ABN 71098869160

PRODUCT INFORMATION

PRODUCT PART NUMBER: **WFI**

DESCRIPTION: **SAFETY ISOLATION VALVE**

BACKGROUND

The Safety Isolation Valve (SIV) is a vital piece of safety equipment within the Hydro Power System.

This valve acts in the same way as an electrical fuse or magnetic circuit breaker does in an electrical circuit. An electrical fuse will blow and a magnetic circuit breaker will trip when a certain current is reached. Similarly, if the flow of the water goes too high the SIV closes off at a pre-determined safe slow rate. The SIV differs from its electrical counterpart in that, when it closes, it arrests the flow of water rapidly and then shuts of slowly. This feature is necessary to stop the increasing of the flow quickly to prevent run away conditions and then stop the flow slowly to prevent hydraulic shock loads and slow down the water in the pipe upstream of the valve at a controlled rate. If the valve does not close slowly the fast moving water will come to an abrupt halt and this will cause a high-pressure surge, which can cause the pipe to shake and make a loud knocking noise. This is known as water hammer. The pipe may be overloaded to the point of failing.

PURPOSE OF SAFETY ISOLATION VALVE

The SIV serves the following purposes:

- Tripping--The SIV automatically closes or trips when the flow rate exceeds a specified limit.
- Controlled Closing--The SIV closes in a controlled way designed to prevent excessive pressure surges or water hammer. It closes rapidly at first to prevent a 'run-away flow', and then it closes at a slow controlled rate to prevent excessive pressure surges.
- Flushing--The SIV is used to safely flush pipelines at flows at 3% to 90% of the nominal closing flow rate.
- Isolation--The SIV can be manually closed to isolate the downstream pipeline.

FEATURES OF THE VALVE

- The SIVs offer low resistance to the flow when fully open.
- The SIVs contain no internal by-pass passages or connections. Hence, the only cause of leakage through a 'closed' SIV could be:
  - dirt trapped between the main poppet and the seat
  - failure of main piston seal.
- Initial rapid closing is followed by a final slow shut-off to control pressure surges and prevent water hammer when the SIV trips due to excess flow through it.
- The SIV is factory pre-set internally to the specified maximum closing flow rate. To prevent tampering or unauthorized adjustment, changing an internal valve part only can alter the maximum closing trip flow. The trip flow setting can however be adjusted downwards (if desired) by turning the hand wheel. An indicator shows the approximate trip setting for all valves larger than 50NB.
- In the event of individual component failure in the valve, the SIV is designed to fail safely. Main seal failure may prevent full closure, but the SIV will close in response to excess flow and will limit the flow to the flushing flow rate.
- Turning the hand wheel easily closes the SIV. The final closing rate is internally slowed down to prevent water hammer.
- The flush flow rate can be increased from zero to 70% of the closing trip flow by activating the flush vent and turning the valve hand wheel to open. This allows controlled flushing of the pipeline.
- The manual opening action will let water discharge from the adjustment housing at a rate of about 1 l/s. The water discharge will stop when the control hand wheel is adjusted past the maximum flow setting or when the flush trigger is released.
- Cartridge construction allows the SIV to be maintained in-line by exchanging service exchange 'cartridge' units. All the wear parts can be changed in one operation. It is preferably to remove a valve for a full service.
- The body casting is made from cast steel to BS 3100 grade A2 and can be made with a wide range of flanges or hub connections. All internal working parts are made from corrosion resistant materials.

TECHNICAL SPECIFICATIONS

The valve is designed to ANSI B16.34.

The valve body is rated to 25 MPa (ANSI Class 1500), but the valve pressure rating is limited by the flanges fitted.

For fatigue life up to 10 million cycles, the valve body pressure rating is reduced to 14 MPa.

Specifications

		50NB	80NB	100NB	150NB	200NB	250NB	300NB
Working Pressure (Max)	MPa	25	25	25	25	25	25	25
Working Pressure (Min) Note 1	MPa	1	1	1	1	1	1	1
Flushing Flow @ 18MPa Note 2	L/sec	15	22	40	64	113	177	255
Closing Trip Flow (Nominal) Note 2	35% above working flow rate							
First Stage Closing Time Note 3	Sec	0.2	0.2	0.25	0.3	0.3	0.35	0.55
Final Closing Time (Min) Note 3	Sec	3.5	3.5	3.5	5	6	8	10
Velocity	Km/sec	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Surge Pressure (Max) Note 4	MPa	5.5	3.4	3.6	2.5	2.6	2.6	2.7
Surge Force	kN	8	12	22	35	61	96	138

Note 1—This flow is the recommended design flow rate for general reticulation. Higher flow rates higher than those above are possible, but pressure drops will be higher as shown in the table below. For SIVs it is strongly recommended that the standard specifications above be adhered to. These closing flows are based on the work carried out by the Chamber of Mines research Organization (COMRO).

TECHNICAL SPECIFICATIONS (CONTD.)
Table of flow / pressure drop

Valve size (NB in mm)	50	80	100	150	200	250	300
Cv (l/s per MPa^0.5)	26	59	100	197	586	977	1152
Cv (USgpm per psi^0,5)	34	78	132	259	772	1286	1516
Flow (l/s)	Approximate pressure drop (m head)						
5	3.8	0.7					
10	15.1	2.9	1.0				
15	34.1	6.5	2.3	0.6			
20	61	11.6	4.1	1.1			
22	73	14.0	4.9	1.3			
25	95	18	6.4	1.6			
30	136	26	9.2	2.4			
40	242	46	16.3	4.2	0.5		
50	378	72	25	6.6	0.7		
60	545	104	37	9.5	1.1	0.4	
64	620	118	42	10.8	1.2	0.4	0.3
70	742	142	50	13	1.5	0.5	0.4
80	969	185	65	17	1.9	0.7	0.5
90	1226	234	83	21	2.4	0.9	0.6
100	1514	289	102	26	3.0	1.1	0.8
113	1933	369	130	34	3.8	1.4	1.0
120		416	147	38	4.3	1.5	1.1
140		567	200	52	5.8	2.1	1.5
160		740	261	67	8	2.7	2.0
177		906	319	83	9	3.3	2.4
180		937	330	85	10	3.5	2.5
200		1156	408	105	12	4.3	3.1
220		1399	493	127	14	5.2	3.7
240		1665	587	152	17	6.2	4.4
255		1880	663	171	19	6.9	5.0
260		1954	689	178	20	7.2	5.2
280		2266	799	206	23	8.4	6.0
300		2602	917	237	27	9.6	6.9
320			1043	270	30	10.9	7.9
340			1178	304	34	12.4	8.9
360			1321	341	38	13.8	10.0
380			1471	380	43	15.4	11.1
400			1630	421	47	17.1	12.3

INSTALLATION

The valve must be installed with the arrow on the body pointing in the downstream direction. Support the pipeline to minimize bending stresses and to withstand pipe surge forces as shown in table 5.1.

Ensure that all clamps are correctly torqued and that the gaps between clamps are even.

Ensure that the upstream lines are clean and have been flushed thoroughly at 1.2 x the maximum working flow before installing the valve.

Install the valve with the handle within 60 degrees of the upright position. This ensures venting when the pipeline is filled.

During transport the valves should be closed. Open SIV's once installed but not charged to prevent damage.

AFTER INSTALLATION AND BEFORE CHARGING THE SUPPLY PIPELINE, OPEN THE VALVE AT LEAST THREE TURNS FOR VALVE 100 MM AND SMALLER AND FIVE TURNS FOR VALVES OF 150 MM AND LARGER. IT IS PREFERABLE TO OPEN THE VALVE FULLY TO ENSURE GOOD LINE FLUSHING DURING CHARGING.

COMMISSIONING

Check and set valve handle

Turn the hand wheel down and ensure that the skirt edge line up with the 0 mark on the spindle guide to within 3 mm. If it does not go down, there is something stuck in the valve.

DO NOT FORCE THE HAND WHEEL WITH BARS AND TOOLS, IT IS DESIGNED TO PROTECT THE INTERNAL PARTS AGAINST DAMAGE, HAND OPERATE ONLY.

Pipeline filling

Prior to filling the pipeline with water, the VALVE HANDLE MUST BE ADJUSTED TO THE POSITION (AS NOTED IN INSTALLATION) ABOVE OR FULLY OPEN. When the pipeline is being filled air will start to discharge from the vent hole followed by water. Once the water discharge is without air, the valve can be adjusted to flow rates down to the lowest flow setting (50 l/s for 200 NB valves) as is indicated on the stem.

The supply flow can now be increased until the valve closes on excess flow. After the valve has closed on excess flow, it can be partly opened to fill the line by turning the control from the closed position while pushing the vent valve on the hand wheel. Within two turns the valve will begin to open just like an isolation valve and the flow can be regulated by turning the hand wheel to the open or closed positions. When the vent trigger is released, the valve will close and when it is pressed again, the valve will open again to the flush rate or less the hand wheel position.

IF THE VENT IS PRESSED WITH THE HAND WHEEL IN THE OPEN POSITION, THE FLOW PASSED WILL NOT EXCEED THE RATED CLOSING FLOW OF THE VALVE AND THEREFORE PROTECTS THE LINE FROM EXCESS FLOW CONDITIONS.

Once the pipeline is filled and almost all the flow stopped, the valve will automatically 'set' fully open. The working position can then be set by adjustment of the control handle to the desired closing flow rate.
THE VALVE WILL NOT SET OPEN IF A DOWNSTREAM LEAK IN EXCESS OF 6% OF THE RATED CLOSING FLOW AT FULL PRESSURE IS PRESENT.

OPERATING PROCEDURES

1. Closing the SIV

   To close the valve, turn the hand wheel down to the smaller flow rates until it closes automatically. If there is no flow through the valve, it will have to be turned right to the 0-flow mark. Once the valve is closed, the turning of the hand wheel can be stopped. DO NOT FORCE THE HAND WHEEL.

   The lower the handle, the lower the trip flow.

2 Opening the SIV

   The SIV is designed to open fully only when a run-away flow condition (e.g. open-ended pipe) does <u>not</u> exist.

   Before opening, check that the valve is primed (full of water, not air) by depressing the trigger until a solid (air-free) stream emerges.

   In normal use the valve handle should be slowly turned upwards (anticlockwise) while at the same time depressing the trigger lever. If the downstream line is full and the pressure drop access the valve is small, then the valve will fully open.

   If the pressure drop across the valve is large (e.g. due to an open-ended pipe) then the valve will only partly open to the flushing position when the lever is depressed. To open the valve fully, determine the cause of the excessive demand, close it off and close and then re-open the valve depressing the trigger while turning the handwheel up.

FAULT FINDING

1. FAULT FINDING

   The valve may malfunction in the following ways:

1.1 It does not open when the hand wheel is turned to open and the vent activated.

   This may be due to:

   - Blocked flush control orifice
   - Dislocated snubber poppet

If the flush control orifice is blocked, the snubber orifice will not generate sufficient pressure drop to enable the main valve to open. If the snubber poppet becames lose and unscrewed, the poppet will not provide the pressure drop required to open the main poppet.

1.2 The Valve Fails to Close

If the hand wheel is turned to close and the valve does not close or is very hard to close the following may be at fault.

2.1 The hand wheel screw thread may be worn.

If it is worn the hand wheel will be turned with no down movement. An emergency clamp can be then be used to temporarily operate the valve until repairs can be affected.

2.2 The poppet seal leaks.

If the poppet seal leaks, the valve will still act as a safety shutdown valve but due to the excessive bypass through the seal, the valve can only be closed fully by turning the hand wheel in until the snubber is pushed open to allow more water in than can flow out of the control chamber

2.3 The pilot seal and / or seat leaks excessively

The pilot seal or poppet set is designed to indicate that it is failing but the internal failure of the seal or seat will not render the valve in operative. Prolonged use of the valve with the seal or seat failed will erode the leak paths to the extent that the safety characteristic may be compromised. A failure of either the seal or the poppet seat is indicated by a discharge from the vent port when the vent control is not activated.

2.4 Dirt is trapped in the valve seat

If a large particle is trapped in the valve seat, the valve will not generate adequate differential pressure to crush the dirt and the valve will be struck open. It will be indicated by a sharp increase in operating force before the valve reached its down position. The size of the dirt will be relative to the amount of stroke that the valve still has to travel to closing. Small (-6mm) brittle particles will be crushed and flushed out without significant damage and may not even be noticed.

2.5 The valve stem seal drain leaks

This is an indication that the pilot stem seal is failing. If it is left for too long in the failed mode the valve may become inoperable. The double seal arrangement with the restricted discharge port size allow complete failure of the first seal without rendering the valve unsafe but complete isolation will be impaired during an excess flow shut-off.

Other factors that can affect the closing or trip flow are:

- The spring force,
- The seal friction which in turn may be dependant on seal thickness, surface finishes, O-ring pre-compression and lubrication,
- The profiles of the poppet and seat and,
- Foreign matter in the poppet/sleeve gap e.g. excessive grease at installation or dirt.

The spring force can also be changed to change the trip flow rate of the valve, but this is not done in the standard valve range.

MAINTENANCE

MAINTENANCE PROGRAM

1. Monthly Inspection

   See that the seal vent does not discharge fluid.

   Feel the hand wheel to ensure that it is free, not bent, not “wobbly” and not hard to move.

   If the valve is open turn the hand wheel in a few turns to close and make sure that it offers more or less constant resistance when turned fast. It is recommended that the valve be operated at least once per month to ensure that line scaling on the parts, which may result from water conditions, is wiped off before it sets too hard.

   If the valve is closed with the hand wheel turned in, ensure that a small downstream flow will not be a problem, then open it one and a half to two turns while depressing the vent turned open or closed while the pilot vent is opened. Open it to full flush position at least once per month.

   Revision Note--dated 01.09.03
   Monthly inspection is recommended as the best practice which would cover all mining environments. Where this is not possible and where mine waters do not meet the COMRO Specification WHP 70 there is an increasing risk that scaling or dirt or corrosion may cause the valve to stick. Because the exact period is difficult to safely determine a conservative (shorter rather than longer) period has been recommended. It is very strongly recommended that at the very minimum, all valves be operated at least once in six months. Because SIV valves are safety critical, and because they operate in harsh environment often with water that is out of specification, users must determine for themselves safe maintenance frequencies. These will depend on the location and the size of the valve. Large valves (which control large volumes of water and hence prevent large uncontrolled release of energy) such as those in valve stations, must be operated regularly.

2. Bi-Annual Inspection

Safety isolation valves that are not regularly operated should be serviced on a bi-annual (24 month) basis.

Valves that are operated on a regular (e.g. monthly) basis be serviced less frequently if the valve operates smoothly and the quality of the water is good.

For this service the valve must be opened and cleaned for inspection. All scale must be removed and the metal running surfaces be cleaned and polished. The seals must be cleaned or replaced if damaged.

The valve must be re-tested after overhaul.

Refer to WFI 3390 000 00 and the associated parts list to follow the text.

The valve body 1 is connected to the high-pressure supply at the right hand flange and the outlet is on the left of the drawing.

The main valve set consisting of the seat 2, the poppet 3 and the sleeve 4 with the poppet bearing and seal housed in the body and held in position by the cover 12 and the bolts 30 and nuts 31. The poppet 3 can seal against the seat 2.

The valve closes against excess flow when the pressure drop across the poppet and seat assembly rises as a result of increasing flow to the point where the hydraulic force on top of the poppet downwards is equal to or more than the spring force plus the hydraulic forces that force the poppet up. As soon as the closing forces exceed the holding open forces, the valve starts closing, the pressure drop increases and then close with great speed. It has "tripped". The main poppet has a snubber poppet concentric in it and this snubber poppet is set to be closed against its seat for the last part (about 3 mm) of the main poppet stroke just before it seats against the main seat. The amount of this "engaged stroke" is determined by the operating pressure, size of valve and the shut-off snubbing flow rate desired.

When engaged with its seat, the snubber poppet all but closes the passage of water from the upstream to the control chamber. The small bypass allows the valve to close slowly over the last part of the stroke to slowly shut off and so prevent upstream water hammer. It also allows the water pressure in the control chamber to drop when the chamber is vented by means of the trigger valve to allow the poppet to lift to the start of snubbing position whereafter it lifts off the snubbing seat to let more water into the chamber than what the vent can let out so that the poppet will "float" in that position.

The hand wheel is used to adjust the position of the main poppet whereby the trip flow rate is adjusted.

On the hand wheel is the vent trigger that opens the vent when depressed to allow the valve to open by venting the control chamber faster than the snubber bypass in its engaged position can make up so that the main poppet will move away from its seat in direct proportion to the position of the snubber poppet relative to its seat.

The maximum stroke of the main poppet is limited by a spacer ring that is calibrated to set the trip flow rate of the valve to a specified maximum. The hand wheel can be used to set the position of the main poppet to "trip" at any desired flow rate. At flow rates less than 15% of the rated flow rate, the closing of the valve will not be snubbed but it will close with a harmless 'click' sound.

The sleeve is sealed in the body by seals 22 and 23. The seat is located and sealed by the press ring 16.

P O Box 849 Joondalup BC, WA 6919, Australia
TEL: +61 (08) 9409 2200 FAX: +61 (08) 9409 2255 MOBILE: +61 0418 176 378
WEB: www.upwey.com E-MAIL: justin@upwey.com