

Benchmarking Performance, Reliability, and Engineering Flexibility in Liquid Cooling Applications

As AI workloads and liquid cooling adoption continue to accelerate, coolant distribution units (CDUs) have become critical to maintaining cooling system performance and uptime. Valves are often treated as commodity components, but their impact on flow control, reliability, maintenance requirements, and total cost of ownership can be significant.

This report compares US Valve IRX and IRX-B valves with standard valve solutions commonly used in CDU applications and examines how valve selection affects overall system performance: from day-one flow characteristics to years of operating cost.

The best CDU valve is the one engineered for the application.

Key Findings



Valve pressure drop directly impacts CDU flow efficiency and cooling performance.



Up to 6x higher flow coefficients than traditional poppet check valves enable greater coolant flow and lower system pressure loss.



Patented internally retained designs eliminate external leak paths for improved reliability.



Custom-engineered connections, materials, and dimensions simplify CDU integration and reduce design compromises.



Patented IRX-B technology combines isolation and backflow prevention while reducing valve footprint by 51%+.



A documented 17% cooling efficiency improvement demonstrates the impact optimized valve performance can have in high-density cooling applications.

Why Valve Selection Matters in Modern CDU Systems

Market Context

The demands on liquid cooling infrastructure have changed dramatically, driven by AI deployments, high-density computing environments, direct-to-chip cooling adoption, and rising uptime expectations. CDUs are now expected to deliver reliable thermal management under increasingly demanding operating conditions: and every component in the fluid path affects performance. As rack densities climb and cooling loops grow more complex, there is less room for any single component to be treated as an afterthought.

The Role of the Valve

Valve performance affects flow, pressure drop, reliability, leak prevention, maintenance and uptime. A valve that underperforms in any one of these areas can quietly undermine the performance of the entire system, even when every other component in the CDU is performing as specified.

The Hidden Cost of “Good Enough”

Choosing a valve based solely on availability or purchase price can result design compromises, increased maintenance requirements, performance, limitations, and higher lifecycle costs. What appears to be a minor component decision during the design phase can become a recurring operational burden once the system is in service.

As rack densities rise and cooling loads increase, valve performance plays a larger role in overall CDU effectiveness.



Excess pressure drop requires pumping more energy to maintain flow rate.



Additional components consume valuable space within a tight CDU design.



Flow restrictions can limit cooling system performance.



Every external joint, cover, or mechanical interface introduces another leak path.

IRX and IRX-B valves are engineered to specifically address these challenges through high-flow, low-pressure-drop designs with patented internally retained architecture that eliminates leak paths while maximizing flow performance giving reliability and cooling efficiency.

The Cost of Valve Selection:

Looking Beyond Purchase Price

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The true cost of a valve extends far beyond its purchase price. In liquid cooling systems, valve selection can directly impact cooling efficiency, pump energy consumption, available cooling capacity, and long-term operational reliability.

Even modest restriction to flow can require more pumping power, increase operating costs, and reduce the effectiveness of heat transfer through the cooling loop. Across an entire CDU these impacts can influence not only cooling capacity and energy consumption, but also the ability to support higher-density computing environments.

For CDU designers and operators, the key question is not simply “What does the valve cost?” but rather “How does the valve affect total system performance?”

Five Questions Every CDU Designer Should Ask

Q1

Is the valve optimized for my specific flow and pressure requirements?

Q2

How does the valve affect pressure drop and overall CDU efficiency?

Q3

What impact does the valve have on pump energy consumption?

Q4

Can the valve support the cooling requirements needed for maximum AI processor performance?

Q5

Can the supplier customize the valve to fit the exact needs of my system?

Benchmark Comparison:

IRX and IRX-B vs. Standard Valves

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US Valves patented IRX/IRX-B technology was developed to address the limitations common to conventional check valve designs. By combining a larger flow area, optimized internal geometry, and elastomer-hinge technology, IRX/IRX-B delivers substantially higher flow performance while eliminating external leak paths. The result are valves with long-life reliability delivering flow coefficients up to 6x higher than traditional poppet-style check valves. Their patented internally retained design eliminates external hinge pins, covers, and associated leak paths, improving reliability while maintaining high-flow performance.

Evaluation Criteria	Traditional Check Valve / Separate Assembly	US Valve IRX	US Valve IRX-B
Primary Function	Standard backflow prevention using conventional check valve architecture	Internally retained elastomer hinge check valve for backflow prevention in liquid cooling systems	Hybrid isolation ball valve + internally retained check valve in one compact body
Leak Path Exposure	Conventional approaches can introduce more potential leak points through design and assembly complexity	Internally retained design is positioned as having no external leak paths	Internally retained design plus combined architecture helps reduce leak points versus separate assemblies
Pressure Drop/ Flow Efficiency	Traditional poppet-style check valves are described as restricting flow and reducing pump efficiency	Positioned as ultra-low pressure drop and optimized for maximum flow	Combines two functions while still supporting low- pressure-drop performance
System Footprint	Separate ball valve + check valve assemblies require more space and more overall length	Compact check valve option for space-conscious Spoling loop designs	Reduces overall length by 50%+ versus separate ball + check valve assemblies
Component Count	Multiple components may be required to achieve isolation + check functionality	Single check valve solution	Combines isolation and check in one valve, reducing total component count
Layout Complexity	More fittings and longer assemblies can increase plumbing complexity in tight layouts	Supports custom integration with different lengths and end connections	Simplifies plumbing layout by replacing separate valve components with one combined solution
Serviceability	Maintenance may require more assembly handling and more space depending on the system layout	Reliable check valve function with application-driven	Isolation + check in one body enables maintenance fitment access without draining systems
Backflow/Pump Protection	Standard backflow prevention depends on valve design and application fit	Designed to prevent backflow in redundant pump systems and improve system reliability	Prevents backflow and pressure spikes while also providing shut-off capability
Customization Options	Often limited to off-the-shelf sizes and connection types	Custom-engineered lengths and end connections available	Custom-engineered lengths and end connections available for tighter integrations
Best-Fit Application	Standard systems where commodity valve architecture is acceptable	CDU loops, immersion cooling systems, and redundant pump applications prioritizing low ΔP and leak-risk reduction	High-density skids and cooling systems where footprint, serviceability, and combined functionality are priorities

The Technology Behind IRX and IRX-B Performance

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USV IRX



Leakproof, IR (internally retained) check valve engineered to maximize CDU efficiency.

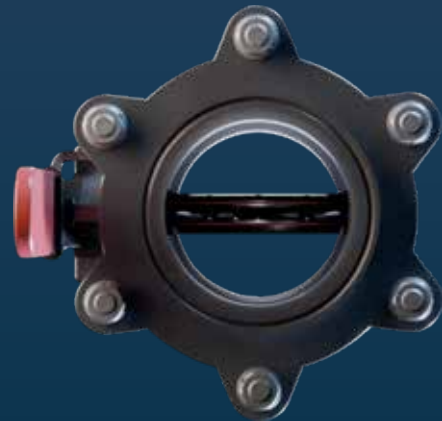
Key Benefits:

- Industry's lowest pressure drop for maximum flow
- Patented, internally retained design eliminates leak paths
- Protects against backflow and pressure spikes in CDU systems
- Custom end connections engineered for your cooling layout

Made For:

CDU engineers who demand maximum efficiency, leak-proof reliability, and protection against expensive chip and hardware failures.

USV IRX-B



Patented, footprint-saving combo valve that delivers isolation and check valve performance in a single, high-flow body.

Key Benefits:

- 51%+ reduction in valve footprint by combining two valves into one
- Prevents backflow during operation and isolates for maintenance
- Same maximum flow and low pressure drop as a standalone IR check
- Simplifies CDU design and reduces potential leak paths
- Custom end connections and piping configurations for tight spaces

Made For:

CDU engineers looking to minimize system footprint while maintaining peak efficiency and dual-function performance.

The US Valve Advantage:

Engineered Around Your Requirements

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A new approach to Industry Challenges

Most valve suppliers offer only catalog-based products. As a result, engineers often need to modify system designs to accommodate whatever valve configurations happen to be available: creating space constraints, flow compromises, integration challenges, and additional engineering effort.

US Valve approaches these challenges with a different lense, with application-first engineering grounded in a clear understanding of operating conditions, thermal performance requirements, and installation constraints. Engineers work closely with customers to deliver an optimized solution built to meet specific flow requirements, pressure requirements, temperature ranges, material specifications, connection types, envelope and footprint constraints, actuation preferences, and design requirements.

Why it matters

This enables engineers to design with fewer compromises, improve integration efficiency, optimize CDU performance, reduce redesign cycles, and accelerate development timelines.

Using this approach, the IRX and IRX-B valves were developed, reducing installation complexity and creating results that speak for themselves.

In a recent high-density CDU application requiring aggressive flow performance, low pressure drop in a compact footprint, US Valve engineers used IRX and IRX-B valves resulting in

Up to

6_x

higher flow
coefficients than
traditional
poppet-style
check valves

17%

cooling efficiency
improvement
supporting
high-density rack
deployments

51%+

footprint
reduction
using the
patented IRX-B
combination
valve

Conclusion:

Setting the Standard for CDU Valves

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As liquid cooling infrastructure evolves, valve selection is becoming a critical, system-level design consideration rather than a commodity purchase.

Supported by over 1 million valves manufactured and sold, patented elastomer-hinge technology, ISO 9001-certified processes, and engineering expertise dating back to 1952, US Valve helps CDU designers improve flow performance, reduce leak risk, simplify integration, and optimize cooling efficiency.

Whether the requirement is maximum flow through an IRX check valve or footprint reduction through the patented IRX-B hybrid valve, US Valve delivers application-specific solutions engineered for modern liquid cooling systems.

This version turns the report from a largely conceptual thought-leadership piece into a proof-driven benchmark document built around tangible engineering advantages.

TRUSTED BY TODAY'S MOST CRITICAL INDUSTRIES

1M+ Valves Delivered

6x Higher Flow*

**Custom Lengths and
Connections**

17% Cooling Gains*

51% Space Savings (IRX-B)

VERIFIED AND TESTED

ISO 9001-Certified

Patented Tech

**Manufactured and Tested
in Linthicum, MD**

70+ Years of Experience

**US Engineered and
Assembled**



Building a New CDU Design?

Struggling to Find a Valve That Meets Your Exact Requirements?
Speak with an IRX engineer about your custom CDU valve solution.



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