# Data Centres – how can I see into my data centres future?

Data centres in North America consume over 2% of the total electrical power generated. In a typical corporate environment, data centre energy costs account for 40-70% of the total electrical bill. In addition, high power servers are generating large amounts of heat in very confined spaces. The legacy approach of continually turning down the temperature on the the A/C units or throwing more cooling capacity is not effective operationally or financially.

> "In most cases, a fully developed air management strategy can produce significant and measurable economic benefits and, therefore, should be the starting point when implementing a data center energy savings program"
> - **The Green Grid**

Arnold Murphy - CEO
Strategic Clean Technology Inc
www.sct-inc.com
613-558-4415

**Data Center – White Paper**

Since the early  2000's the energy consumption of servers has increased significantly, growing from 150 W per server to an average of over 500 W's. High end gear is now consuming  1kW or more per server. Server prices have dropped significantly, resulting in a doubling of server sales in the last 5 years. Combine this with increased density and you have the potential for significant power and heat issues in the data centre. Up to now most operators have combat the heat issue by lowering the set points on the CRAC (computer room air conditioner). This works until the next electricity bill arrives and combined with the increase in energy charges, can have a major negative affect on the operating costs of the data centre and the bottom line of the company.

**Introduction**

The basic principle of physics that one kW of energy generates 3412 BTU of heat. The increased power consumption of servers means they require more energy to operate and more energy to cool the increased BTU's as they generate more heat. Combine this with the higher density of new equipment, such as blade servers and virtualized machines, and the problem is further compounded. Broad based cooling strategies are no longer effective.

The legacy approach of cooling the entire data centre to an acceptable level doesn't work as the high end equipment will not receive enough air to be cooled, and the vast majority of air being delivered in the data centre will bypass its function and return to the CRAC without serving any useful purpose. For cooled air to be effective it must pass through the server.  Not around, or over or under – air flowing over a server does nothing to cool the tightly compacted components inside.

Managing air flow and delivery is a new dimension to data centres that has arisen due to the increased density and intensity of heat generated by servers.  By properly managing air flow the life expectancy of the data centre can be extended in a number of ways.

**The dynamic nature of today's data centre**

Blade servers offer great processing power in a small space, however the heat generated from these machines must be dealt with carefully.  A few years ago a typical rack of IT equipment would consume 2kW of power, and generate less than 7000 BTU requiring about a half ton of cooling capacity. Today it is not uncommon to have racks of blade servers consuming 14kW of power – a 7 times increase in heat production, resulting in nearly 50,000 BTU being generated which in turn requires over 4 tons of cooling!

Ironically, the vast majority of data centres have over capacity cooling systems, yet they don't meet the needs of the upgraded IT equipment. Obvious redundancy is required in case of failure. Data centres with 3 times over capacity cooling systems and recurring hot spots around the racks is not uncommon.

CFD analysis enables you to model the data centre in detail, showing air patterns for supply and return, identify problem areas and test solutions such as containment without incurring the cost with a negative result.

Running a data centre requires a holistic perspective on everything that is going on within the data centre, on an on-going basis. Even in an equipment static environment, virtualized servers can change the heat profile dramatically within a few minutes. If the number of virtualized servers exist within the data centre they can change the air dynamics of the entire room. The result is higher temperature air return from the racks to the CRAC's, which if not managed properly, will impact the inlet air temperature of the nearby racks, potentially increasing the inlet temperature to unacceptable levels. Yet this phenomenon is not clearly identified on the occasional walk-about.

**So what can you do?**

In an existing data centres there are a number of things to consider. First, in nearly 100% of the cases there is no disruption allowed to the operation of the data centre. Secondly, the budget to make changes is usually quite limited. Thirdly, the payback on the cost of changes is usually expected to be within 24 months or less. Given these limitations what can you do?

The first step is to find out what the air patterns are within your data centre. Air, like water takes the path of least resistance. Air bypass of 35-70% is not uncommon. If the air bypass is 60%, then only 40% of the air provided by the cooling system is serving a useful purpose. The remaining 60% is being processed (costing energy), being distributed by the fans (costing energy) and being returned for processing without cooling any heat from the IT equipment. That's equivalent to paying someone 100% of their salary, but only requiring that they show up for work 40% of the time. Sweet gig if you can get it!
Next is to delve deeper into the air patterns to see where is the air going. Most data centre have air pockets which are places that have a limited amount of cooling due to the flow off of walls or underfloor obstructions. Pumping more air into an underfloor air plenum does not mean the cooled air will get to the servers that need it. Underfloor obstructions such as cable trays, posts, or the placement of wall abutements can cause the air to take very diverse paths. Like water flowing over rocks, if obstructions exist turbulence is created and rather than air going upward through the perforated tile, it may in fact be drawing warm air down into the plenum, causing problems throughout the data centre.

A common mistake in data centres is the row configurations impeding air flow back to the CRAC unit. In order for the cooling system to work efficiently, hot air from the back of the racks must be able to return to the CRAC units with minimum amount of mixing with the cold air. The higher the return air temperature to the CRAC the more efficiently the CRAC unit will run, and vice versa. Ceiling height, rack placement, perforated tile placement all impact the efficiency of the hot air return.

A logical conclusion would be to do aisle containment. But which is best? We've seen environments where it appeared cold aisle containment was the logical answer, but in actual fact by implementing cold aisle containment the heat issues and hot spots in the data centre were exacerbated. Aisle containment is not an simple answer. Numerous aspects have to be considered such as the equipment configuration, the placement of the CRAC units, height of the floor plenum, under floor obstructions, ceiling height and ceiling plenum height.

The best approach is to do a Computational Fluids Dynamics (CFD) study. CFD has only recently been applied to data centres. In a model, the data centre with all equipment configurations and characteristics is built. The placement and heat load of each rack is taken into account along with the room characteristics, along with the IT equipment and infrastructure such as CRAC units. The capacity of the cooling systems, both in air delivery and BTU's, is built into the model. The result is a visual replication of how your data centre operates. By executing a CFD run on this model we can show you where the cold air is going and how the hot air is getting back to the CRAC units. It will identify air bypass, either through the racks, cable cutouts or other holes in the floor tile. In an existing data centre, validation of the baseline results can be taken through actual measurements of temperature and air flow.

Once the baseline is validated then changes to heat loads, perforated tile layouts, or aisle containment can be modeled to determine the impact. By running various scenarios you are able to determine not only the best approach but what impact that solution will have on the data centre. This approach allows you the see what changes should be made to the data centre and what impact those changes will have . It takes the guessing out of the equation and can save you a lot of money in the process by avoiding costly mistakes.

For more information on Computational Fluid Dynamics and how it can improve your data centre visit our website at www.sct-inc.com or give us a call ( 613-558-4415).

*SCTi focuses on data centre energy and operational efficiency with the objective of helping data centre operators save money while improving their data centre. By taking a holistic view of the data centre SCTi can help you save money, extend the life expectancy of the data centre and the infrastructure.*