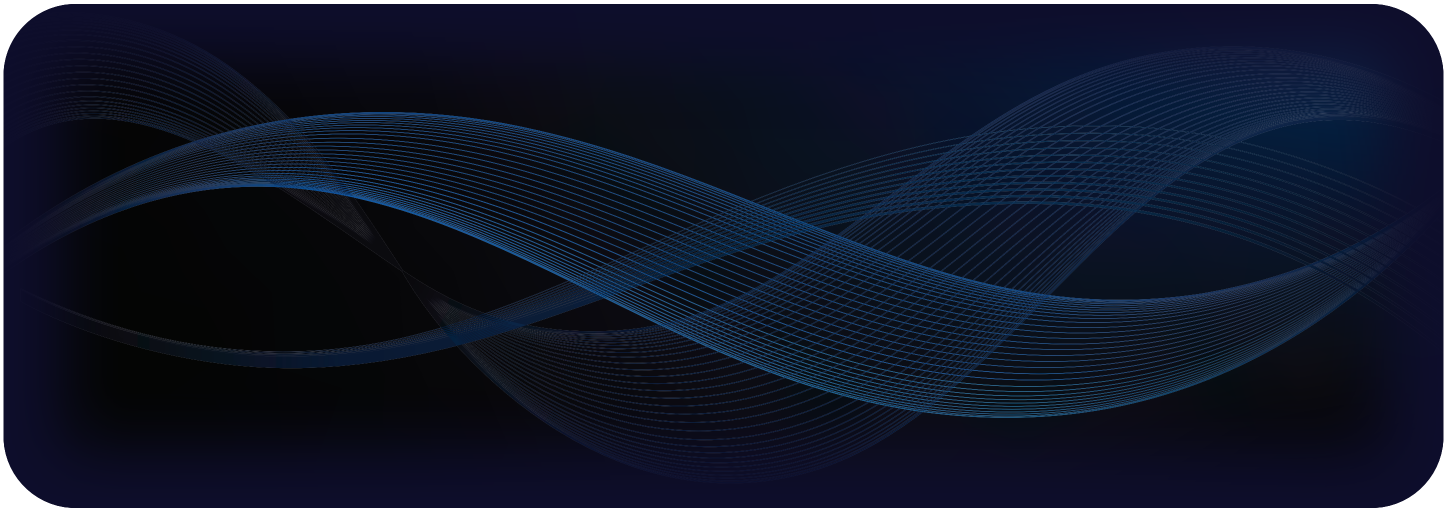
The ABC's of Quick Disconnects in Liquid Cooling Applications

Part 3: S-V, from Spillage to Vibrations



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Effective fluid management in liquid cooling is an imperative when used with expensive and sensitive electronics. Fortunately, many important considerations in a cooling system can be addressed up front. A huge range of connection technology factors—from spillage at connection or disconnection to vibration in transport or use—can affect how well critical connections like quick disconnects (QDs)work within a liquid cooling system.

Part 3 of the series "The ABC's of Quick Disconnects in Liquid Cooling Applications" addresses some of the top connector considerations for designing, building and maintaining optimal liquid cooling systems.

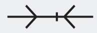
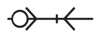
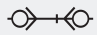
SPILLAGE

Q. What amount of fluid loss is acceptable upon each disconnection of the quick disconnect? Is the coolant a regulated or hazardous material?

A. The amount of allowable spillage will depend on the end-use application. Many times, if fluid loops are in close proximity to high powered electronics, spillage needs to be kept at a minimum – preferably near zero. Spillage is an inherent effect of closing valves – having absolutely no spillage is impossible. Depending on flow size, a typical dry break non-spill QD will emit less than a drop of fluid upon disconnection. Spillage rates of CPC products are noted in product documentation. At 0 psi, the smallest CPC liquid cooling QD (an Everis® LQ2 QD) emits less than 0.015 cc per disconnect. This will result in a wetted surface, but will not be enough volume to create a drop. Under pressure, spillage volume increases slightly. If the system fluid is a regulated or hazardous material, containment, and disposal protocols of absorbent supplies, if used, will need to be managed.

SHUTOFF OPTIONS

Q. Do you need automatic or integral shutoff valves in the quick disconnects for your application?

	Description	Cv Impact
	Straight-Through: Free-floating; neither connector half features a valve, necessitating flow stop prior to disconnection	Maximum CV at connection
	Single Shut-off: One side of QD contains a valve to prevent coolant release.	Nominal CV loss to flow resistance
	Double Shut-Off: Both QD halves contain valves; poppet valves trap a small amount of liquid within the coupling body that can drop when disconnected.	Insignificant Cv loss to flow resistance
	Flush-faced valves ensure maximum containment of fluid upon disconnect	Insignificant Cv loss to flow resistance

SPECIAL REQUIREMENTS

Q. What unique scenarios or features must the product address or possess?

A. Liquid cooling quick disconnects, couplings, and quick connect fittings are used in everything from data centers to medical equipment. Knowing an application's certifications or performance requirements at the outset informs product selection. Sterilization, NSF listed, REACH compliance, RoHS (Restriction on Hazardous Substances) compliance, USP Class VI approved materials, special packaging, color coding, assemblies and keying are some examples of common application-specific requirements. When an off-the-shelf QD does offer the necessary features, engineers should contact CPC to discuss delivery options or custom engineered QD solutions.

A. Most connectors recommended for liquid cooling applications are non-spill or "dry break." Quick disconnects are generally in close proximity to the critical electronics or energy conversion systems subject to liquid cooling. Disconnecting a non-spill QD results in a wetted surface on the valve faces—not even enough fluid to create a droplet. Shut-off or wet break valves in quick disconnects offer less pressure drop in the system, but the tradeoff is fluid loss upon disconnection. Coolant loss can be problematic for a number of reasons so QDs with a shut-off valve structure other than dry break are not typically recommended for the vast majority of liquid cooling system applications.

TEMPERATURE

Q. What is the temperature range of your application? How much will temperature fluctuate, and how often?

A. When selecting a connector, it is important to understand maximum and minimum temperatures of storage, shipping, ambient conditions, and the operating environment. The temperatures experienced by a liquid cooling system can affect component and subcomponent performance and longevity. Different types of materials perform differently at different temperatures or have optimal temperature ranges for use. For example, when amorphous polymers approach their glass transition temperature, they can permanently deform Anticipation of thermal ranges is why quick disconnects that are purpose designed and built for liquid cooling are constructed of high-performance polymers, which are not susceptible to the limitations of commodity plastics. As temperature decreases, elastomers experience durometer changes, which can impact their sealing abilities. Fluorosilicone, for example, performs better at lower temperatures than some of its elastomer counterparts, such as EPDM and FKM. With metals having high thermal conductivity, housing materials can be hot or cold to the touch. Finally, engineers working on liquid cooling systems should think about not only the end-use operating temperature range but should also consider the shipping and storage temperature and ambient environment ranges as well.

TERMINATION

Q. How are you connecting the coupling to the rest of the system? Will it be connected to a hose, manifold, or threaded port?

A. Quick disconnects are designed with a multitude of termination styles. Common termination options include hose barbs and threads. Distinct styles of hose barbs are intended for different types of hoses. Triple barbs are compatible with more rigid, thin-walled hoses. External hose clamps are often used with this combination of hose barb and hose style. Locking hose barbs, on the other hand, are intended for use with more flexible, thicker-walled hoses. Threaded terminations are also available in many styles. G-threads (ref. ISO 1179) and SAE ORB threads (ref. SAE J1926) are the most popular styles of threaded terminations. The most common thread styles include an elastomeric seal to guarantee leak-free connections. Alternate terminations are also available upon request.

Left to right: NPT, BSPT (R), SAE ORG, BSPP (G)

TESTING

Q. What kind of testing are liquid cooling quick disconnects subjected to? What independent, subassembly or system-level tests do liquid cooling systems need to undergo?

A. Liquid cooling quick disconnects go through a rigorous testing regimen during the product validation and release process prior to going to market. This testing includes leak testing, cycle testing, and temperature testing, among others. Validated specifications can be found on CPC's website and product specification sheets. If more detailed information is required, please reach out to a representative of CPC for more information. As for liquid cooling systems, there are some other tests that are beneficial and commonly performed. Corrosion, shock and vibration, shipping, and liquid cooling loop pressure and temperature tests are often performed as part of system-level verification and validation steps. System manufacturers may choose to run simulation tests. Independent labs can also be called upon to perform subcomponent, component or subsystem-level testing.

TOLERANCE

Q. What mounting methods are recommended for installing blind mate quick-disconnects. What degree of float tolerance is required? How do blind mate quick disconnects remain fully connected during use?

A. Understanding each QD's tolerances at connection and how these tolerances affect flow and system performance is key to designing a system that operates as intended. Radial, axial, and angular float may be required to ensure that the quick disconnects can connect properly and perform as intended. Even small amounts of misalignment with blind mate connectors could cause leaks or damage to the QD. Another tolerance to consider is the connected length vs. flow tolerance. Everis® BLQ products are designed with intentional overstroke, creating a range of stroke lengths that achieve full flow. Typically, the valves can achieve full flow even with a 1-2 mm gap between the hard-stops on the body and insert. Commonly in blind mate applications, the quick disconnects are mounted on a panel or manifold and an external latching mechanism separate from the quick disconnects is implemented to secure parts in place. Mounting kits are available for most blind mate products to assist with alignment within tolerance.

TRANSPORTATION

Q. Will the liquid cooling system be pre-assembled and transported over land or via air? Will the system be shipped with fluid already in the system?

A. Both ground and air transportation are susceptible to fluctuating environmental conditions. Systems shipped with fluid inside are subject to atmospheric pressure changes as well as expansion of the fluid inside if the system is charged with a water-based coolant and subject to freezing. Elevation changes could cause very high pressure or negative pressure within the system. If this is the case, an integrated pressure relief valve within the QD can help equalize pressure during the shipping process. Vibration during transport is another consideration. Violent or jarring vibrations could loosen a joint. To address this, one should ensure sufficient torque of any threaded termination subject to jostling during transportation. Violent or jarring vibrations could also displace valves enough for fluid to leak. In this case, it's possible to increase the force of the internal springs that hold the valves shut; however, connection force would increase. System level testing is recommended to account for variables in transportation.

TUBING

Q. What type, material, and size of tubing are you using? Will the system be using rigid or flexible tubing and are clamps required?

A. The hose type, material, and inner diameter influence QD termination options. Rigid, thin-walled hoses typically are compatible with triple barb terminations. External hose clamps further secure this combination of hose barb and hose style. Flexible, thicker-walled hoses often require locking hose barbs to secure connectors. With this combination, external clamps are not recommended because the clamp placement could create a leak path. Most importantly, system designers must also verify the chemical compatibility of the tubing materials with the liquid cooling fluid to help avoid corrosion or other incompatibility issues which have the potential to impact QD and system performance.

VIBRATION

Q. Will the liquid cooling system be installed in a location with seismic activity? Or will it experience vibration during operation, such as would be common in a transit application?

A. Liquid cooling quick disconnects are designed to withstand forces and pressures of side load, impact, and vibration that would be expected in a typical liquid cooling of electronics application. However, QDs can sometimes be installed in dynamic environments. Liquid cooling systems operate holistically so system designers should calculate and test for vibration impact at the system level for all components at all connection points. Shock and vibration test results at the individual component level are available from most QD manufacturers upon request.

To learn more about CPC connector technologies and the Everis® line of products specifically designed for use in liquid cooling of electronics applications, visit our website or contact us at 1-800-444-2474. Also, see other technical guides and white papers on key topics in liquid cooling such as QD specification, chemical compatibility, flow and ambient conditions: https://www.cpcworldwide.com/Resources-Support/Literature/Liquid-Cooling.

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