Operational Considerations for Single-Phase Immersion Cooled Data Centers
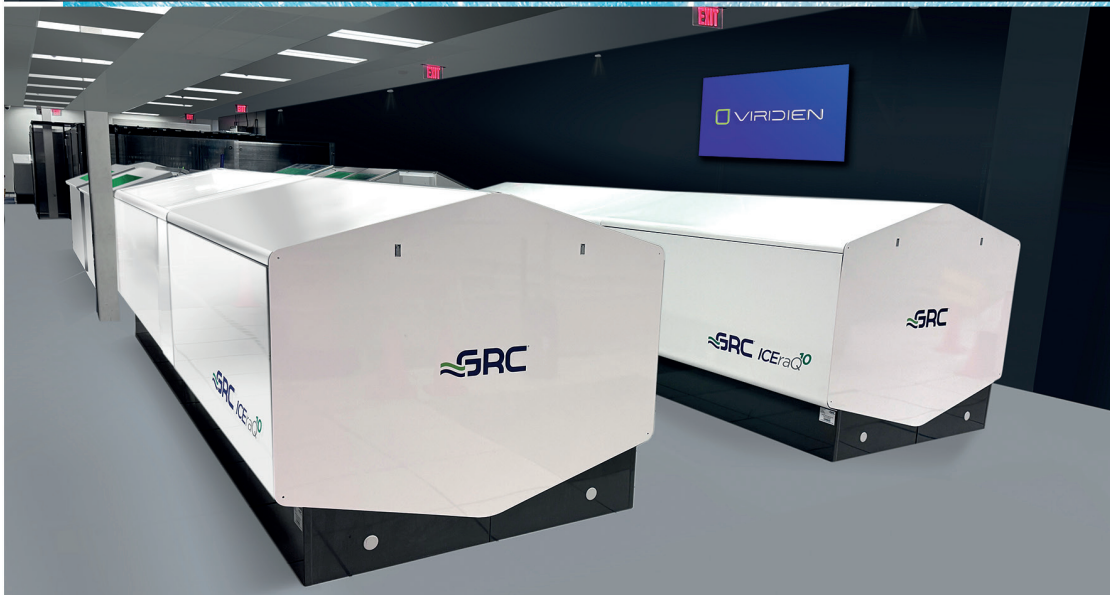
Prepared by Viridien - A GRC Client Since 2010

Content

Introduction

We at CGG began our journey with immersion cooling 10 years ago and it's only gained momentum.

As the need for data centers to operate at higher densities rises, so does the necessity for this technology. That's why we decided to share our experience operating an immersion-cooled data center in this guide. We hope to educate soon-to-be adopters on the operational considerations to keep in mind when deploying single-phase immersion cooling in their data centers, so they can take full advantage of the many benefits it offers right from the start.

Image 1: GRC's immersion-cooling ICEraQ2 systems provide an open, quiet, comfortable work and data environment.

Versus

Air-cooled data centers are cold and noisy without the compute density of comparable immersion-cooling space.

First Impressions

Single-Phase Immersion Cooling Versus Legacy, Air-Cooled Systems.

The first thing you'll notice when you walk into our immersion-cooled data center is that it's virtually silent. The high-pitched whirring of server fans and air handlers found in air-cooled sites are replaced by the subtle hum of fluid pumps.

Next, you'll realize that the temperature is set higher than what you would experience in an air-cooled data center. With immersion cooling, A/C is only needed for technician comfort.

Last, you'll immediately see our immersion-cooled data center appears more open, better illuminated, and less overwhelming. (See Image 1). Waist-high horizontal racks afford an unobstructed view throughout the room, making the infrastructure look less complex. This despite the fact our operation supports double the compute of our legacy, air-cooled data center in the same space.

Learn More About the Differences in These Two Technology >> grc.com/blog

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Immersion Simplifies Data Center Operations

Ease of Installing, Servicing, and Maintaining IT Equipment.

We've found immersion cooling makes both IT and data center infrastructure easy to service, maintain and operate.

The horizontal rack design makes installing, servicing, and maintaining IT equipment very simple by providing ready access to each individual server.

The non-toxic coolants from GRC's ElectroSafe® partners are completely safe to handle.

Nevertheless, some technicians choose to wear nitrile gloves to avoid having to wipe their hands dry.

In contrast to densely packed vertical racks, there's no need to handle heavy IT equipment high in the vertical racks or low to the ground when installing or retrieving servers in GRC's horizontal racks. For bulky or heavy servers, you may find it easier to employ a hoist-based assisted lift. (See Image 2)

Image 2: Servers can be easily lifted out of the horizontal rack system with hoist-based assist lifts.

Air-cooled vertical rack height can make access to some ICT equipment difficult

Versus

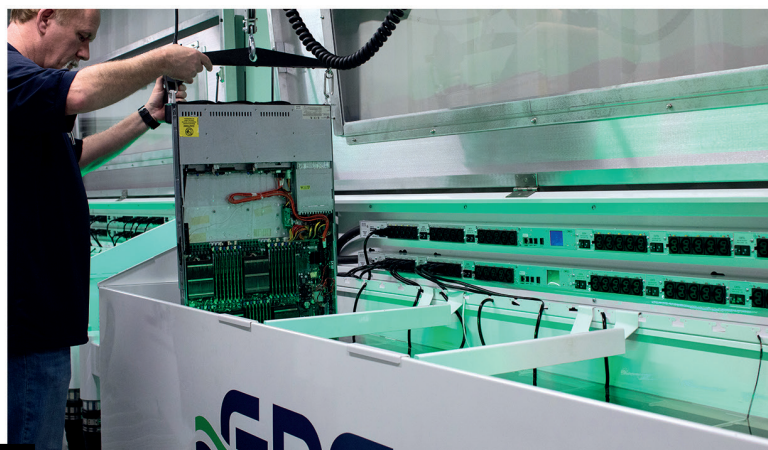Air-cooled data centers do not provide for technician comfort or ICT workspace.

Image 2: GRC ICEraQ systems provide a convenient worktable-high workspace.

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Eliminate Hot Aisle Work Limitations

Many work councils and governmental regulatory agencies, such as OSHA, limit the amount of time personnel can spend in hot aisles (typically 122-140°F/50-60°C or higher). Because all the heat generated is contained within the racks rather than released into the environment, immersion-cooled data centers operate at a comfortable temperature for our technicians, eliminating the safety hazard and administrative time spent ensuring compliance.

Convenient Rack-Mountable Service Rails

GRC's immersion cooling systems come equipped with rack-mountable service rails for resting servers, storage, networking, and other compute devices when they're removed for maintenance. Along with creating a convenient waist-high workbench, the rails allow residual coolant to return into the rack, not on the floor. (See Image 3)

Helping Technicians with Operational Silence

Another key advantage of immersion cooling is the virtually silent environment eliminates the need for hearing protection. Along with health considerations, it also permits technicians to more easily communicate to troubleshoot and resolve issues right at the rack.

Reliability Equals Reduced Service Calls

The immersion cooling systems also help reduce the number of service events by improving server reliability. Servers immersed in ElectroSafe coolants are protected from dust and other air-pollutants, along with moisture and oxygen, hence corrosion. What's more, the absence of server fans eliminates vibrations and reseat errors.

Tips for RMAs and Depot Repairs

While in-rack repair and maintenance in an immersion-cooled data center is straightforward, there are a few simple considerations for the RMA of immersion-cooled servers and other components. To contain any residual coolant, we recommend using zip-lock-style bags to transfer and ship wet components from the rack. Also, before packaging them, components can easily be cleaned using ultrasonic cleaners or organic, VOC-free cleansers such as Simple Green®. This readily available product also comes in the form of wipes, which are great for swabbing hands, or cleaning spills and splashes.

Suggested Accessories:

Absorbent Wipes

Organic VOC-Free Cleaner

No Longer Required:

Hearing Protection

Cold-Aisle Protective Vests/Jackets

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Two Moving Parts - One Simple, Powerful System

We've found the simplicity & efficiency of GRC solutions have allowed us to do a lot more, with lower expenses and in less time & space, while providing:

- Ultra-efficient operation
- Lower upfront capital expenditures (CAPEX)
- 50% reduction in total energy consumption
- Reliable performance

Simply changing the medium of heat transfer from air to their ElectroSafe coolant reduces data center complexity dramatically.

Only Two Moving Parts

A Coolant Pump

A Water Control Valve

Complicated chiller plants, air handlers, humidity controls, and the like are replaced with just two moving parts: a coolant pump, and a water control valve.

Essentially all the complex moving parts typically associated with data center cooling are replaced with fewer, more efficient, easier-to-maintain components, to say nothing of environmental benefits.

This translates into a more reliable system with fewer headaches. In fact, the systems are so low maintenance they only require one filter change each year.

Since compressor-based cooling is not required, the need for refrigerants, along with worries about the cost, availability, regulations, and the GWP (global warming potential) of these substances, are eliminated. As immersion-cooled servers save so much power, this directly correlates to a significant reduction of traditional back-up power (UPS) requirements.

Readying IT Equipment for Immersion: Considerations Limitations

Today, the vast majority of servers running in immersion systems are either air cooled servers optimized for immersion, or servers that are specifically designed for immersion. Both require the same best practice parts selections over their air-cooled counterparts. These steps take place at the server vendor's factory or at an engineering services firm that has been engaged to ready the servers for use in an immersion environment. The primary optimizations that are made to the servers are:

Removal of Chassis and PSU Fans:

Fans are not needed for coolant flow, and the additional resistance caused by the fluid will cause the fans to eventually fail, causing a fan/fault alarm. Therefore, removing the chassis and PSU fans altogether is the best practice.

Image: Indium foil applied to a CPU

Replacing Thermal Paste Between CPUs/GPUs and Heat Sinks with Indium Foil:

Over time, thermal pastes will dissolve into the immersion fluid. Indium foil, a metallic thermal interface material that is compressible and resembles aluminum foil, performs the same function as thermal paste but is suitable for use in an immersion environment.

Modifying Chassis Design:

The chassis should be designed to include handles or hoisting features to simplify removal from the tank. Also, to ensure maximum fluid circulation around the server components, all air shrouding should be removed and any openings that would restrict fluid flow should have grates removed.
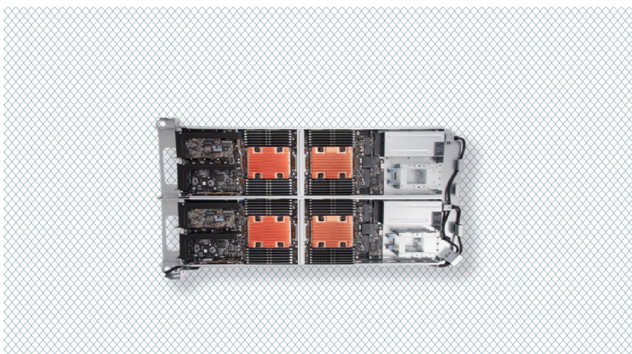

Image: Server designed for immersion from Hypertec

Hard Drive Selection

Legacy HDDs that have a vent hole may not work reliably in an immersed environment, as coolant will seep into the casing and the platters will not spin at the correct RPM. Hard drives that are suitable for use in immersion include:

SSDs/Flash/NVMe Storage Devices:

Commonly used nowadays given their superior performance, reliability and lowering costs. These types of drives can be immersed without any modifications.

He-filled HDDs:

Most high-capacity hard drives (>10TB) are helium-filled (hermetically sealed). These spinning HDDs also work well in an immersion environment and do not need any modifications.

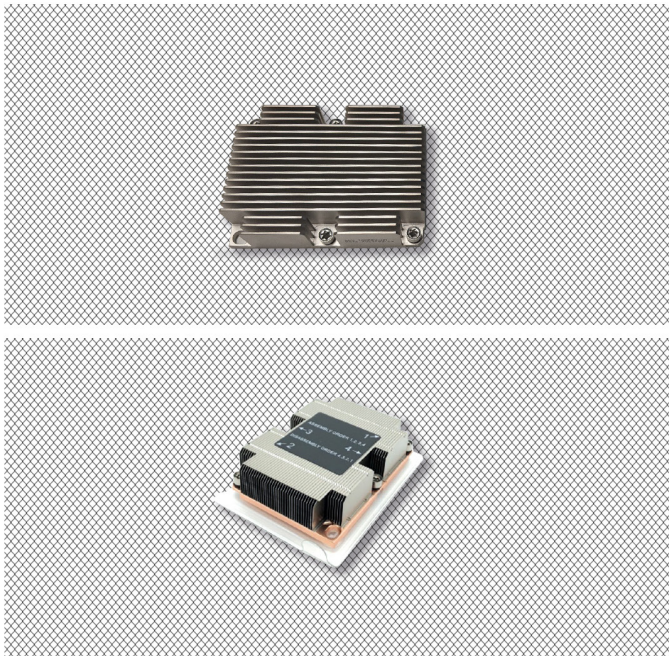Image: Heat sink designed for use in immersion

Image: Compared with a conventional air-cooled heat sink

Thermal Design: Immersion Optimized Heat Sinks

Heat sinks optimized for single phase fluids are the best option and should be used rather than standard air-cooled heat sinks whenever possible. Air-cooled heat sinks are designed with numerous thin fins to maximize the surface area exposed to airflow to dissipate heat effectively. However, these thin fins are not thick enough to efficiently conduct heat in an immersion environment, resulting in the complete surface area of the heat sink not being utilized for heat transfer. Heat sinks designed for use in immersion use fewer, thicker fins that ensure heat can be transferred to the tip of each fin for maximum cooling efficiency.

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Product Labels

Labels for serial numbers, asset management or other system components tend to release into the coolant over time when proper adhesives or compatible labels are not used. GRC tanks have built in strainers to catch labels if they do release, as well as a 300 Micron full flow Y strainer and a 10 Micron side stream filter.

This prevents any labels or other stray material that is released into the immersion fluid from damaging the system. However, the Y strainer should be checked at least twice a year or as indicated by remote monitoring pressure values. To avoid these issues, acrylic, nylon, polyester, or oil-proof labels utilizing permanent adhesive are recommended. Acrylic adhesives are also compatible.

Cabling: Material Compatibility
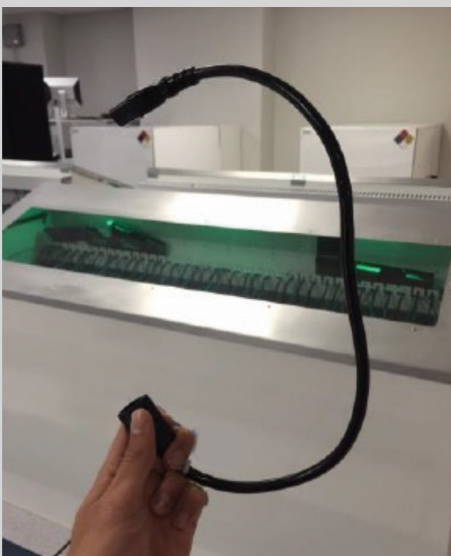
Some types of PVC jacketed cables will stiffen over time in single phase coolants. To avoid these issues, select networking or power cords with the following jacket types:

• Nitrile / Buna-N
• PTFE (Teflon)
• Polyurethane (PUR)
• FEP (Fluorinated ethylene propylene)
• TPE (Thermoplastic elastomer)

These types of cable jackets can commonly be found in plenum rated cables. Plenum rated cables are meant for long runs in underfloor or overhead grey spaces with low smoke ratings and are typically made from the alternative materials listed above. The incremental cost difference between PVC and an alternative jacket material is negligible.

Fiber Optics

Until recently, most immersion systems used copper DAC's due to the lack of availability of immersion-compatible products. However, in the past 5 years immersion-compatible fiber optic solutions from vendors like Formerica, Cisco, and Eoptolink have been introduced, featuring sealed fiber optics solutions that are fully compatible and warranted for use in immersion environments.

## Maintaining Good Data Center Hygiene

GRC systems have been designed to fully contain the ElectroSafe coolant. However, introducing liquid in the data center – presumably from splashes and spills while servicing IT equipment- naturally raises questions about data center hygiene.

GRC systems minimize the chances of a spill occurring. But sometimes spills are unavoidable. For that reason, they're equipped with integrated containment or with secondary containment decks. This ensures that any potential spills or splashes, including those coming from servers, cables, hands, and so on, will be safely captured at the system.

To meet stringent building code requirements, clients may also install expandable bladders to safeguard against unlikely leaks.

Features like these are a great solution for small-scale or modular deployments (even amongst existing infrastructure.) But larger sites can also employ room-level containment using measures like foam spill berms, underfloor containment, and more.
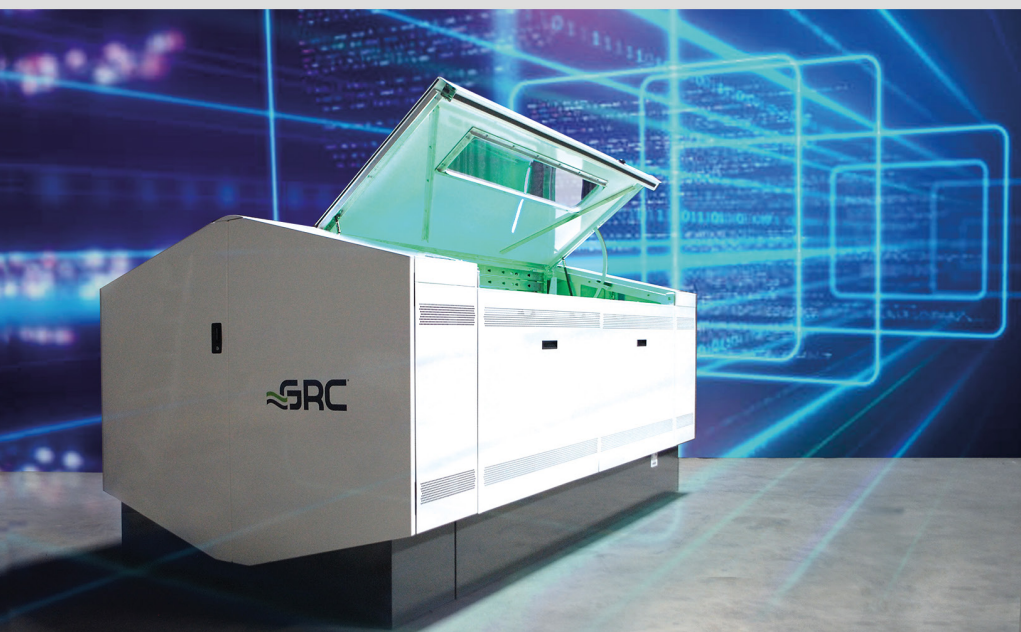
How to Easily Clean Spills

Though unlikely, if you do encounter a spill, it can be cleaned very simply with absorbent pads, solvent-based cleaners, or a mop. Again, we recommend having organic, VOC-free cleansers such as Simple Green® on hand.

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## GRC's Service Warranty and Conversion-to-Immersion Process

Having partnered with GRC for 10+ years, we can attest to their world-class Service Warranty coverage. GRC provides their clients a single point of contact, quick response times (typically within 24 hours), plus a consistent standard of service with technicians in 150+ countries around the world.

This is especially beneficial for companies with a multi-national footprint, giving them the confidence and peace of mind that their data centers have access to the same high-quality service regardless of where they're located.

Conclusion

In our experience, immersion-cooled data centers are not more difficult to operate, just different. Those accustomed to running air-cooled sites will experience a brief but very manageable learning curve to the many benefits the technology has to offer- notably reduced costs and maintenance, superior cooling at higher densities, plus a better working environment. GRC has been providing us innovative, single-phase immersion cooling systems since 2010. They're always ready to help with implementation, training and ongoing support with operational best practices.

Next-Gen Cooling And a Global Benchmark in Sustainability

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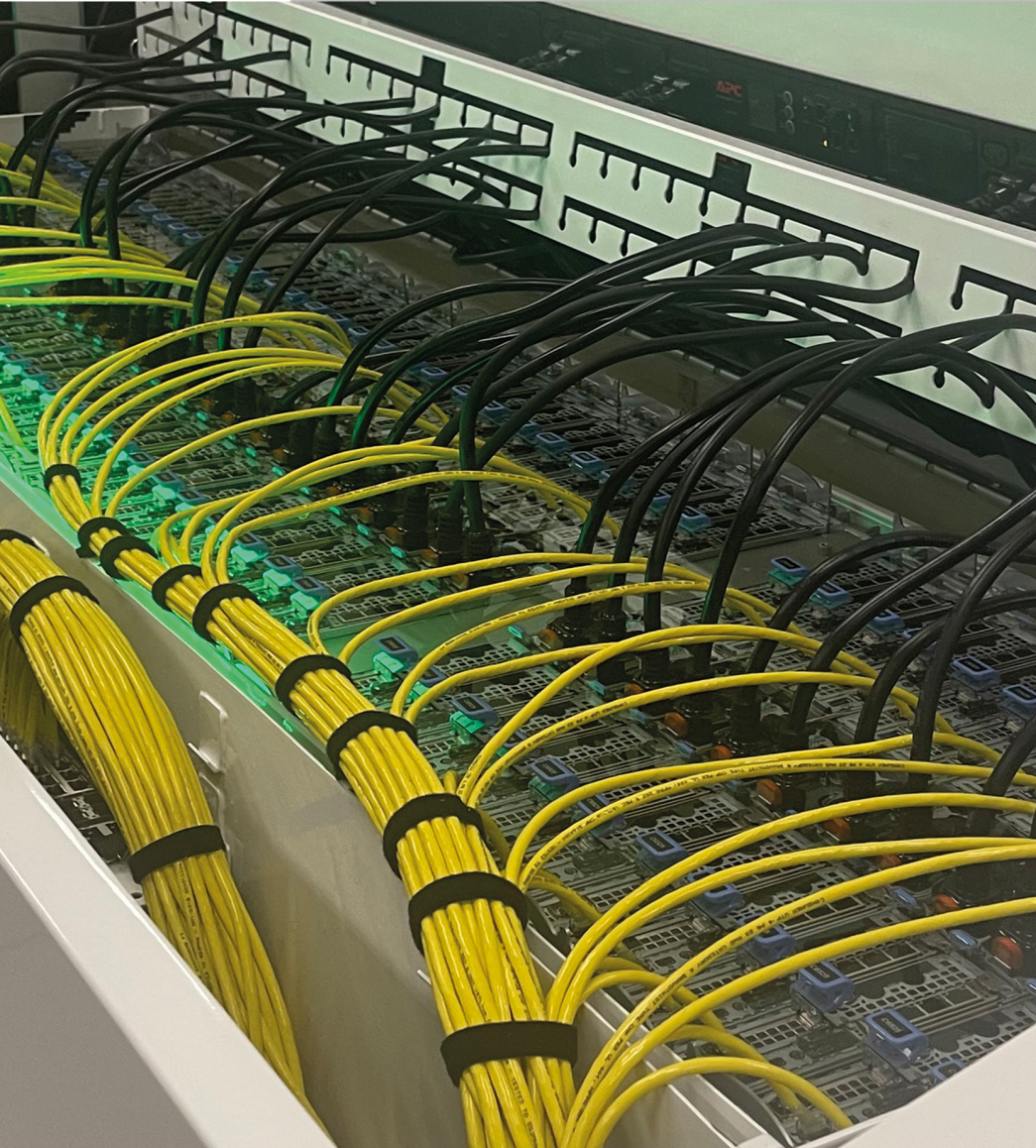
To Learn More About
How GRC Can Help You
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