

CO₂ mission critical cooling

Is CO₂ the answer to cooling high density blade server technology? Guy Hutchins, Sales Director of TROX AITCS, certainly believes so.

While the financial sector is reeling from the sub-prime debt crisis and we all wait to see what will happen next with the economy, it seems to be business as usual for the sector's engineers. And for the mission critical sector, charged with designing, installing and maintaining the services in data centres and trading floors, life remains as demanding as ever albeit the focus may have shifted a little. Large capital expansion projects may well have slowed down a little while the market takes stock, but projects to beef-up a facility's resilience are still running full steam ahead. At a time when the heat is on, now is not the time for your cooling to fall over!

MANAGING THE RISK

So, what's new in the world of data centre cooling? Well, we have continued to see the trend of server loads increase and high density (HD) has become established as a viable way of packing more powerful blade servers into a smaller space. Consequently the HD sector has attracted cabinet and cooling vendors to emerge with either chilled water or refrigerant cooled cabinets. There is obviously a stark difference between the two cooling mediums, but how on earth does a user make an informed choice? It generally comes down to the client's attitude towards water in his data centre.

Of course chilled water has been in data centres for over 50 years, with the large mainframes actually using CHW as their cooling medium. There are some big brand names behind water cooled HD cabinets, but will their success be determined by their brand or their technology?

Some clients are relaxed about water; others adamantly reject the notion of mixing water and electronics in their data centre. It is then that they

are faced with a dilemma: can they survive on close control units (often referred to as CRAC units) and simply spread the servers over a larger area and use what is commonly called a low density (LD) solution or do they opt for electrically benign refrigerant cooled HD cabinets, typically CO₂.

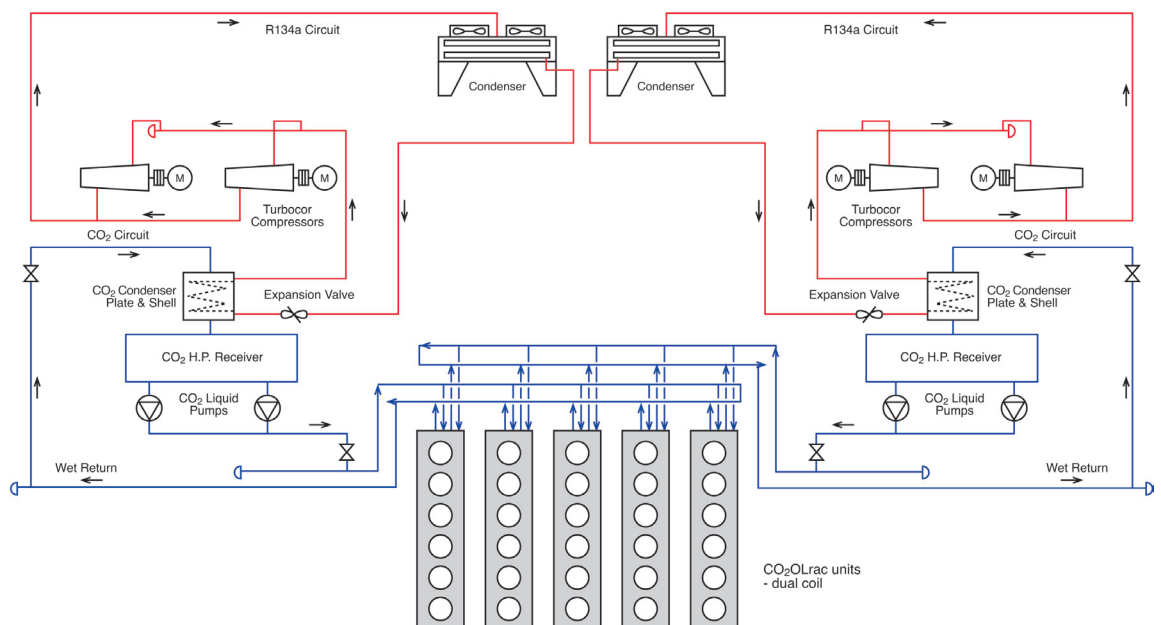
Fundamentally it will come down to the client's attitude towards risk, after all that is what mission critical clients and engineers are about. Day-in day-out they assess risks to the facility and essentially the business; they identify weaknesses, potential failures and manage them out.

CO₂ NOW FULLY PROVEN

Liquid CO₂ mission critical cooling is now established as the alternative to CHW HD cabinets; with over 1.7MW of cooling installed in the UK alone it is no longer cutting edge or bleeding edge technology it has a proven track record.

Every kilogram of liquid CO₂ absorbs over seven times the amount of heat that can be absorbed by water. The increased capacity enables pipe diameters to be reduced by up to 50%, it also reduces fluid pumping volumes, saving valuable power. The latest free cooling plant options will even improve the current 30% energy saving against CHW. Most importantly the power savings will reduce the carbon footprint of the facility. There has never been a more important time to embrace energy efficient solutions; the challenge is to wring every last drop out of the system.

It seems that everybody is talking about their green data centre design. For TROX AITCS it is quite straight forward, green means a complete supply and installed turnkey system that uses energy efficient CO₂ liquid cooling for HD and LD areas. In order to



Right: System schematic for N + N configuration

do this we're already working on a CO₂ CRAC unit that will make the panacea a reality.

Cost comparisons between CO₂ HD versus CHW LD solutions have proven that capital costs per kW of cooling can actually favour the CO₂ technology even when the scheme demands an N+N design (a duplicate run and standby system). The major reason is down to the real estate costs; the plant room floor area will be similar regardless of whether it's LD or HD cooling. However the technical space (housing the equipment racks) itself can shrink dramatically when 30kW cabinet are used. And 40/50kW CO₂ cabinets are only a matter of months away and should future proof the facility from increasing heat loads for some time to come.

As you would expect with a company totally focused on a niche market, we are dynamic and extremely agile with the ability to embrace product enhancements and bespoke design at a moments notice. In its short life the design of the CO₂OLrac™ unit has gone through a number of product refinements; in just three short years we're on the 4th generation of the design.

FAIL SAFE

Our experience and knowledge bank of the system's resilience has moved on leaps and bounds through some fairly demanding site integrated system testing (IST). The IST process allows all failure mode scenarios to be replicated and cross-checks to be made of the appropriate back systems. We were fortunate enough to install the system on a project where both CHW (400kW) and CO₂ (800kW) cooling systems were used with rows of CHW HD cabinets alongside CO₂ HD cabinets. The comparative operational issues of the systems are still being assessed and I'm sure that there will be pros and cons to each.

However, on the topic of failure mode testing we were delighted with the results. The client's wisdom, (they have to remain anonymous), of deploying two alternative systems has proven to be a very smart move. The CO₂ system's intrinsic resilience (a system or product's inherent ability to tolerate cooling failure due to automatic compensation and back-up by adjacent cooling units) came into its own.

Firstly, the CO₂ system demonstrated that failure of a single unit (its heat was not absorbed and escaped to the room) had no measurable effect on local cabinet air inlet temperatures and therefore had no impact on the operation of the blade servers housed within its, or other, cabinets. It's worth noting here that with sealed cabinets (closed architecture) which lose cooling, would cause its blades to overheat in around 10-20 seconds if the sealed cabinet doors failed to open!

Secondly; in a separate failure test a single CHW cabinet was failed and its heat discharged directly adjacent CO₂ cabinets. The local ambient temperature rose by not more than a couple of degrees and the excess heat was absorbed by the CO₂.

Things got really interesting in subsequent tests, particularly when the entire CHW cabinets were failed,

effectively adding an additional 50% heat load to the CO₂ system: it still coped! The inlet temperature rose to 27°C, but never exceeded ASHRAE's recommended server 'air on' limit of 32°C. This is made possible with the CO₂ HD 'open architecture' design which allowed the heat from the CHW failed cabinets to be absorbed in the CO₂ system. Another key aspect is the CO₂ 50 percent overfeed, a standard element of the design.

However, it was the final test when the entire CO₂ system was deliberately failed where the intrinsic resilience of CO₂ really came into its own. At this point there was 800kW of load discharged into a space of around 1000m². In this case the buildings thermal mass, heat loss, air volume, and background CRAC units saw the conditions reach a state of equilibrium at 27°C.

QUALITY AT A PRICE

This is a high quality system. It is efficient, effective and highly resilient; and that comes at a price. We've been involved in cost studies where we've seen a sharp intake of breath when the topic of price comes up. The price, if considered in isolation, will stand out. However, start doing the math's of low versus high density, multiply the HD technical floor area by three or four to establish an equivalent LD scheme and then consider the impact that it has on the construction of the building shell along with the expensive high technology fit-out that brings the space to life. You may well be surprised that an HD data centre can actually offer a marginal saving against LD data centre on a £/kW basis. And the result: you have a state of the art data centre whose HD cooling system will not only reduce the cost of ownership; it will also have a very positive impact on the carbon footprint of the data centre and provide a future proof cooling system long into the future.



Left: ABN Amro – 300kW CO₂ mission critical cooling

Below: 4th Generation CO₂OLrac™

