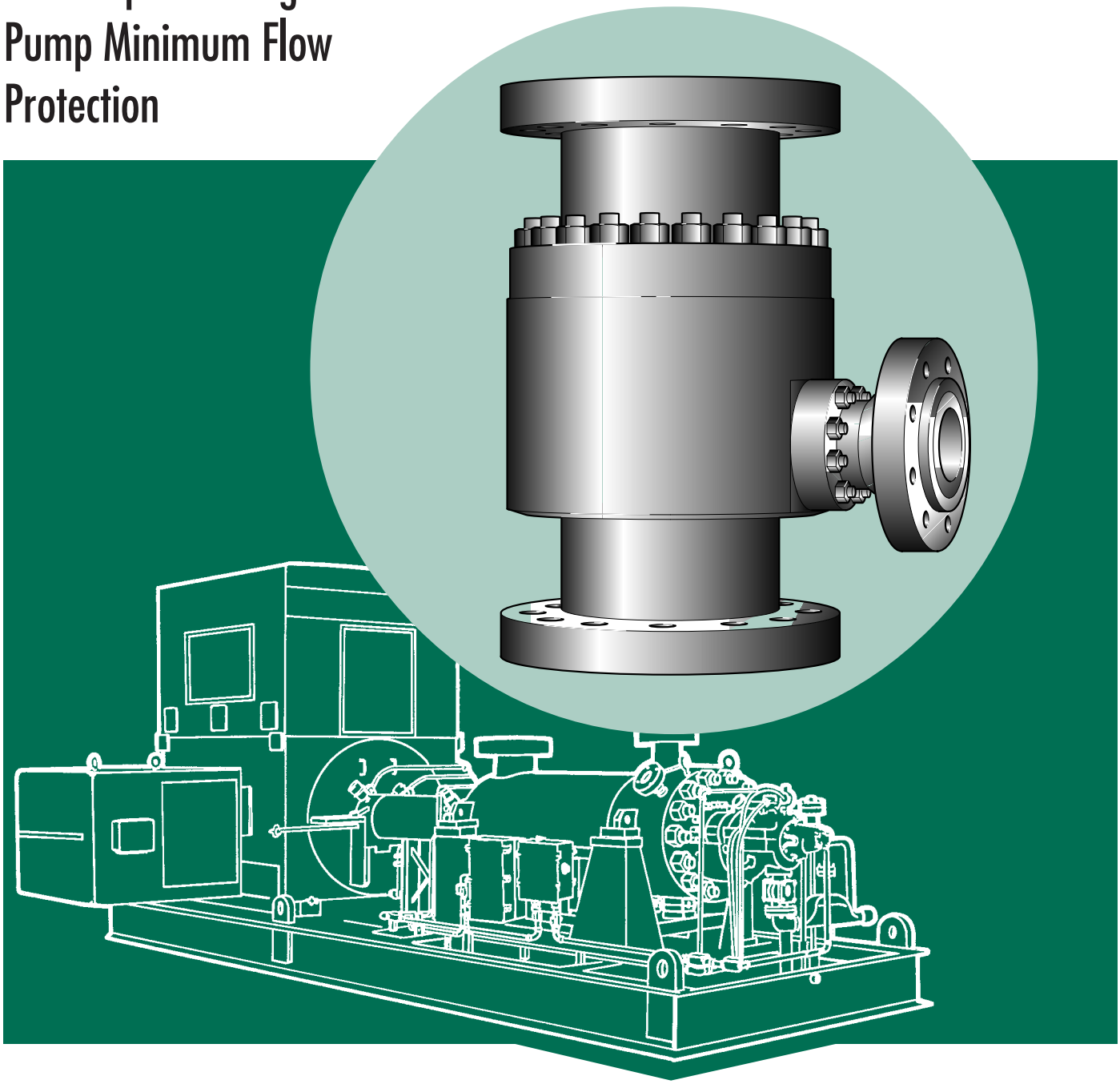
Automatic Recirculation Valves

One Step Centrifugal Pump Minimum Flow Protection

HPM Series



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Centrifugal Pumps Require Protection

If you use centrifugal pumps for any liquid-boiler feed water, condensate, or process fluids, a significant investment has been made in the pump, driver and related controls. Minimum flow protection is vital upon pump start up and low demand conditions. If reliable protection does not exist, the following unfavorable effects can interfere with the performance and reliable operation of the pump.

The liquid's temperature will rise due to friction and hydraulic losses within the pump. **Figure 2a** illustrates the temperature rise in relationship to the H-Q curve. The curve indicates that at or near the best efficiency point, the temperature rise is minimal and not significant to the pump operation. The process flow removes the generated heat from the pump. The temperature increases as the flow through the pump is reduced. Frictional and hydraulic losses generate heat, while the quantity of fluid to which this heat is transmitted is reduced. The rise in temperature results in the formation of vapor. The elevated temperature / vapor pressure of the liquid results in problems ranging from damaged seals and bearings to complete failure of the rotating element.

Internal recirculation within the pump, often termed incipient recirculation, can cause a form of cavitation leading to impeller damage. Internal recirculation is illustrated in **Figures 2b and 2c**.

High specific speed pumps have power curves which rise as the flow reduces. If adequate flow is not maintained, motor overload will result.

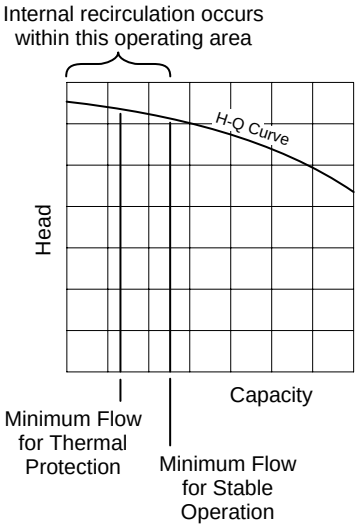
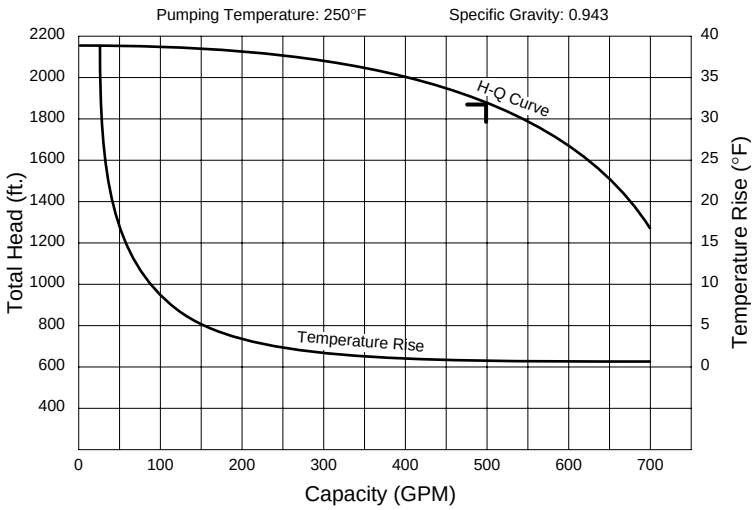
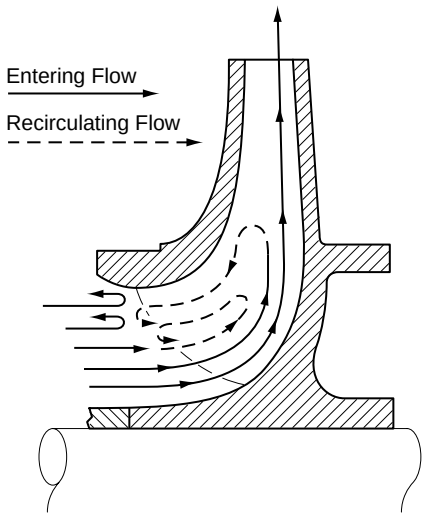


Figure 2b



Typical characteristic curve of a multistage centrifugal pump illustrating temperature rise versus capacity.

Figure 2a



Pump impeller section illustrating the recirculation of liquid at the inlet during operation at low flows.

Figure 2c

Minumum Flow Protection Methods

Centrifugal pumps can be protected by one of three methods:

Continuous Recirculating System

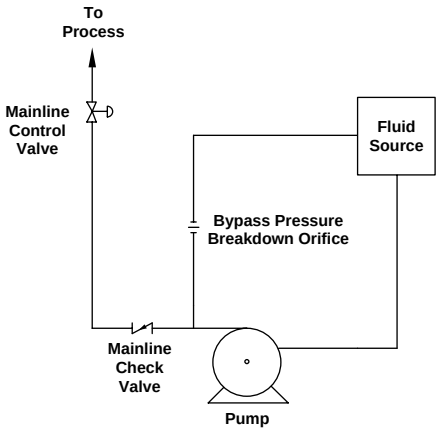
The desired minimum flow volume is recirculated regardless of the system demand for fluid. Fixed orifices reduce the pressure before discharging. Continuous recirculating provides reliable pump protection, however, it is **very inefficient and costly**. The pump and driver must be sized to allow for the additional flow that is recirculating even when the flow demand rate exceeds the required minimum flow. See **Figure 3a**.

Instrument Controlled System

Recirculating occurs only when the process flow demand drops below the required minimum flow rate. Instrument controlled systems eliminate the inefficient and costly to operate constant recirculating systems. However, the necessary system components; check valve, flow meter, pressure reducing valve and related piping result in a **considerable expense** to purchase, install and maintain. See **Figure 3b**.

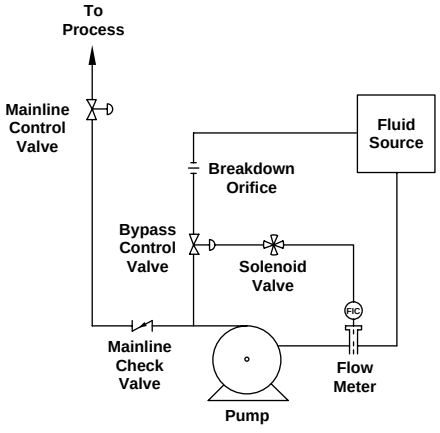
HBE Automatic Recirculating Valves

The automatic recirculating valve performs all flow sensing, bypass pressure reduction, reverse flow protection and modulating recirculating flow in an integral three port valve. The valve performs the same function of an instrumented system without the multitude of components, piping connections and system design expense. The valve is flow operated and does not require any air or electricity to operate. See **Figure 3c**.



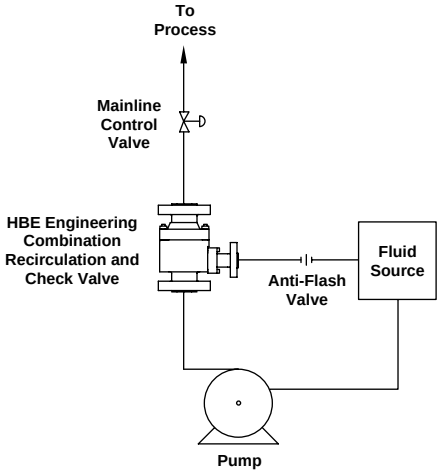
Continuous Recirculation System
(very wasteful of energy)

Figure 3a



Conventional Multi-Component System
(many components to install and maintain)

Figure 3b



HBE Engineering System
(simple, energy efficient and reliable)

Figure 3c

HBE HPM Automatic Recirculation Valve ANSI Class 600-2500

Introduction

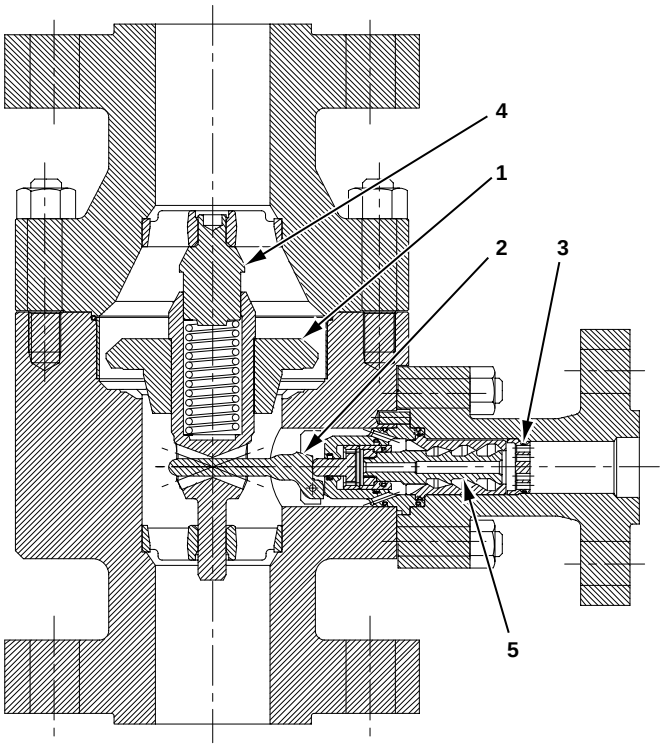
The HPM Series Automatic Recirculation Valve was developed for high pressure centrifugal pump protection. Popular applications include boiler feed water, petroleum fluids, and steel mill hot strip descale water.

The HPM provides economical and reliable protection against low and reverse flow. By combining the functions of main line check valve, flow sensing element, bypass flow control, bypass pressure reduction, pulsation dampener and bypass line check valve, the valve eliminates at least seven components necessary with a conventional system. The valve operates without air or electric power and is easily installed with three connections.

Principle of Operation

The valve is installed on or close to the pump discharge, just as an ordinary check valve would be. Upon pump start-up and without process demand, the bypass is completely open, recirculating the necessary minimum flow. Once process demand starts, the spring loaded disc is lifted and held in position by flow demand. Until main flow demand exceeds recommended minimum flow, the valve will modulate. As the main flow demand increases beyond recommended minimum flow, the bypass will close and all flow will go to the process.

One Valve–Many Functions



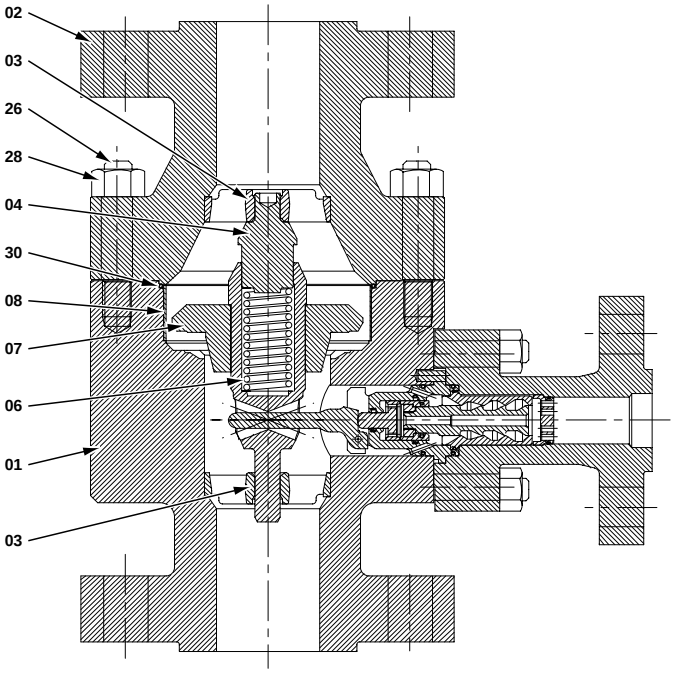
The HPM Series Automatic Recirculation Valve is the one valve that provides at least five essential functions. Following are those functions:

1. **Check Valve Disc** prevents reverse flow and positions the bypass for open, closed or modulating flow by detecting the process flow demand.
2. **Bypass** modulates open when main flow demand falls below the recommended minimum pump flow. Multiple stage pressure reduction prevents flashing/cavitation.
3. **Flow Straightener** eliminates turbulent discharge. Fluid exits valve as a spray rather than a jet. Reduces erosive wear on downstream piping.
4. **Integral Pulsation Dampener** protects system from waterhammer if sudden changes in flow demand occur.
5. **Integral Check Valve** in bypass prevents reverse flow when bypass is routed into a common return line.

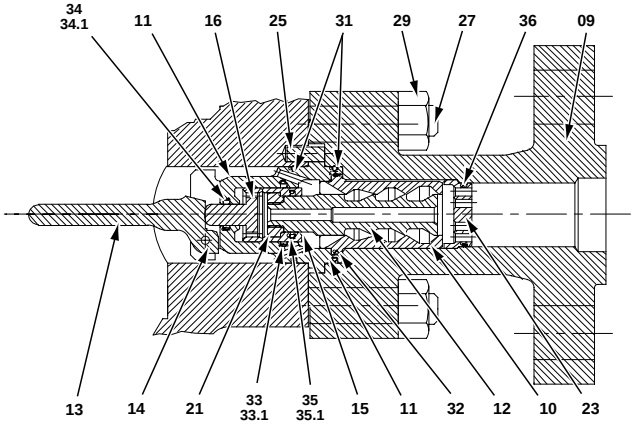
Materials of Construction

Pos.	Description		Material	Specification
01	Lower Body		A105 Carbon Steel	ASME A 105
02	Upper Body		A105 Carbon Steel	ASME A 105
03	Valve Stem Guide		A105 Carbon Steel	ASME A 105
04	Guide Bolt		416 Stainless Steel	ASTM A 582
06	Spring		302 Stainless Steel	AISI 302
07	Check Valve		416 Stainless Steel	ASTM A 582
08	Liner		304 Stainless Steel	ASTM A 276
09	Bypass Branch		A105 Carbon Steel	ASME A 105
10	Vortex Housing		416 Stainless Steel	ASTM A 582
11	Control Head		416 Stainless Steel	ASTM A 582
12	Vortex Plug		431 Stainless Steel	MIL-S-18732D
13	Lever		431 Stainless Steel	MIL-S-18732D
14	Pivot Pin		316 Stainless Steel	AISI 316
15	Vortex Bushing		431 Stainless Steel	MIL-S-18732D
16	Piston		431 Stainless Steel	MIL-S-18732D
21	Vortex Plate		416 Stainless Steel	ASTM A 582
23	Flow Straightener		431 Stainless Steel	MIL-S-18732D
25	Guide Pin		316 Stainless Steel	AISI 316
26	Stud		A193-B7 Steel	ASTM A 193-B7
27	Stud		A193-B7 Steel	ASTM A 193-B7
28	Hex Nut		A194-2H Steel	ASTM A 194-2H
29	Hex Nut		A194-2H Steel	ASTM A 194-2H
30	O-Ring		+	
31	O-Ring		+	
32	O-Ring		+	
33	O-Ring		+	
33.1	Glyd-Ring		Filled PTFE	
34	O-Ring		+	
34.1	Glyd-Ring		Filled PTFE	
35	O-Ring		+	
35.1	Glyd-Ring		Filled PTFE	
36	O-Ring		+	

>>> Recommended spare parts.
Provided as "complete bypass assembly".
+ Application Dependent
For other body materials available, contact HBE with your service conditions.



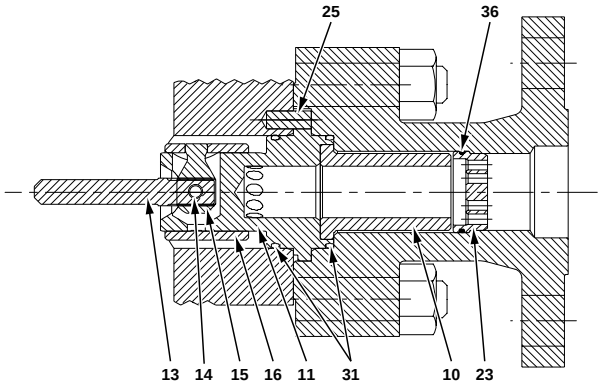
HPM 600 lb.-2500 lb.



HPM 600 lb.-2500 lb. Bypass Detail

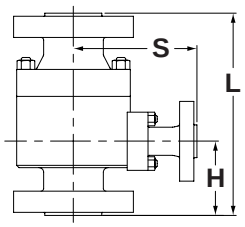
Pos.	Description		Material	Specification
10	Bypass Bushing		416 Stainless Steel	ASTM A582
11	Control Head		416 Stainless Steel	ASTM A582
13	Lever		416 Stainless Steel	ASTM A582
14	Pivot Pin		316 Stainless Steel	AISI 316
15	Crank Arm		416 Stainless Steel	ASTM A582
16	Control Brushing		416 Stainless Steel	ASTM A582
23	Flow Straightener		431 Stainless Steel	MIL-S-18732D
25	Guide Pin		316 Stainless Steel	AISI 316
27	Stud		A193-B7 Steel	ASTM A-193-B7
29	Hex Nut		A194-2H Steel	ASTM A-194-2H
30	O-Ring		+	
31	O-Ring		+	
36	O-Ring		+	

>>> Recommended spare parts.
Provided as "complete bypass assembly".
+ Application Dependent



LPM 150 lb.-300 lb. Bypass Detail

Dimensions, Weights and Flow Ratings



Valve Size			Max. Main Flow		Max. Bypass Flow		Bypass Max. Cv	Weight		Dimensions					
Main	Bypass	ANSI	GPM	M^3h	GPM	M^3h		Lbs.	Kg.	L (in)	L (mm)	H (in)	H (mm)	S (in)	S (mm)
1-1/2	1	150 300 600 900 1500	150	34	60	14	2.9 2.9 1.3 1.1 0.9	42 70 70 70 95	17 32 32 32 43	7-7/8 10–1/4 10–1/4 11-13/16 12-3/16	200 260 260 300 310	2-5/16 3-9/16 3-9/16 4-516 4-3/4	75 90 90 110 120	6-1/8 7-1/2 7-1/2 7-7/8 8-7/16	155 190 190 200 215
2	1	150 300 600 900 1500	220	50	60	14	3.7 3.7 2.7 1.7 1.6	59 90 106 106 130	27 41 48 48 59	9-1/16 11-13/16 11-13/16 13-3/8 13-3/4	230 300 300 340 350	3-9/16 4-1/2 4-5/16 5-1/8 5-1/8	90 115 110 130 130	6-7/16 7-5/16 7-5/8 8 9-3/16	163 185 193 203 233
2-1/2	1-1/2	150 300 600 900 1500	330	75	150	34	6.8 6.8 3.5 2.6 2.4	92 132 152 152 196	41 59 68 68 88	11-7/16 13-3/8 13-3/8 14-15/16 15-3/4	290 340 340 380 400	4-5/16 4-15/16 4-15/16 5-1/2 5-11/16	110 125 125 140 145	6-7/8 7-13/16 8-11/16 9-1/16 9-13/16	174 199 220 230 250
3	1-1/2	150 300 600 900 1500	500	114	150	34	10.1 10.1 5.2 4 3.5	114 163 185 185 268	51 73 83 83 121	12-3/16 14-15/16 14-15/16 16-1/8 17-11/16	310 380 380 410 450	4-1/2 5-1/2 5-1/2 5-7/8 6-1/2	115 140 140 150 165	7-13/16 8-11/16 9-7/16 9-13/16 10-13/16	200 220 240 250 275
4	2	150 300 600 900 1500	900	204	250	57	12.3 12.3 8.5 5.6 5.2	178 246 277 277 431	80 111 125 125 200	13-3/4 16-15/16 16-15/16 17-11/16 20-1/2	350 430 430 450 520	4-15/16 6-1/8 6-1/8 6-5/16 7-1/2	125 155 155 160 190	8-5/16 9-7/16 10-1/2 11 11-13/16	211 240 266 280 300
5	2-1/2	150 300 600 900 1500	1100	250	400	91	21.7 21.7 11 9.5 6.5	268 400 455 455 638	121 180 205 205 287	15-3/4 19-11/16 19-11/16 20-11/16 25-9/16	400 500 500 525 650	5-5/16 6-7/8 6-7/8 7-5/16 9-1/4	135 175 175 185 235	10-1/2 11-7/16 12-3/16 12-3/16 13-7/16	266 290 310 310 341
6	3	150 300 600 900 1500	2000	454	550	125	31 31 14 12 10	398 601 636 636 977	179 270 286 286 440	18-7/8 21-5/8 21-5/8 23-1/16 27-9/16	480 550 550 585 700	6-1/2 7-1/2 7-1/2 7-7/8 9-13/16	165 190 190 200 250	12-1/2 12-5/8 13-3/16 13-3/4 15-15/16	318 320 335 350 405
8	4	150 300 600 900 1500	3300	749	900	204	51 51 22 20 16	774 1027 1102 1102 1727	348 462 496 496 783	23-5/8 25-9/16 25-9/16 26-9/16 33-7/16	600 650 650 675 850	7-7/8 8-7/16 8-7/16 8-7/8 11-5/8	200 215 215 225 295	15 15-13/16 15-15/16 15-15/16 18-11/16	381 402 405 405 475
10	6	150 300 600 900 1500	4400	999	1230	279	86 86 35 25 22	1355 1571 1813 1885 2825	615 712 822 855 1281	28-3/4 30-1/2 31-1/2 31-1/2 38-3/8	730 775 800 800 975	9-7/16 10-1/4 10-5/8 10-5/8 13	240 260 270 270 330	19-1/2 20-1/4 20-1/2 20-1/2 22-7/16	495 515 520 520 568
12	6	150 300 600 900 1500	6600	1498	1900	431	116 116 55 35 30	2825 3265 3771 3920 5876	1281 1481 1710 1778 2665	33-7/16 35-1/2 41-3/8 41-3/8 45-1/4	850 902 1051 1051 1149	11 11-13/16 14-3/16 14-13/16 15-3/4	280 300 360 360 400	20-7/8 21-11/16 25-9/16 25-9/16 27-9/16	530 551 649 649 700

Flow ratings are based on 60° F water with specific gravity of 1.
Contact HBE for 2500 lb. valve data and applications with flows higher than 12" rating.
Dimensions ± 1/8". Dimensions are the same for Flanged and BWE.

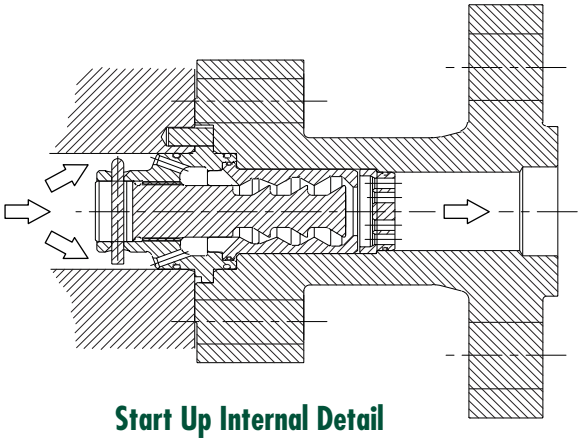
Start Up Internals

One of the most common means of valve damage is start up debris. Regardless of how clean the system is, weld pearls, wear ring particles and other items seem to end up inside control valve internals and damage seating surfaces enough to cause premature leakage.

Take the risk out of start up operations by using start up bypass internals. These factory installed internals take the place of the standard operating internals and provide continuous flow during start up and flush out any debris.

The internals are field adjustable if flow changes are required.

After completion of start up the internals are easily removed and replaced with operating internals.



Start Up Internal Detail

Pump Run Out Protection

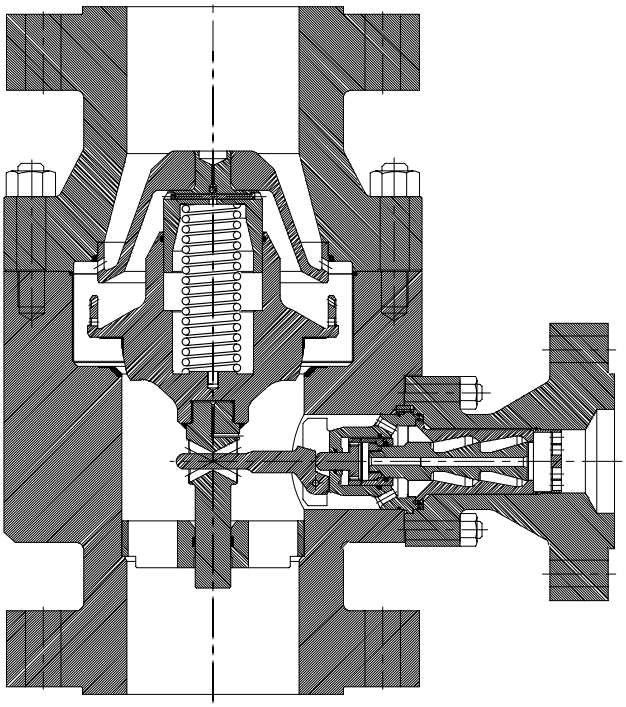
Normally pump protection valves are limited to minimum flow protection; however, severe damage can occur to the pump and driver by exceeding the intended operating range of the pump.

Damage due to excessive flow can be eliminated by designing a “Maxi-Flow” as an addition to the standard minimum flow valve.

Excessive flow protection is achieved by installing an insert with a row of orifice holes into the main valve body. During normal main flow operation the fluid passes through the holes with a minimal pressure head loss. In addition a special disc is provided which has a sleeve around the diameter with a row of orifice holes.

The disc is at full lift when the forward flow reaches the maximum desired flow rate. At full lift the orifice holes in the body insert and disc line up stopping additional flow.

Maximum flow protection prevents exceeding the steam drum desired water level if the drum level control valve failed open in boiler feed service. For process fluids and sea water in which pipe corrosion is a concern the maximum flow protection provides run out protection if piping leaks occur from corrosion.



Run Out Protection Detail

How to Order and Specify

The centrifugal pump shall be protected by the HPM Model automatic recirculation valve which is completely self-contained and fully automatic via flow activation.

The valve protects the pump from reverse flow and prevents overheating during low process demands.

Operation of the valve bypass will be modulating so the sum of the main and bypass flow will never be less than the minimum flow requirement of the pump.

Valve design will incorporate a radial split body spring assisted check valve disc and multi-stage vortex plug bypass assembly. Materials of construction will consist of a A-105 forged carbon steel body housing with stainless steel internals. If service conditions dictate other materials are available such as stainless steel, low temperature steel and other alloys.

The valve will be designed to operate without flashing or cavitation occurring during bypass operation. Any necessary accessories such as orifices or anti-flash valves will be provided by HBE to prevent flashing or cavitation in the bypass piping.

Required Application Data

Main Flow

Minimum	_____	GPM (m^3/hr)
Maximum	_____	GPM (m^3/hr)
Normal	_____	GPM (m^3/hr)
Minimum Pump Flow	_____	GPM (m^3/hr)

Pump Discharger Pressure @

Normal Flow	_____	PSIG (kpa)
Bypass flow	_____	PSIG (kpa)
Shut off	_____	PSIG (kpa)
Bypass Backpressure	_____	PSIG (kpa)

Temperature

Normal	_____	°F (°C)
Maximum	_____	°F (°C)

Liquid

* Specific Gravity	_____	
* Vapor Pressure	_____	psia
* Viscosity	_____	centipoise

(* if other than water)

Valve Model Legend

HPM-24-150-XXXX

Model Designation

LPM - Low pressure modulating automatic recirculating valve with forged body housing. 150 and 300 lb. ANSI Class.

HPM - High pressure modulating automatic recirculating valve with forged body housing. 600, 900, 1500 and 2500 lb. ANSI Class.

Size Code

04 = 1"	20 = 5"
06 = 1.5"	24 = 6"
08 = 2"	32 = 8"
12 = 3"	40 = 10"
16 = 4"	48 = 12"

Pressure Class Code

015 = 150
030 = 300
060 = 600
090 = 900
150 = 1500
250 = 2500

Quote/Order File Number

The example translated is an HPM model, 6" - 1500 lb. flanged valve with an HBE file locator number. A written description of the material of construction and end connections follows this model number.

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