HBE ENGINEERING Inc.

SINCE 1984

Automatic Recirculation Valves

One-Step Minimum Flow Protection · ASME Class 600 – 2500

HPM

KEY FEATURES

- Five functions in one valve
- Multi-stage bypass pressure reduction
- Integral pulsation dampener & check valve
- Self-powered — no air or electricity

HBE Engineering, Inc.

220 Day Dr · Three Rivers, MI 49093 U.S.A.
Phone (269) 279-2035 · Fax (269) 278-6745
www.hbe-engineering.com · sales@hbe-engineering.com

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.

Temperature Rise & Vapor Formation

The liquid's temperature will rise due to friction and hydraulic losses within the pump. Figure 2a illustrates the temperature rise and hydraulic anomalies 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 complet failure of the rotating element.

Minimum Continuous Safe Flow

Minimum continuous safe flow (MCSF) is the flow at which a pump can operate continuously without excessive wear from hydraulic anomalies and temperature rise associated with low-flow conditions.

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

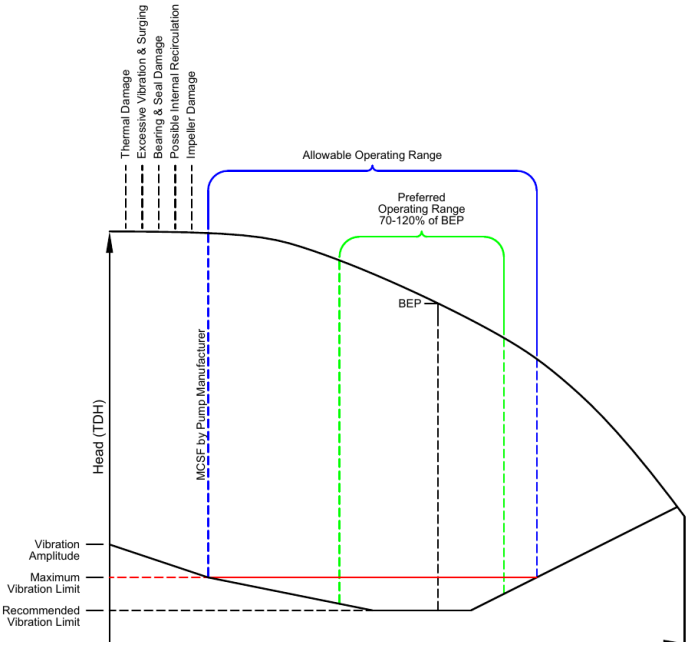


Figure 2b

Pump operation & distress points

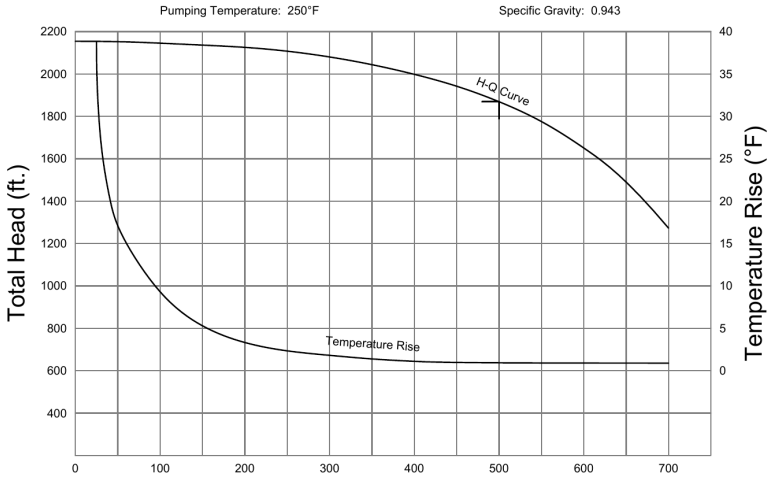


Figure 2a

Characteristic curve: temperature rise vs. capacity

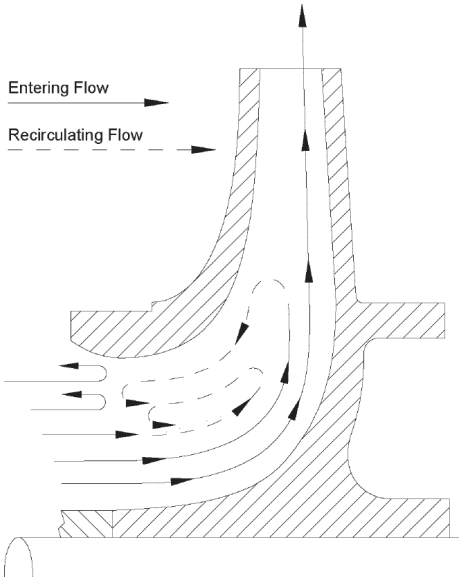


Figure 2c

Impeller section: recirculation at low flow

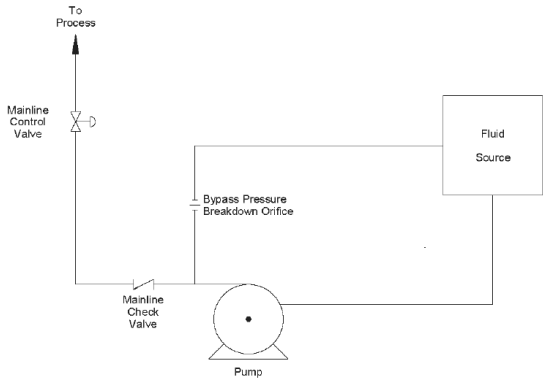
Minimum Flow Protection Methods

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.

Figure 3a

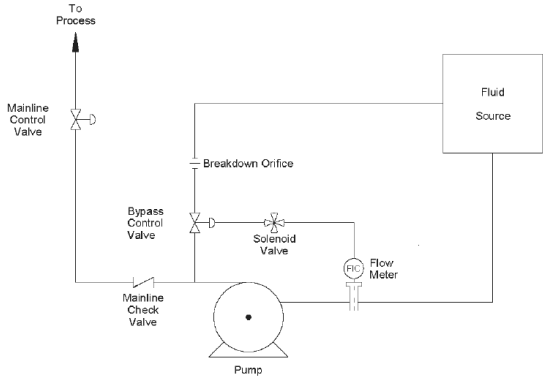


Continuous Recirculation System
(very wasteful of energy)

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.

Figure 3b

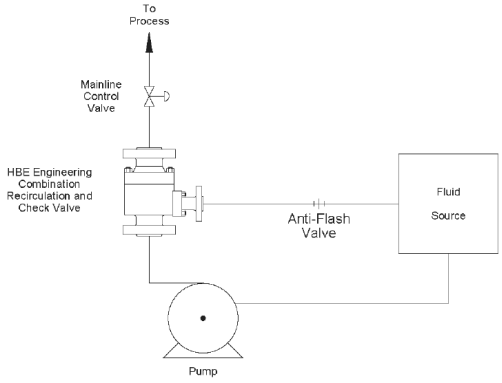


Conventional Multi-Component System
(many components to install and maintain)

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.

Figure 3c



HBE Engineering System
(simple, energy efficient and reliable)

Introduction

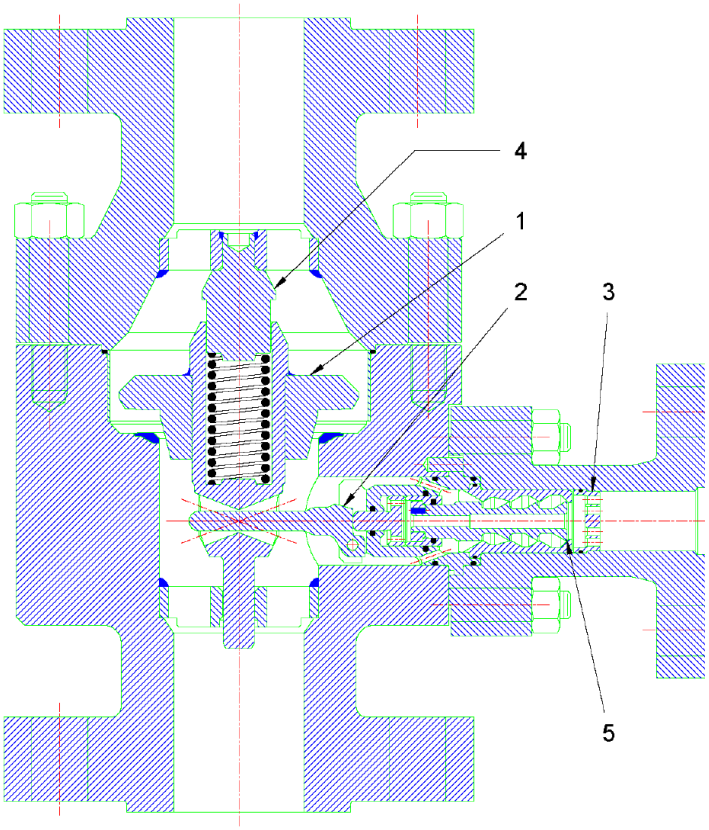
The HPM Series Automatic Recirculation Valve was developed for high pressure centrifugal pump protection. Popular applications include boiler feed water, petroleum fluids, and steel mill hot strip descale water. The HPM provides economical and reliable protection against low and reverse flow.

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



HPM sectional — functional callouts

The HPM provides five essential functions:

1. Check Valve Disc prevents reverse flow and positions the bypass for open, closed and 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 the valve as a spray rather than a jet, reducing erosive wear on downstream piping.

4. Integral Pulsation Dampener protects the system from waterhammer if sudden changes in flow demand occur.

5. Integral Check Valve in the bypass prevents reverse flow when the bypass is routed into a common return line.

Materials of Construction

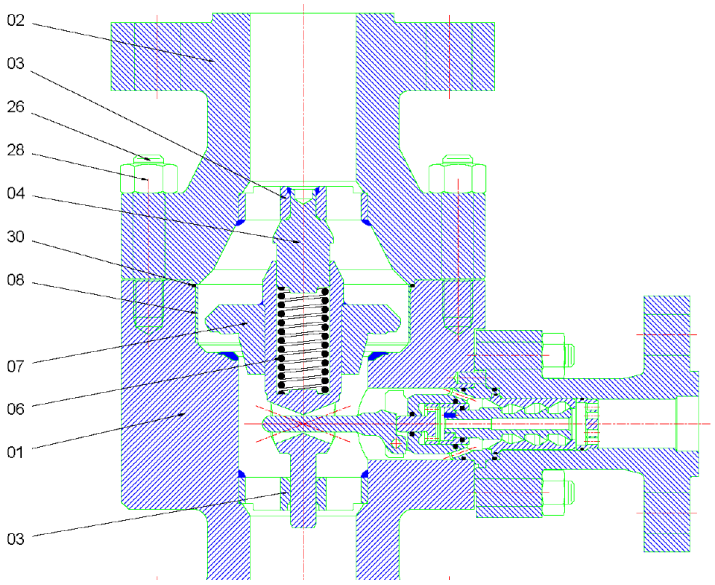
HPM Class 600–2500

Item	Description	Material	Spec.
1	Lower Body	Carbon Steel	ASTM A105
2	Upper Body	Carbon Steel	ASTM A105
3	Valve Stem Guide	Carbon Steel	ASTM A105
4	Guide Bolt	Stainless Steel	ASTM A582 416
6	Spring	Stainless Steel	ASTM A313 302
7	Check Valve	Stainless Steel	ASTM A582 416
8	Liner	Stainless Steel	ASTM A240 304
9	Bypass Branch	Carbon Steel	ASTM A105
10	Vortex Housing	Stainless Steel	ASTM A582 416
11	Control Head	Stainless Steel	ASTM A582 416
12	Vortex Plug	Stainless Steel	ASTM A276 431
13	Lever	Stainless Steel	ASTM A276 431
14	Pivot Pin	Stainless Steel	ASTM A276 316
15	Vortex Bushing	Stainless Steel	ASTM A276 431
16	Piston	Stainless Steel	ASTM A276 431
21	Vortex Plate	Stainless Steel	ASTM A582 416
22	Lock Pin	Stainless Steel	AISI 303
23	Flow Straightener	Stainless Steel	ASTM A276 431
25	Guide Pin	Stainless Steel	AISI 300 Series
26	Stud Bolt	Alloy Steel	ASTM A193 Gr. B7
27	Stud Bolt	Alloy Steel	ASTM A193 Gr. B7
28	Hex Nut	Alloy Steel	ASTM A194 Gr. 2H
29	Hex Nut	Alloy Steel	ASTM A194 Gr. 2H
30	O-Ring	By Application	----
31	O-Ring	By Application	----
32	O-Ring	By Application	----
33	O-Ring	By Application	----
33.1	Glyd-Ring	PTFE	----
34	O-Ring	By Application	----
34.1	Glyd-Ring	PTFE	----
35	O-Ring	By Application	----
35.1	Glyd-Ring	PTFE	----
36	O-Ring	By Application	----

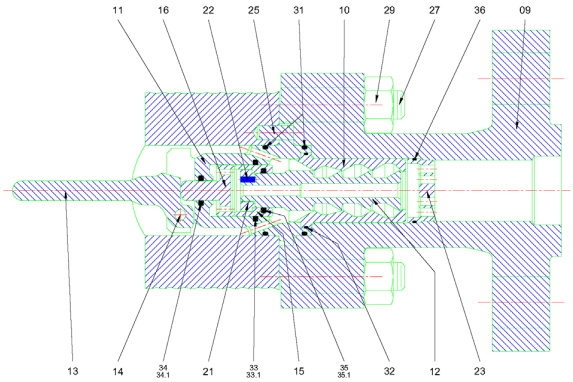
LPM Class 150–300 Bypass — Recommended Spares

Item	Description	Material	Spec.
10	Bypass Bushing	Stainless Steel	ASTM A582 416
11	Control Head	Stainless Steel	ASTM A582 416
13	Lever	Stainless Steel	ASTM A582 416
14	Pivot Pin	Stainless Steel	ASTM A276 316
15	Crank Arm	Stainless Steel	ASTM A582 416
16	Control Bushing	Stainless Steel	ASTM A582 416
23	Flow Straightener	Stainless Steel	ASTM A276 431
25	Guide Pin	Stainless Steel	AISI 300 Series
27	Stud Bolt	Alloy Steel	ASTM A193 Gr. B7
29	Hex Nut	Alloy Steel	ASTM A194 Gr. 2H
31	O-Ring	By Application	----
36	O-Ring	By Application	----

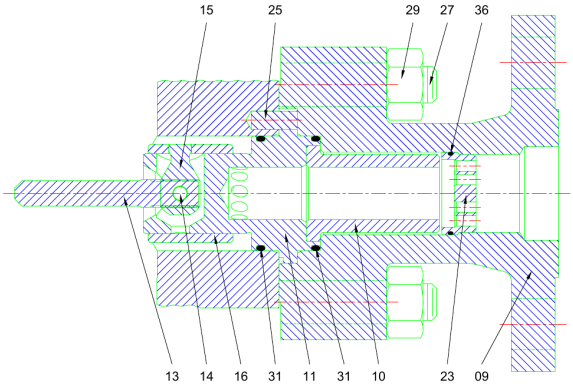
HPM Class 600–2500



HPM Class 600–2500 Bypass Detail

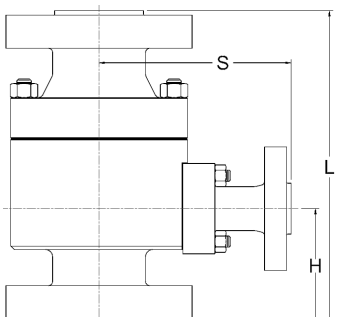


LPM Class 150–300 Bypass Detail



Dimensions, Weights & Flow Ratings

Flow ratings are based on 60°F water with specific gravity of 1.0.
Dimensions are identical for Flanged and BWE construction.



Valve Size			Max. Main Flow		Max. Bypass Flow		Bypass	Weight		Dimensions					
Main	Bypass	Class	GPM	M^3h	GPM	M^3h	Max. Cv	Lbs.	Kg.	L (in)	L (mm)	H (in)	H (mm)	S (in)	S (mm)
1-1/2	1	150	150	34	60	14	2.9	42	19	7-7/8	200	2-15/16	75	6-1/8	155
		300					2.9	70	32	10-1/4	260	3-9/16	90	7-1/2	190
		600					1.3	70	32	10-1/4	260	3-9/16	90	7-1/2	190
		900					1.1	70	32	11-13/16	300	4-5/16	110	7-7/8	200
		1500					0.9	95	43	12-5/8	320	4-3/4	120	8-7/16	215
2	1	150	220	50	60	14	3.7	59	27	9-1/16	230	3-9/16	90	6-7/16	163
		300					3.7	90	41	11-13/16	300	4-1/2	115	7-5/16	185
		600					2.7	106	48	11-13/16	300	4-5/16	110	7-5/8	193
		900					1.7	106	48	13-3/8	340	5-1/8	130	8	203
		1500					1.6	130	59	14-3/16	360	5-1/8	130	9-7/16	240
2-1/2	1-1/2	150	330	75	150	34	6.8	92	42	11-7/16	290	4-5/16	110	6-7/8	174
		300					6.8	132	60	13-3/8	340	4-15/16	125	7-13/16	199
		600					3.5	152	69	13-3/8	340	4-15/16	125	8-11/16	220
		900					2.6	152	69	14-15/16	380	5-1/2	140	9-1/16	230
		1500					2.4	196	89	15-3/4	400	5-11/16	145	10-1/4	260
3	1-1/2	150	500	114	150	34	10.1	114	52	12-3/16	310	4-1/2	115	7-13/16	198
		300					10.1	163	74	14-15/16	380	5-1/2	140	8-11/16	220
		600					5.2	185	84	14-15/16	380	5-1/2	140	9-7/16	240
		900					4	185	84	16-1/8	410	5-7/8	150	9-13/16	250
		1500					3.5	268	122	18-1/8	460	6-1/2	165	11-1/4	285
4	2	150	900	204	250	57	12.3	178	81	13-3/4	350	4-15/16	125	8-5/16	211
		300					12.3	246	112	16-15/16	430	6-1/8	155	9-7/16	240
		600					8.5	277	126	16-15/16	430	6-1/8	155	10-1/2	266
		900					5.6	277	126	18-1/8	460	6-5/16	160	11	280
		1500					5.2	431	200	20-7/8	530	7-1/2	190	11-13/16	300
5	2-1/2	150	1100	250	400	91	21.7	268	122	15-3/4	400	5-5/16	135	10-1/2	266
		300					21.7	400	181	19-11/16	500	6-7/8	175	11-7/16	290
		600					11	455	206	19-11/16	500	6-7/8	175	12-3/16	310
		900					9.5	455	206	21-1/16	535	7-5/16	185	12-3/16	310
		1500					6.5	638	289	25-9/16	650	9-1/4	235	13-7/16	341
6	3	150	2000	454	550	125	31	398	181	18-7/8	480	6-1/2	165	12-1/2	317
		300					31	601	273	21-5/8	550	7-1/2	190	12-5/8	320
		600					14	636	288	21-5/8	550	7-1/2	190	13-3/16	335
		900					12	636	288	23-1/16	585	7-7/8	200	13-3/4	350
		1500					10	977	443	27-9/16	700	9-13/16	250	15-15/16	405
8	4	150	3300	749	900	204	51	774	351	23-5/8	600	7-7/8	200	15	381
		300					51	1027	466	25-9/16	650	8-7/16	215	15-13/16	402
		600					22	1102	500	25-9/16	650	8-7/16	215	15-15/16	405
		900					20	1102	500	27	685	8-7/8	225	15-15/16	405
		1500					16	1727	783	33-7/16	850	11-5/8	295	18-11/16	475
10	6	150	4400	999	1230	279	86	1355	615	28-3/4	730	9-7/16	240	19-1/2	495
		300					86	1571	713	30-1/2	775	10-1/4	260	20-1/2	520
		600					35	1813	822	31-1/2	800	10-5/8	270	20-1/2	520
		900					25	1885	855	34-5/8	880	11-7/16	290	20-1/2	520
		1500					22	2825	1281	38-3/8	975	13	330	22-7/16	570

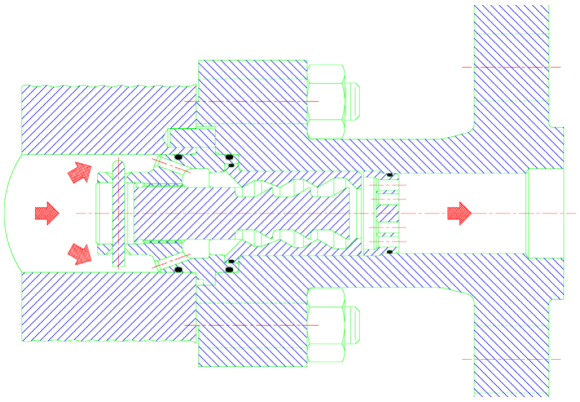
Contact HBE for Class 2500 valve data and for applications with flows higher than the 10″ rating. Dimension tolerance ± 1/8″.

Start-Up Internals & Run-Out Protection

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.

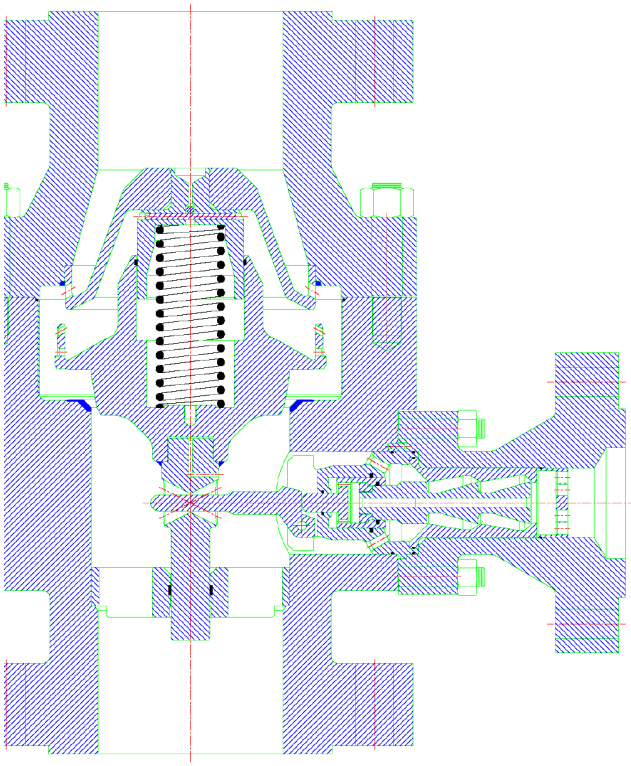


Start-Up Internal Detail

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 & 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 A105 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

Pump Orientation ☐ Vertical ☐ Horizontal

Main Flow

- Minimum _____ GPM (m³/Hr)
- Maximum _____ GPM (m³/Hr)
- Normal _____ GPM (m³/Hr)
- Minimum Pump Flow _____ GPM (m³/Hr)

Pump Discharge 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 (*if other than water)

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

Valve Model Legend

HPM-24-150-17203

Example: HPM model, 6″ Class 1500 flanged valve with an HBE file-locator number.

HPM	Model Designation
24	Size Code
150	Pressure Class Code
17203	Quote / Order File No.

Model Designation

LPM — Low pressure modulating ARC valve, forged body housing. ASME Class 150 and 300.

HPM — High pressure modulating ARC valve, forged body housing. ASME Class 600, 900, 1500 and 2500.

Size Code

04=1″ 06=1-1/2″ 08=2″ 12=3″ 16=4″
20=5″ 24=6″ 32=8″ 40=10″ 48=12″

Pressure Class Code

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

HBE Engineering, Inc.
220 Day Dr · Three Rivers, MI 49093 U.S.A.
Phone (269) 279-2035 · Fax (269) 278-6745
www.hbe-engineering.com · sales@hbe-engineering.com