ARE YOU READY?

COMMISSIONING LIQUID COOLING SYSTEMS FOR DATA CENTRES: LESSONS LEARNED FROM CAI'S GLOBAL EXPERIENCE



INTRODUCTION

As AI workloads continue to drive rack densities beyond the limits of traditional air cooling, liquid cooling is rapidly becoming a critical component of next-generation data centres. Based on CAI's experience commissioning Liquid-to-Chip and Immersion Cooling systems across Asia, the Middle East, and North America, one conclusion stands out:



Liquid cooling systems must be treated and commissioned as critical process infrastructure, not as traditional HVAC systems

The difference between a successful deployment and a troubled one is often determined during commissioning.

CAI'S EXPERIENCE

CAI has supported multiple liquid cooling deployments, including:

- Liquid-to-Chip cooling for hyperscale facilities in Malaysia.
- Two-phase immersion cooling deployments in the Middle East.
- Large-scale immersion cooling projects in North America.

This experience spans design reviews, factory testing, commissioning, integrated systems testing, and operational readiness



5 Lessons Learned

1. FLUSHING IS EVERYTHING

The majority of early-life issues originate from contamination rather than equipment failure. Debris, scale, welding residue, and particulate matter can damage pumps, block cold plates, and significantly reduce cooling performance.

Lesson: Invest more time in flushing, verification, and cleanliness than you think is necessary. up to an 88% increase in the speed and accuracy of executions. This improvement is largely due to the streamlined digital processes enabled by autoLOTO, which replace cumbersome manual checks and reduce the time workers spend securing energy sources.

2. FLUID QUALITY IS CRITICAL

Cooling performance depends on fluid chemistry and cleanliness.

Poor liquid quality can lead to:

- Corrosion
- Fouling
- Reduced heat transfer
- Warranty concerns

Lesson: Fluid testing, monitoring, and controlled fill procedures are essential.

3. CDU REDUNDANCY MUST BE PROVEN

Cooling Distribution Units (CDUs) are the heart of direct-to-chip cooling systems. Starting equipment is not enough. True commissioning requires validation of:

- Automatic changeover
- Pump redundancy
- Failure modes
- Controls integration
- N+1 and 2N performance

Lesson: Redundancy testing under load is one of the most valuable commissioning activities.

4. LEAK PREVENTION REQUIRES MORE THAN LEAK DETECTION

Liquid cooling introduces a new category of operational risk: connection integrity. CAI's experience shows that most leak events occur at interfaces such as quick-disconnect couplings, manifolds, hoses, and CDU connections rather than fixed pipework. Leading OEMs emphasise leak prevention through robust connection design, self-sealing couplings, rigorous testing, and disciplined installation practices. For commissioning teams, the focus should be on validating connection integrity through inspection, pressure testing, operational testing, and maintenance simulations, rather than relying solely on leak detection systems

Lesson: Functional leak testing and operational procedures are as important as the detection system itself.

5. INTEGRATED SYSTEMS TESTING FINDS THE REAL PROBLEMS

Most components pass individual tests. The real challenges emerge when:

- CDUs interact with the building cooling system.
- Multiple control systems communicate.
- Redundancy transfers occur.
- Full thermal loads are applied.

Lesson: End-to-end testing before IT deployment significantly reduces operational risk.

Working Closely with OEMs Liquid cooling technology is evolving rapidly, particularly within the AI and hyperscale sectors. To remain at the forefront of this development, CAI works closely with:

- CDU manufacturers
- Liquid cooling technology providers
- Immersion cooling OEMs
- Controls vendors
- Chiller and heat rejection manufacturers

This collaboration allows CAI to:

- Develop commissioning methodologies for emerging technologies.
- Validate OEM operating assumptions.
- Improve failure testing and operational readiness.
- Capture lessons learned across multiple deployments.
- Reduce risk for clients adopting new cooling technologies.

Rather than viewing OEMs solely as vendors, CAI treats them as strategic partners in delivering successful projects.



LOOKING AHEAD

As rack densities continue to increase and AI infrastructure becomes mainstream, liquid cooling will transition from a specialist solution to a standard design requirement.

Future success will depend on:

- Earlier commissioning involvement during design.
- Stronger collaboration between owners, OEMs, and commissioning teams.
- More sophisticated testing methodologies.
- Greater focus on fluid quality, redundancy, and operational resilience.

CONCLUSION

CAI's experience across global liquid cooling deployments consistently demonstrates that successful outcomes depend on robust commissioning methodologies. By combining practical commissioning expertise with close collaboration across the liquid cooling supply chain, CAI continues to help clients safely deploy the next generation of AI-ready data centres.

For organisations evaluating or implementing liquid cooling technologies, CAI recommends engaging early in the design and commissioning lifecycle to reduce risk, improve operational readiness, and accelerate deployment. Our teams across the USA, EMEA, and APAC regions are available to share project experience, lessons learned, and commissioning best practices through technical workshops, presentations, and project-specific consultations.

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