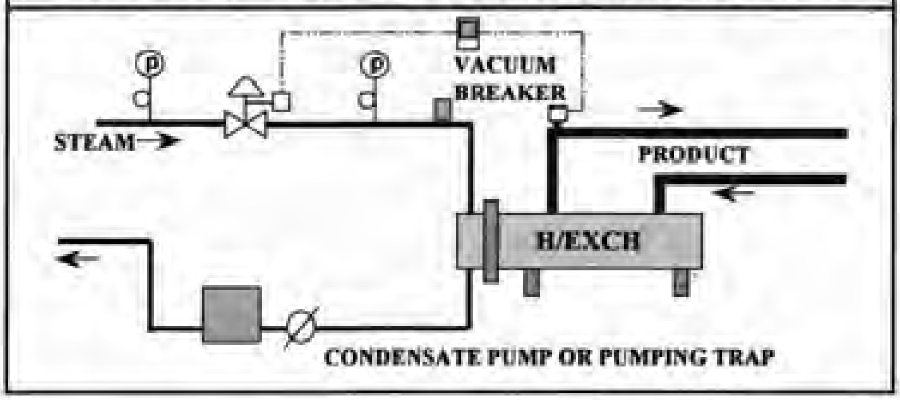
A VACUUM CONDITION EXISTS IN THE STEAM SPACE

This condition will lead to condensate being held up in the heat exchanger, resulting in poor temperature control, waterhammer & corrosion damage

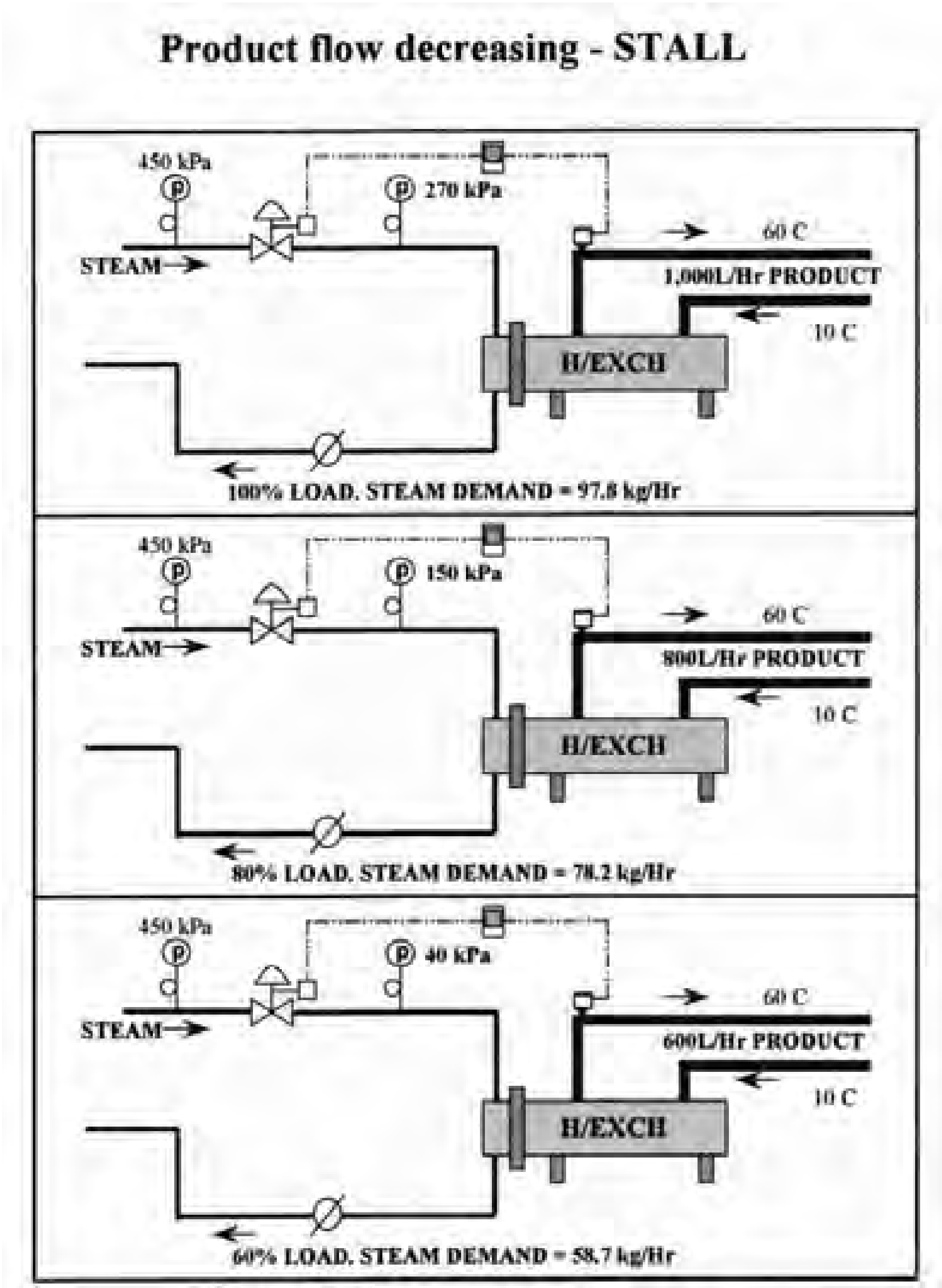
One of the Solutions

A vacuum breaker must be installed on the steam inlet & a condensate pump or pumping trap installed to return the condensate

REFER TO THE CORRECT INSTALATION SHOWN BELOW

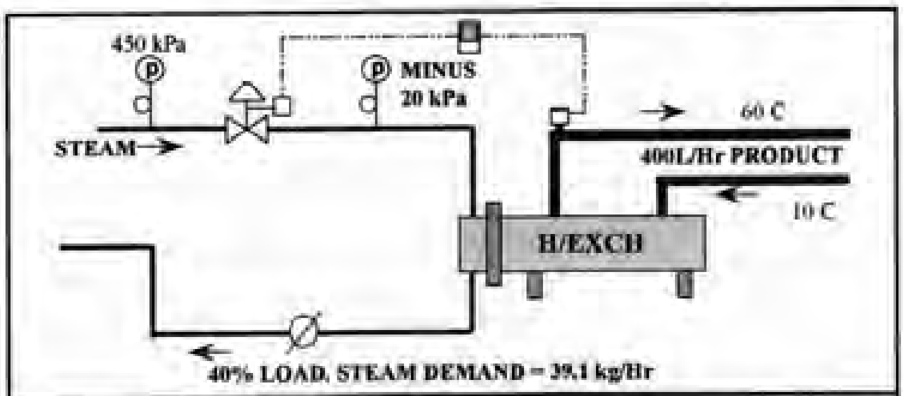


Control Valve – Effect of the product flow decreasing (Page 1/2)



Control Valve – Effect of the product flow decreasing (Page 2/2)

Product flow decreasing - STALL



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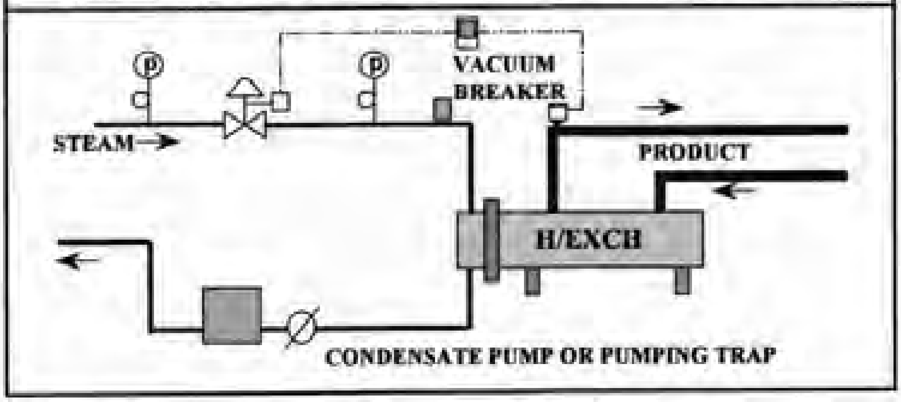

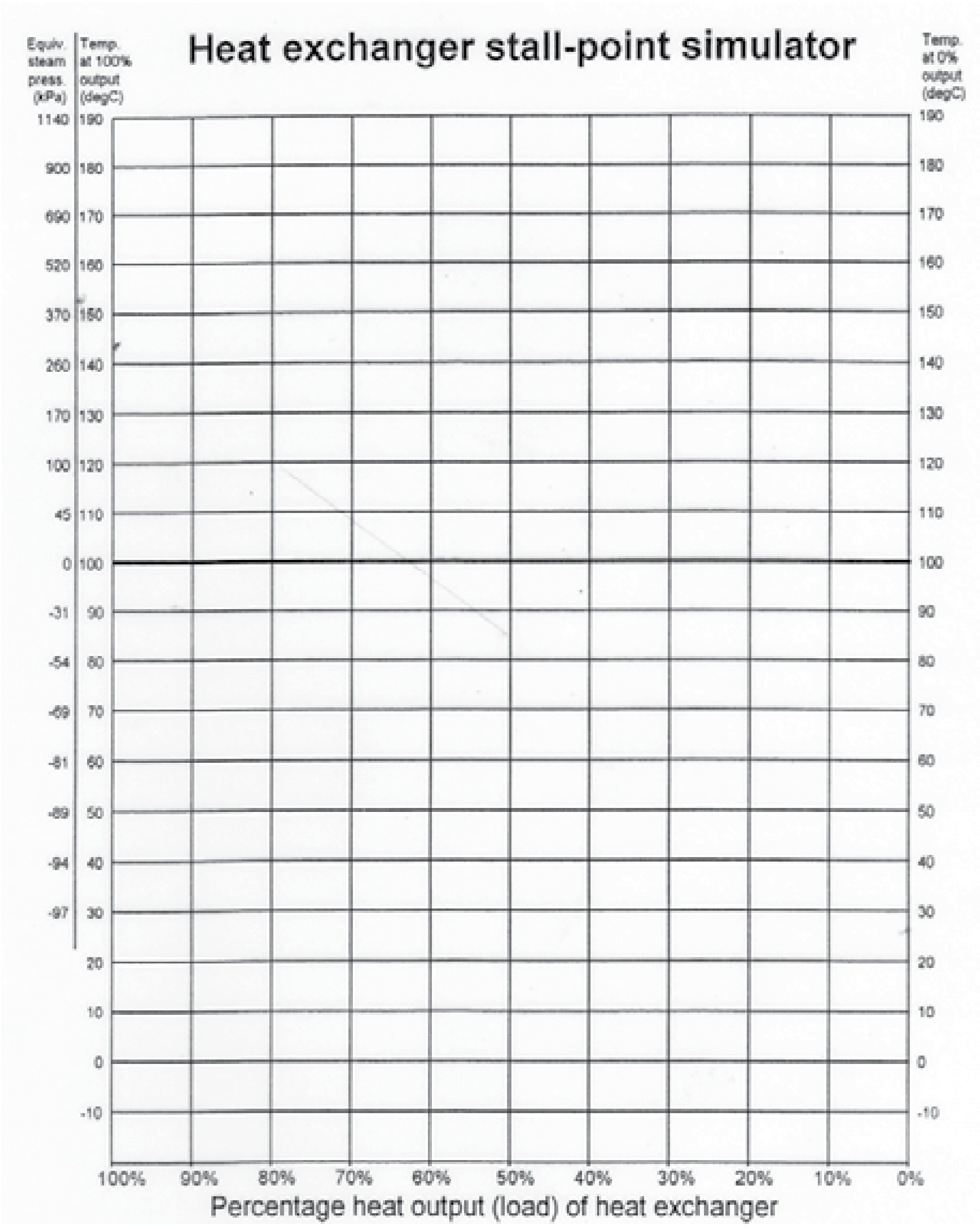
Heat exchanger stall-point simulator
Equiv. steam press. (kPa)
Temp. at 100% output (degC)
Temp. at 0% output (degC)
1140 190
900 180
690 170
520 160
370 150
260 140
170 130
100 120
45 110
0 100
-31 90
-54 80
-69 70
-81 60
-89 50
-94 40
-97 30
20
10
0
-10
100% 90% 80% 70% 60% 50% 40% 30% 20% 10% 0%
Percentage heat output (load) of heat exchanger