

Enertech NozzleCheck Check Valve Solutions

Over 40 Years of Nuclear Experience

Enertech, a product and service brand of Curtiss-Wright Nuclear, has been committed to the nuclear power industry since 1967 with the development of the first nuclear qualified hydraulic large bore snubber for Diablo Canyon. Today, Curtiss-Wright Nuclear exclusively focuses on providing products and services to the worldwide nuclear power industry including commercial nuclear power plants, NSSS suppliers, A&E's and the U.S. Department of Energy.

Curtiss-Wright Nuclear provides the nuclear power industry with one of the largest and most diverse range of product offerings which includes: valves, actuators, pumps, snubbers, heat exchangers, heaters and filtration, instrumentation, sealing products, and diagnostics and condition monitoring equipment. We have coupled these nuclear qualified products with a team of application and design engineers who can help size and select the best product to meet your application's performance and reliability requirements.

NozzleCheck Axial Flow Check Valves

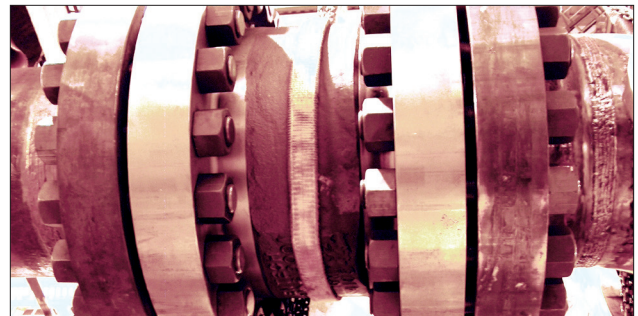
The Enertech NozzleCheck (NCV) axial flow check valve is designed to stop reverse flow using a non-slam, fast closing disc. This unique design results in improved reliability and performance compared to conventional check valves. A fundamental feature of the NozzleCheck valve design is its ability to close at the moment flow stops, thereby avoiding the pressure surge and impact of reverse flow. NozzleCheck valves were first installed in European nuclear reactors in the 1970s to replace Main Feedwater swing check valves. The introduction of the NozzleCheck design

resulted in the reduction of failures, improvement in overall seat leakage performance, and the mitigation of water hammer.

Curtiss-Wright Nuclear has manufactured commercial, Safety-Related, and ASME Code Section III NozzleCheck valves for over 20 years. Currently there are over 1000 NCVs installed in the worldwide nuclear power industry. The NCV has become the valve of choice for the most demanding check valve applications such as high head, parallel pump discharge, vertical pipe runs, low flow/high turbulence lines (directly downstream of pumps, elbows, etc.) and restrictive shut-off applications. NozzleCheck valves have become the global standard for reverse flow protection having completed final testing for use as a High Energy Line Break check valve for Generation III+ reactors.

Specifications

The unique design of the NozzleCheck valve allows it to operate in a variety of applications from Containment Isolation air, steam, and water applications that are subjected to extensive Local Leak Rate Test Requirements to Large Bore Feedwater Discharge applications where the elimination of water hammer occurrences are absolutely critical for system reliability. Enertech NozzleCheck Valves can be supplied in a full range of sizes from ½" to 60", pressure ratings from 150 to 4500 lbs., and can handle temperatures as high as 1290°F.



Design Advantages

Non Slamming Disc: Spring loaded disc and short stroke, returns disc to the seat before reverse flow can develop.

Low V_{min} : The helical spring is designed to allow full valve opening with the disc rested against the diffuser at low flow rates without any disc flutter.

Zero Leakage: Self-guiding mechanism of the disc into the seating surface. After the spring pushes the disc to the seat, the reverse line pressure provides the additional force to guide the conical disc through the cone-shaped path into its final position.

Minimal Pressure Drop: Minimum pressure drop across the valve is achieved due to the unique hydrodynamic flow path created by the diffuser and the body internal configuration.

Mounting in Any Orientation: The valve is not position sensitive. It may be placed in any direction, including vertical pipe runs and near elbows.

Flexibility of Design: Can be customized to the unique requirements of an application.

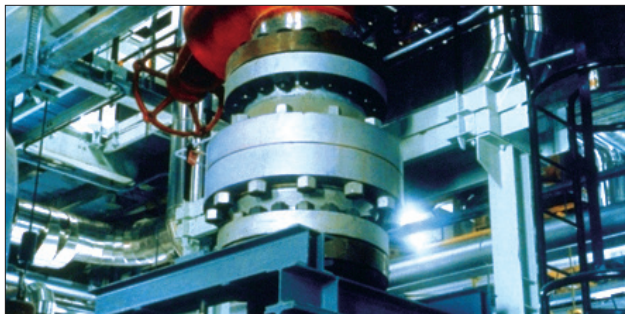
Extensive Engineering Analysis: Through the use of full qualification flow testing and state of the art flow analysis software, Curtiss-Wright Nuclear is able to optimize design via performing complex flow simulations, thereby minimizing the time and cost for product delivery.

Nuclear Quality Assurance

Curtiss-Wright Nuclear's extensive certifications demonstrate a firm commitment to comply with the Nuclear Industry's Regulations, Codes, and Standards which provide our valued customers with the most reliable and fully qualified products. Our QA Program has been audited since the early 1990's by the Nuclear Utility Procurement Issues Committee (NUPIC) including observation of the NUPIC Process by the NRC.

NozzleCheck Safety-Related and ASME Code check valves are manufactured to the highest quality in accordance with:

- 10CFR50, Appendix B
- ASME Section III, Class 1, 2 and 3, N Stamp
- ANSI B16.34 and B31.1
- MSS-SP-61
- NQA-1
- QME-1



Theory of Operation

Theory of Operation

The Enertech NozzleCheck Valve is constructed with only a few components. The valve is normally closed; however, when the minimum cracking pressure is exceeded, the disc is rested on the diffuser. The NozzleCheck valve has one of the lowest V_{min} of any check valve design in the industry, thereby eliminating mid position travel, back tapping, disc flutter and other issues that may arise from inconsistent flow. When the flow is stopped, the short stroke length and spring assist, forces the self-aligning disc closed immediately upon reverse flow. The disc is assisted further with isolation as the flow contacts the disc.

Body and Diffuser

The valve body and diffuser in the NozzleCheck valve provide a streamlined optimal flow path which has minimal turns, gradual area changes, and smooth edges which reduces pressure loss. This results in higher C_v and smaller pressure drops.

Disc and Seat

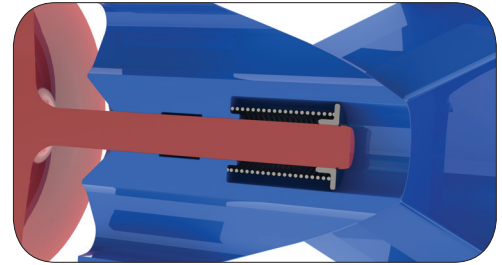
The NozzleCheck design incorporates the use of a low mass conical disc to minimize seat impact forces. When closed, the disc is self-aligning and finds the best seating position to form a tight shut-off. The seating surfaces are metal to metal and the wide contact seat area ensures low seating stress. This low seating stress reduces the need for hard facing of the seating surfaces typical in other in-line contact sealing valves.

Spring

The spring assist on the NozzleCheck Valve helps the disc to respond quickly to flow reversal. The spring pushes the disc to the closed position prior to reverse flow reaching the valve. This significantly reduces pressure surge and the threat of water hammer, compared to other designs.

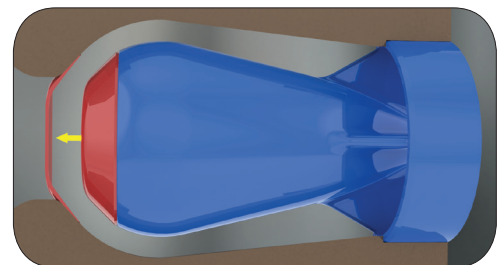
Low Mass Disc

The low mass disc enables extremely fast closure speed upon reverse flow. This allows system designers to meet 2—4 fps V_{min} system velocities. Industry experience supported by EPRI research rate this as the most important characteristic to avoid water hammer and pressure surge induced damage.



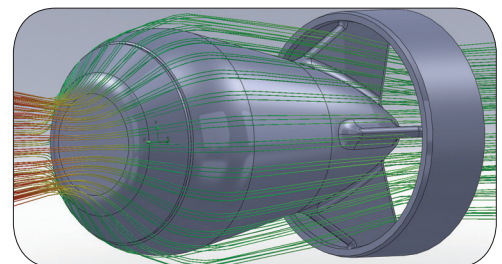
Short Stroke

Compared to conventional check valves that use a large radius arc for closure, the NozzleCheck eliminates this with a short stroke. This eliminates the problems of disc flutter causing hinge pin and bushing wear and back tapping.



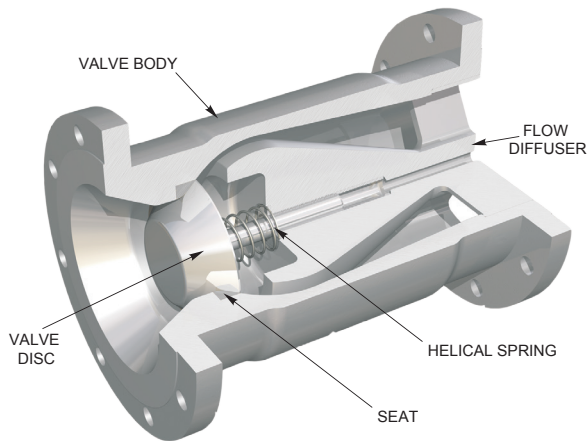
Optimized Flow Performance

Stable operation assures long service life and zero scheduled maintenance. The self-centering disc allows continuous self-alignment using non-fatigue springs floating on a radial guide assembly.

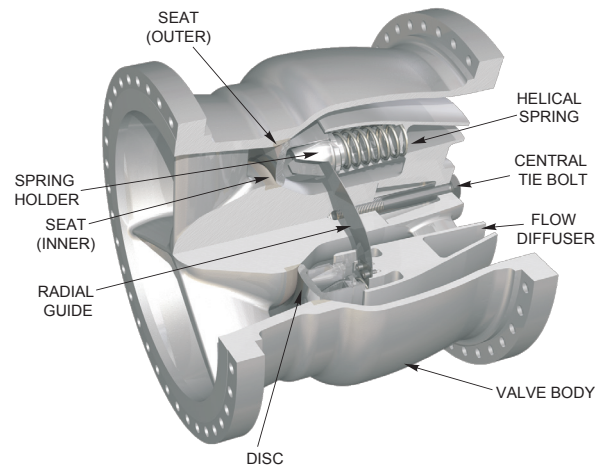


Standard Material of Construction

DRV-Z



DRV-B



Component

Standard Carbon Steel

Stainless Steel

Valve Body

ASTM A216 WCB/ASTM A105

ASTM A351 CF8M/ASTM A479 316

Diffuser

ASTM A216 WCB/ASTM A105

ASTM A351 CF8M/ASTM A479 316

Valve Disc

ASTM A351 CF8M/ASTM A479 316

ASTM A351 CF8M/ASTM A479 316

Seat

Integral 309L Stainless Steel

Integral to Body

Helical Spring

Inconel X-750

Inconel X-750

Radial Guide

Inconel X-750

Inconel X-750

Screw

ASTM A193 B8M

ASTM A193 B8M

Central Tie Bolt

ASTM A193 B7M

ASTM A193 B7M

Guide Bushing*

17-4PH Stainless Steel

12" & Larger

* For carbon steel 10" sizes and smaller only

NozzleCheck Product Overview

DRV-Z: Small Bore NCV

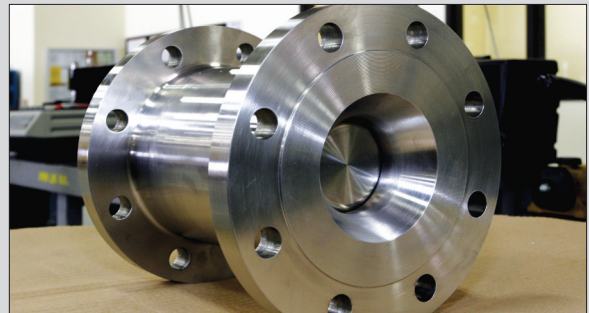
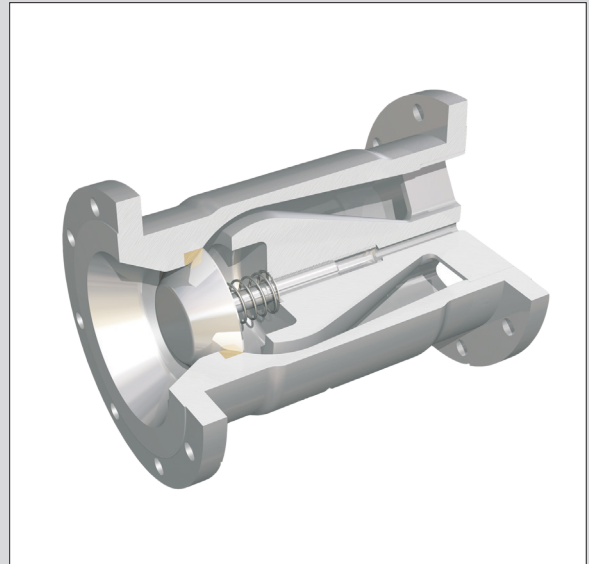
The NozzleCheck Model DRV-Z features a short opening and closure stroke length and low-mass disc that allows the valve to be fully open and stable at much lower flow rates/flow velocity (V_{min}) than conventional check valves. This feature significantly reduces the amount of disc oscillations and eliminates the leading cause of hinge and seat wear typically seen with swing check valves. The disc in the DRV-Z valve is a combination of the disc and a guiding stem used to align the disc and sealing surface of the body during operation. The use of a preloaded compression spring in this design closes the valve prior to reverse flow of the media. The diffuser in the DRV-Z minimizes internal hydraulic losses resulting in a high Cv value and shields the spring from fluid and particulate impingement.

Application Highlight:

Aux. Feedpump Discharge

Conventional swing check valves were installed in an auxiliary feedpump discharge line that was 1.5 pipe diameters downstream of an elbow. This installation caused turbulence and disc flutter due to a distorted flow profile. The valves were cross tied to the other auxiliary feedpump discharge which had the potential to cause severe check valve slam due to reverse flow in the event of a pump trip.

The NozzleCheck DRV-Z was selected because of its ability to close before significant flow reversal, thereby eliminating the problem of pressure transients that cause check valve slam. In addition, one of the primary requirements of this application was that the utility must be able to check operability of the valve every quarter without disassembly. To solve this problem the DRV-Z was designed with a mechanical inspection port to stroke the valve without disassembly. The DRV-Z met the basic function of preventing reverse flow, eliminated the adverse effect of pressure transients, and was unaffected by upstream elbow disturbance because of its low V_{min} capability.



Basic Specifications

- Sizes: ½" – 14"
- Pressure Class: 150 to 4500lb
- Body Type: Flanged, Butt weld, and Socket Weld

Nuclear Power Systems and Applications

- Aux. and Emergency Feedwater
- HPCI/RCIC Turbine Exhaust
- Containment Isolation
- Component Cooling Water
- Boric Acid Injection
- Instrumentation Air
- Safety Injection
- Main Steam Bypass
- Vacuum Breaker

DRV-B: Large Bore NCV

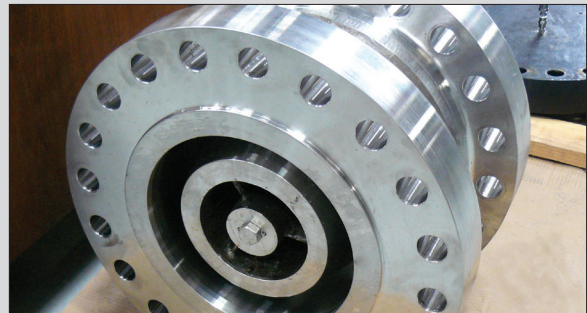
The NozzleCheck Model DRV-B is specified for large bore applications where high flow capacity is required. This design uses a ring shaped disc to minimize mass, while creating a geometry that provides minimal pressure drop. The DRV-B has an inner and outer flow path. The inlet flow is diverted through the circular opening on the inside of the “halo” and also on the outside. Once flow passes the disc, it is guided via a hydrodynamic diffuser to the outlet of the valve. The diffuser is used to reduce the amount of low-flow areas, flow reversals, and turbulence to maximize the pressure recovery. The large annular area is the cavity directing flow around the outside of the disc. The smaller inner circle typically has three vanes 120° apart and acts as the cavity that directs flow from the inner disc area to the outlet of the valve. The DRV-B typically uses three springs to control the closing speed of the valve. At low flow/pressure conditions, the spring is necessary to move the disc to the seat. The springs are used to allow the disc to float into the best seating position and eliminate the possibility of misalignment.

Application Highlight:

Service Water Pump Discharge

A PWR in the Northeast had large bore swing check valves installed in its service water system that were persistently causing system problems when the valve disc slamming occurred during valve closure. The valves were located on the system’s pump discharge and violently closed upon flow reversal occurring at pump starts and stops.

The NozzleCheck DRV-B was selected because of its short stroke length, light disc, and spring assist upon reverse flow. The DRV-B check valve was capable of being fully tested during operation and eliminated an operator workaround that required visual confirmation of no pump reverse rotation.



Basic Specifications

- Sizes: 12" – 60"
- Pressure Class: 150 to 2500lb
- Body Type: Flanged and Buttweld

Nuclear Power Systems and Applications

- Feedwater
- Service Water / Salt Water Pump Discharge
- HPCI Turbine Exhaust
- CCW Pump Discharge
- Containment Isolation

NozzleCheck Product Overview

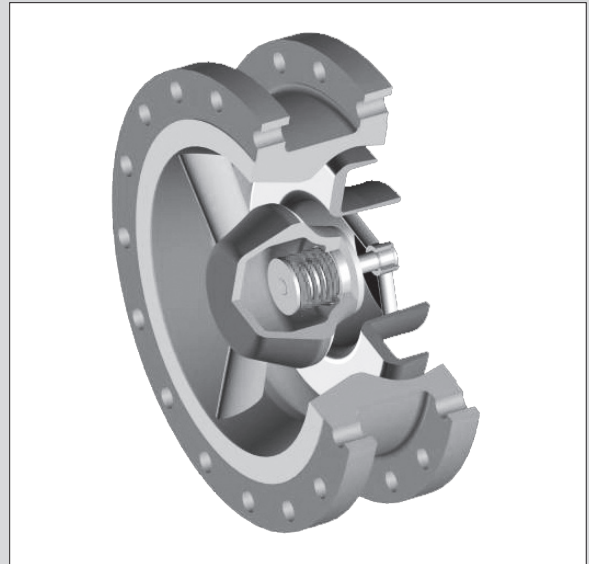
KRV-B: Large Bore, Short Face NCV

The NozzleCheck Model KRV-B is specified for applications requiring a short face to face dimension as well as the ability to eliminate damaging pressure surges during pump trip transients. The KRV-B has a higher pressure drop compared to other longer face to face NozzleCheck designs due to its short outlet diffuser. The KRV-B has a ring shaped disc similar to the DRV-B, but the mass is higher since the disc is connected to the central shaft of the valve. The shaft is connected to the disc via a set of integrally cast vanes. The KRV-B separates the incoming flow into inner and outer flow streams and also straightens the flow with inlet vanes. The KRV-B uses only one spring to apply a closing force to the disc to control speed and reduce water hammer. The stem design on the KRV-B is supported by a bearing surface that is contained and shielded from any debris or impingement by the incoming flow. The disc to stem interface includes an anti-rotation mechanism to prevent disc rotation due to flow.

Application Highlight: Extraction Steam

A 1100 MWe PWR had dual plate check valves installed in the steam extraction lines feeding the LP feedwater heaters located in the condenser. The valves were installed in a vertical pipe run and were designed to prevent the backflow of water to the turbine in the event of a LP feedwater tube rupture in the heater and the backflow of flashing fluid to the turbine in the event of a turbine trip. These check valves were requiring maintenance every outage due to constant fluttering in the line, causing fatigue failure of the spring and disc.

The NozzleCheck KRV-B was selected because of its ability to remain fully open at low velocities, while providing tight metal to metal shutoff. Additionally, the KRV-B minimized pressure drop which maximized turbine efficiency. The KRV-B allowed for trouble free operation, eliminating disc flutter and the possibility of spring/disc fatigue.



Basic Specifications

- Sizes: 12" – 60"
- Pressure Class: 150 to 2500lb
- Body Type: Wafer and Flanged

Nuclear Power Systems and Applications

- Service Water / Salt Water Pump Discharge
- Extraction Steam
- CCW Pump Discharge
- High Pressure Core Injection
- Main Steam

DRV-N: Normally Open NCV

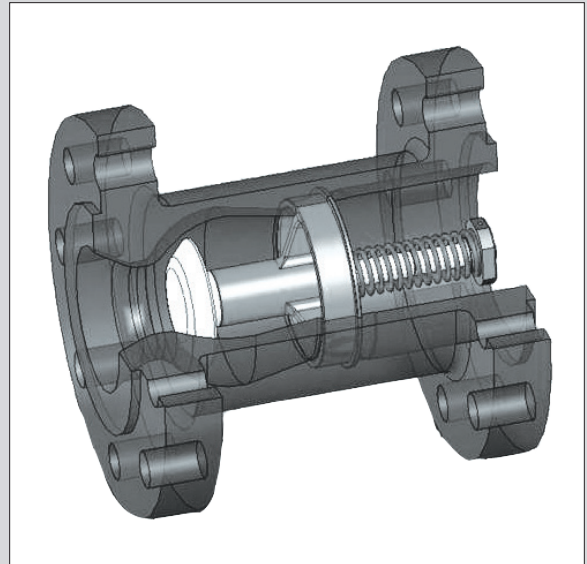
In some applications the fluctuation in pressure, downstream leaks, or other phenomena can result in constant chatter of a check valve causing hinge pin wear or damage to the seating surface. Enertech's Model DRV-N, Normally Open NozzleCheck valve, has been designed to withstand the rigors of these types of applications. This particular design has a similar body configuration to the Model DRV-Z, but rather than a normally closed design that is opened using system pressure, the disc in the DRV-N is opened using a spring. As a result, the valve is unaffected by pressure changes and the problem of constant cycling is avoided. Furthermore, the DRV-N employs the use of a stem guide rather than a diffuser. This feature provides a less congested flow path so that the backpressure can effectively close the valve when flow exceeds normal levels. When closed, the disc is self-aligning and finds the best seating position to form a tight shut-off.

Application Highlight:

AFPT Steam Supply

A 1200 MWe PWR in the South had swing check valves installed in the steam supply lines to the Aux feedpump turbines in order to isolate the backflow of steam in the event of an upstream main steam line break. These check valves were constantly chattering and causing damage to the seating surfaces combined with increased hinge pin wear that resulted in frequent maintenance.

Because of the fluctuation in steam generator pressure, it was extremely difficult to install a check valve that would not chatter. Thus, the DRV-N Normally Open NozzleCheck valve was selected because of its unique design that opens the disc using a spring, rather than relying on system pressure. As a result the valves no longer cycle, eliminating the maintenance costs associated with damaged seating surfaces and hinge pin wear.



Basic Specifications

- Sizes: ½" – 12"
- Pressure Class: 150 to 4500lb
- Body Type: Flanged, Butt-weld, and Socket Weld

Nuclear Power Systems and Applications

- AFPT Steam Supply
- Applications with Fluctuation in Pressure

NozzleCheck Product Overview

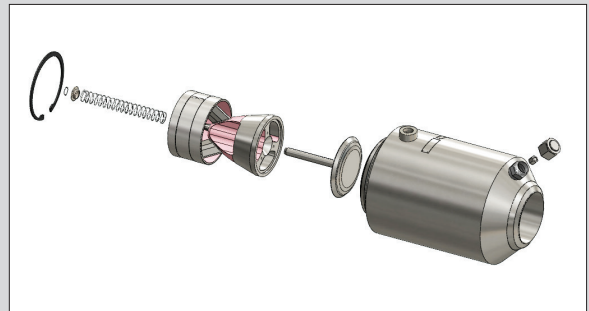
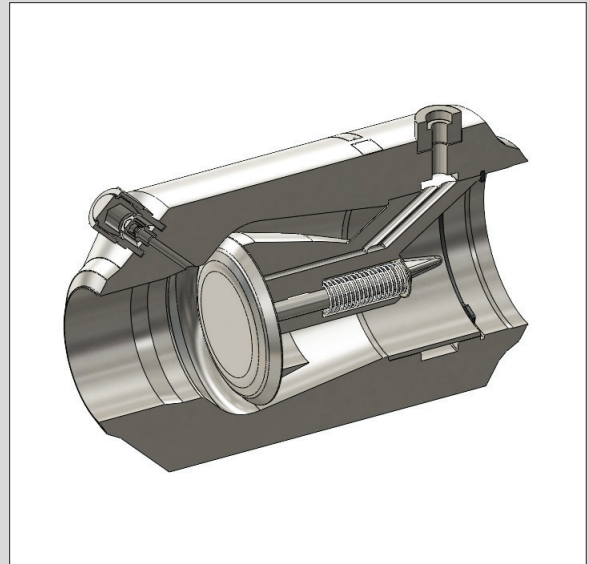
XRV: Specially Engineered NCV

The NozzleCheck Model XRV is Enertech's next generation, premium, small and large bore check valve design that has been specified as the check valve of choice for critical isolation applications in the Generation III+ reactors. This highly engineered valve is custom designed to the unique requirements of an application including those that require valve closure under extremely low flow, while still providing Cvs that are comparable to swing check valve designs. Additionally, the XRV can be designed with unique inspection ports that allow for in-service testing, which was not previously available with weld end assemblies. The XRV is custom manufactured to the dimensional and flow requirements of an application and is not limited by proximity to the discharge end of pumps or elbows.

The XRV is the check valve of choice for non-standard applications that require extensive flow modeling and simulation to determine the most appropriate design to meet the optimum requirements of an application.

Application Highlight: Containment Isolation

Enertech's custom designed model XRV has been used in a passive system where isolation is required. This particular design instituted a modified normally open check valve design with a highly engineered diffuser which allowed for closure of the valve upon reverse flow under extremely low flow conditions. To ensure functionality, a first in-kind test port was designed which allowed in-service tests that simulated the actual flow conditions of the application. No other check valve design was able to enact a passive isolation function, close under extremely low flow conditions, and provide true in service testing that simulated the actual flow conditions experienced by the valve when operated. The XRV met the exact requirements of this critical application.



Basic Specifications

- Sizes: ½" – 60"
- Pressure Class: 150 to 4500lb
- Body Type: Wafer, Flanged, Buttweld, and Socket Weld

Nuclear Power Systems and Applications

- Tank or Vessel Vacuum Protection
- Gas Pocket Venting
- Containment Isolation
- Excess Flow
- All Non-Standard Critical Applications

Standard Dimensions & Flow Characteristics

DRV-Z														
Body Size (in)	L (in)			D (in)					Weight (lb)					Flow Coefficient Cv
	ANSI 150 ANSI 300 ANSI 600	ANSI 900	ANSI 1500	ANSI 150	ANSI 300	ANSI 600	ANSI 900	ANSI 1500	ANSI 150	ANSI 300	ANSI 600	ANSI 900	ANSI 1500	
1	3.94	7.09	7.09	4.25	4.88	4.88	5.88	5.88	9	9	15	20	31	20
2	4.72	7.09	7.87	6.00	6.50	6.50	8.50	8.50	20	20	24	33	88	84
3	7.50	7.09	7.87	7.50	8.25	8.25	9.50	10.50	36	51	66	71	121	227
4	10.0	9.45	9.45	9.00	10.00	10.75	11.50	12.25	71	84	101	132	183	366
6	13.78	14.25	13.78	11.00	12.50	14.00	15.00	15.50	108	154	214	299	485	881
8	17.19	17.72	17.72	13.50	15.00	16.50	18.50	19.00	230	267	360	529	728	1692
10	19.69	19.96	19.69	16.00	17.50	20.00	21.50	23.00	287	390	593	683	1190	2761

DRV-B							
Body Size (in)	L (in)		D (in)		Weight (lb)		Flow Coefficient Cv
	ANSI 150	ANSI 300	ANSI 150	ANSI 300	ANSI 150	ANSI 300	
12	13.78		19.00	20.50	375	507	3410
14	17.75		21.00	23.00	551	705	5874
16	17.91		23.50	25.50	772	970	6280
18	20.47		25.00	28.00	926	1279	8240
20	22.44		27.50	30.50	1257	1609	10180
24	26.97		32.00	36.00	1984	2756	18000

KRV-B							
Body Size (in)	L (in)		D (in)		Weight (lb)		Flow Coefficient Cv
	ANSI 150	ANSI 300	ANSI 150	ANSI 300	ANSI 150	ANSI 300	
12	7.13	7.13	19.00	20.50	243	353	1686
14	7.24	8.74	21.00	23.00	298	507	2398
16	7.52	9.13	23.50	25.50	397	661	3284
18	7.99	10.39	25.00	28.00	507	838	4157
20	8.62	11.50	27.50	30.50	639	1102	5470
24	8.74	12.52	32.00	36.00	838	1433	7542

NozzleCheck Customization Options

Enertech NozzleCheck Valves include a variety of customizable options including:

- Exotic Materials**
 Available in Duplex, Super Duplex, and Titanium for highly corrosive brackish and raw water applications
- Position Indication**
 Can be equipped with test ports for in service testing and real time position indication to verify disc position
- Soft Seat**
 Offered with a soft seat on the disc, to ensure critical bubble tight shut-off



*All values are approximate and subject to change.
Please contact Curtiss-Wright Nuclear for specification details for non standard configurations.

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