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Managing data centres for energy efficiency

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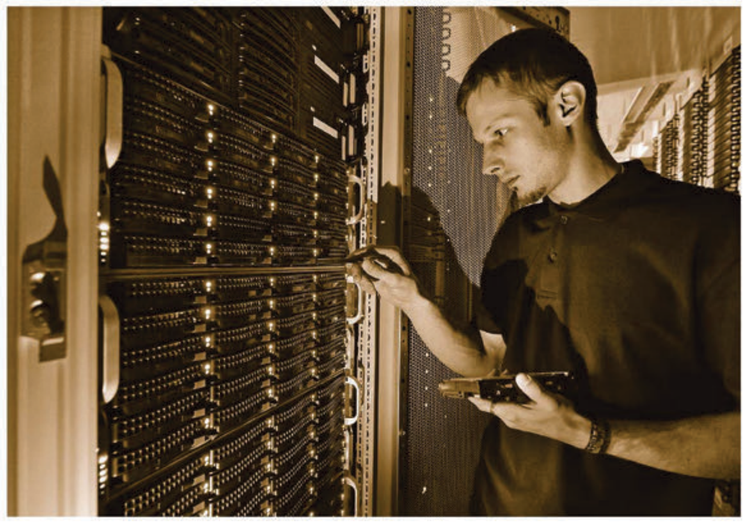


Datacentres can present a daunting and complex environment to manage with many conflicting requirements based on equipment installed, data security, resilience levels, technology improvements, equipment renewal, operational practice and finally the human factors. Powering the equipment and maintaining the environment can account for over 98 per cent of the building's energy use and maintaining uptime is a core deliverable in the datacentre operational requirements, sometimes leading to a desire for reliability over energy efficiency amongst data centre management.

Already accounting for over 2 per cent of global energy use and forecast to double by 2025, managing energy efficiency in data centres must be a core objective to meet government targets for climate change.

In an ideal world, all data centres would be new with the most up to date equipment and designed to maximise free cooling, be fully monitored and controlled and have integrated renewable energy installations connected to a foresighted network infrastructure. In reality they are not and this presents considerable difficulties in ensuring that energy efficient operation is considered and maintained.

Two types of system

There are two main types of system within the data centre:

Information technology infrastructure (IT) dealing with the information processing aspects of the data centre, such as servers, storage and network switching.

Physical infrastructure (PI) which allows the IT infrastructure to function, including power networks, cooling and ventilation and security.

They key to energy efficient operation is understanding what type of equipment you have, how and when it operates, what operating parameters it has and how you manage its environmental conditions to maintain the equipment's performance. To complicate matters, technology improvements, legacy equipment and density demands put pressure on efficient delivery, stress on power supplies and cooling and ventilation capacity.

By setting a robust survey methodology and undertake an energy audit to understand where energy is being used, how the environment is being managed and where energy is being wasted. A survey methodology should include:

- a review of IT and PI installations;
- policy to review on replacement;
- consider existing equipment arrangement, rack location, size, obstructions such as columns;
- existing cooling and ventilation arrangement, is there an existing hot/cold aisle arrangement;
- configuration of Computer Room Air Conditioning (CRAC);
- aisle width (see equipment manufacturers guidelines);
- ceiling heights and obstructions;
- floor plenum depths/obstructions;
- cabling arrangements;
- lighting positions and cable runs;
- fire detection and suppressions systems;
- working areas around installations;
- schedule racks, IT equipment and operating requirements;
- assess if there is conflicting hold and cold separation such as wrongly positioned floor grills, cold-on-cold or hot-on-hot installations, conflicting hot/cold along the row, and assess if these can be changed and if there is a process to understand how this happened;
- review energy use data;
- check control operating setpoints; and
- review policies, procedures and guidance

Facility power management should provide a detailed insight into the status and operation of the entire electrical distribution network (from utility feeds, to transformers, to PDUs, to racks) within the facility to allow a full understanding and management of the electrical distribution network. A basic package of monitoring and control should include:

- facility power;
- facility environmental controls;
- security; and
- IT rooms, racks and specific equipment

With key functions providing energy use measurement by means of submetering or on board measurement of energy use, power monitoring of current conditions (critical and non-critical load), power alarming, and "power analytics". These functions support critical activities such as notification of and response to electrical network problems, maintenance (planned and unplanned), capacity planning, facility expansion/retro-fit projects, energy efficiency projects, power quality analysis, and power reliability analysis.

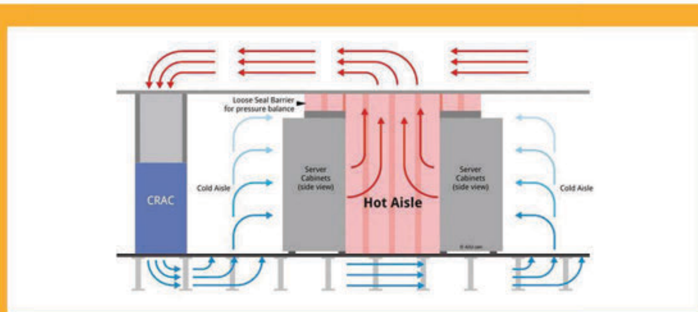
Providing hot and cold aisle containment greatly improves the efficiency of the cooling system and should be the starting point when designing installations and reviewed when replacing IT equipment. Recent energy audits to data centres by the author found many instances of conflicting hot and cold aisle containment, caused mainly by poor layout, positioning of floor grills, positioning of racks, positions and direction of equipment within the racks and inconsistencies/gaps in containment panels, all leading to hotspots and airflow issues affecting efficient operation.

Cold aisle containment

Key benefits of hot and cold aisle containment are:

- maintaining or increasing power rack density through mitigating hot air exhaust recirculation
- preventing hotspots within the system by providing a lower uniform air inlet temperature
- increased reliability through minimising hot spots;
- improved cooling capacity by managing the cold air supply and hot air return to the cooling units by minimising air leakage paths;
- allows bespoke solutions to high density replacement equipment;
- allows separation and close down of redundant units; and
- increases energy efficiency

Implementing a programme of containment can provide substantial improvements in energy efficiency, especially in legacy datacentres suffering from issues associated with density increases affecting cooling and



MAIN TYPES OF CONTAINMENT

Ducted Hot Aisle Containment System (Ducted HACS)
Can be used with a hard floor or raised floor installation, enclosing the hot aisle with the rest of the room acting as a large cold air plenum.

Suitable for rooms where:

- the rooms are frequently occupied with staff;
- racks are arranged in an existing hot/cold arrangement;
- there is a uniform distribution of racks;
- there are stand-alone equipment installations at the perimeter;
- there is a drop ceiling hot air return plenum;

However, it is necessary to check cabling, lighting, fire and security implications.

Cold Aisle Containment System (CACS) Utilises the raised floor, encloses the cold aisle with the rest of the room acting as a hot-air return plenum.

Suitable for rooms where:

- there is an existing hot/cold aisle configuration of racks; and
- there is a raised floor with cold air in floor plenum in place and uniform distribution of racks.

However, it is necessary to check under-floor obstructions, consider cabling, lighting, fire and security. In addition, it is important to ensure isolation partitions are installed to prevent hot air recirculation and ensure appropriate ventilation rates/air pressure.

Ducted Rack
Ducted rack is suitable for installations with distributed racks or high density racks where the hot aisle is ducted into a dropped ceiling arrangement.

Suitable for rooms where:

- there is front to back airflow;
- there is an existing drop ceiling air return plenum or where additional ducting runs at ceiling level can be installed;
- bespoke solutions are required for high density equipment, especially for retrofitting existing rooms;
- multiple different types of racks are installed;
- variation of ventilation is required throughout the room; and
- obstructions prevent other methods of containment.

Consideration must be given to ceiling heights, rack size, access, security and fire provisions. This may require airflow and pressure modelling.

Row-Cooled Hot Aisle Containment System (Row-Cooled HACS)
A simple and effective solution to improve efficiency in a row-cooled arrangement is to add ceiling panels over the aisle. This method can also be effective when high-density racks are added into low density areas.

Rack Air Containment System (RACS)
Integrating rack based cooling units within the racks to circulate air in the containment area.

Suitable for rooms where:

- there is high density stand-alone equipment;
- a bespoke solution is required;
- space for additional ductwork is not available;
- complete isolation is required; and
- where security is required such as multi-client rooms.

ventilation performance.

Equipment mounted in racks cools itself by drawing ambient air from the data centre or network room. If the heated exhaust air is allowed to return to the air inlet of the equipment, an undesirable overheating condition may occur. Datacentres and network rooms should be designed to prevent equipment from drawing heated air, and within the racks themselves the possibility exists for hot exhaust air to be recycled into the equipment air intake. This is mainly caused when hot exhaust air returns above or below the equipment and back to the air intake and is a primary cause of equipment overheating.

Recommended practice is to use airflow management blanking panels in any vertical spaces in the rack to maintain proper airflow. Using a rack without blanking panels results in improper cooling that can lead to thermal damage. If any of the vertical space in the rack is not filled by components, the gaps between components cause a change in airflow through the rack and across the components. Analysis of thermal profile through the racks would show increased temperature ranges from the bottom to top of the racks, additionally contributing to increased instances of stress and premature failure within the high level components.

Racks running hotter

Studies by the Uptime Institute indicate that 10 per cent of racks run hotter than recommended guidelines. As datacentre rack power densities increase, instances of hot spots will increase. When hot spots continue for an extended period, it affects equipment reliability, performance, and has implications on manufacturer's warranties. Understanding the cause of hot spots is critical to fixing them while simultaneously getting other benefits such as saving energy and avoiding the capital expense of adding more cooling units. Good practice is to monitor temperature within the facility, investigating the cause of hot spots and taking steps to remedy the causes before they affect performance.

IT equipment is designed to operate efficiently within temperature and humidity ranges. Understanding these and how the cooling and ventilation installation maintains these is critical in maintaining an energy efficient operation. An inlet temperature of 27oC is recommended and temperature sensing either on board equipment or remote sensing should be installed and monitored to assess if this is being achieved. In reality, most are set too low, wasting energy by over cooling. There are multiple case studies and strategies available, indicating that for each 1oC increase in inlet temperature an energy saving on up to 4 per cent can be achieved. However, it is important to fully understand airflow and where hot spots may occur through temperature sensing and modelling.

IT equipment drawing more than 8 kW per rack enclosure is considered high density. Fully populated racks of servers can draw from 6 kW to 35 kW per rack. Yet the majority of data centres today are designed for a power density of less than 4 kW per rack. Installations that exceed the design density of the facility is one of the greatest risks to efficient operation, causing stresses on the power and cooling systems, downtime from overloads, overheating, and loss of redundancy. A process should be in place to assess density implications during any equipment replacement.

Proper design review

When undertaking refurbishment and replacing equipment, ensure that a proper design review is undertaken to both power supplies and cooling and ventilation provision. As the industry drives towards higher and higher density equipment, bespoke cooling solutions are becoming a necessity to maintain uptime and resilience and maintain the energy performance of the remaining equipment. Consideration should be given to the wider floor, room and building interaction to the rack replacement areas and modelling of both temperature and air movement should inform the basis of any replacement strategy. Keeping appropriate records and understanding what the operating parameters are for the new equipment should be mapped against the existing power cooling and ventilation capability.

Energy efficiency driver

It is evident that datacentres are energy-intensive installations, as technology advances and through regular programmes of upgrading, a robust energy efficiency strategy should be a key driver in specifying equipment. Providing lower energy servers with wider effective operating ranges has the added benefit of reducing the loads applied to the HVAC equipment. In legacy installations it is key to plan replacement equipment with a consequential review of the environmental control set points to maximise the energy efficiency of the HVAC operation.

Energy managers should consider following the 2016 Best Practice Guidelines for the EU Code of Conduct on Data Centres, setting objectives for replacement of legacy equipment including:

- the inclusion of energy efficiency as a specified requirement for new or replacement installations, this may be through the use of Energy Star, SERT, SPECPower or a bespoke performance specification, considering the full system efficiency including converters and power supply characteristics;
- the calculation of data centre inventory and aim for PUE of 1.0 post replacement of legacy equipment;
- the setting of specific operating temperature and humidity ranges for existing and new installations:

1) Legacy: 15°C to 32°C inlet temperature (59°F – 89.6°F) and humidity from 20 per cent to 80 per cent relative humidity and below 17°C maximum dew point (62.6°F)

2) New: 10°C to 35°C inlet temperature (50°F to 95°F) and humidity within 20 per cent relative humidity to 80 per cent relative humidity or 21°C (69.8°F) dew point.

3) Optimal inlet temperature should be 27°C, except where this results in relative humidity outside of above range, where outlet temperature exceeds maximum of above stated range.

- setting group energy policy in terms of inlet temperatures, outlet temperatures, humidity and chilled water temperatures, then monitor through site operational compliance assessment. Review bi-annually or on technology change.
- the requirement of a temperature range energy use analysis for all new and replacement installations to allow a full design review of corresponding cooling and ventilation requirements
- ensuring a programme of blanking is included in new and replacement equipment rollout, including recommissioning of cooling and ventilation as the programme proceeds;
- the specification of M&E equipment that does not require cooling in itself during normal operation;
- consideration of the energy requirements of the installations based on a phased approach, taking into account future technology enhancements;
- the requirement that old equipment is replaced in groups with corresponding recommissioning of local HVAC systems to suit new operating requirements.
- the provision of sub-metering and sensors to monitor energy use against temperature and allow detailed performance monitoring; sub-metering should separate IT, HVAC, offices, and warehouses as much as practically possible.
- ensuring the removal of redundant equipment.
- the requirement of the keeping of a register with location, type and operating parameters of equipment.
- the consideration of layout for airflow in setting out replacement installations to prevent hot spots.
- the need for modular high efficiency UPS installations in line with the IEC 62040 series for UPS systems.
- the development and implementation of a group-wide measuring and monitoring programme to include incoming and sub-metering HH readings for at least IT equipment and HVAC;
- the scheduling of temperature and humidity setpoints against energy use; and
- the setting of targeting and action triggers.

In summary, good energy efficiency is about knowledge and using this to trigger efficiency action. By implementing a programme of monitoring a fuller understanding of energy use leads to an insight into where energy is being wasted and where over cooling is occurring. Understanding airflows and temperature requirement leads to a better understanding of areas where problems are likely to occur such as hot spots. Ensuring policies and procedures are reviewed and updated leads to a proper assessment during change.

CPD SERIES 14 | MODULE 07 | JANUARY 2017

ENTRY FORM

DATA CENTRE MANAGEMENT

Please mark your answers on the sheet below by placing a cross in the box next to the correct answer. Only mark one box for each question. You may find it helpful to mark the answers in pencil first before filling in the final answers in ink. Once you have completed the answer sheet in ink, return it to the address below. Photocopies are acceptable.

QUESTIONS

1. What is the inlet temperature range for legacy datacentres?

☐ 10°C to 32°C
☐ 15°C to 32°C
☐ 10°C to 35°C
☐ 15°C to 35°C

2. What would be considered as a high-density rack?

☐ 2kW
☐ 4kW
☐ 6kW
☐ 8 kW

3. What does HACS mean in terms of containment?

☐ Heating Arrangement Containment System
☐ Heated Access Containment System
☐ Hot Air Containment System
☐ Hot Aisle Containment System

4. What thermal profile would be experienced with poor use of blanking panels in racks?

☐ No affect
☐ increased temperature ranges from the bottom to top of the racks
☐ increased temperature ranges from the top to the bottom of the racks
☐ Uniform increase in temperature

5. How much energy can be saved for each 1°C uplift in inlet temperature?

☐ up to 6 per cent
☐ Up to 4 per cent
☐ Up to 2 per cent
☐ All the above

6. What benefits does airflow modelling provide?

☐ up to 6 per cent
☐ Up to 4 per cent
☐ Up to 2 per cent
☐ All the above

7. What containment system is most suitable for complete isolation of a rack?

☐ HACS
☐ CACS
☐ RACS
☐ Row-cooled HACS

8. What equipment should be specified that does not require cooling in itself during normal operation

☐ IT Equipment
☐ M&E Equipment
☐ Racks
☐ Cable trays

9. What is the recommended humidity range for new equipment?

☐ 20 per cent to 80 per cent relative humidity
☐ 100 per cent relative humidity
☐ 15 per cent to 85 per cent relative humidity
☐ Over 20 per cent

10. What is considered to be the optimum inlet air temperature?

☐ 18°C
☐ 22°C
☐ 32°C
☐ 27°C

Please complete your details below in block capitals

Name .... (Mr. Mrs, Ms) ....

Business ....

Business Address ....

....

....

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email address ....

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Completed answers should be mailed to:

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