Future facilities
Author Mark Seymour - Founding Director

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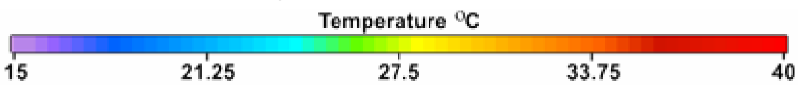
Blades – How Can We Manage The Environment?

The desirability of a new IT solution has probably never been clearer than it is with the blade server based solutions now being offered. The fact that they are compact and scaleable, not to mention their ease of installation, means that they are indeed an attractive option from an IT perspective. The increasing power densities mean that hot-spots are more likely, not just risking the availability of the blades servers themselves, but also the availability of other equipment in the facility. As a consequence, many organisations have been reluctant to install blades at all, or impose restrictive practices to limit their installation and use, thus minimising the impact of these issues.

In reality what issues will have to be faced in order to be able to install such equipment more liberally? This document uses airflow modelling (in the form of FLOVENT™ by Flomerics) to illustrate some of the issues associated with cooling high power equipment. Except where shown colour relates to air temperature on the scale as shown below.



Based on nameplate power a cabinet containing such equipment might be loaded to 15kW. Assuming that the cooling is to be carried out using air delivered by down-flow units there have been 2 traditional methods to deliver the air used to cool the equipment.

Direct Cooling

One approach is to provide air directly from the floor void into the bottom of the cabinet. The problem with this is that the high power dissipation requires high air volumes for cooling and so the equipment would have to be set back much further than normal to provide a wide enough air channel in front of the equipment. The problem with this type of arrangement is particularly severe near the bottom where the air normally has to follow a torturous air path in order to pass from the opening under the cabinet to the channel in front of the equipment.

The figures below show the degradation that occurs for the equipment at the bottom due to the increasing resistance to flow as it increases to accommodate the rise in power dissipation from 5kW (Figure 1) in the rack to 10kW (Figure 2).

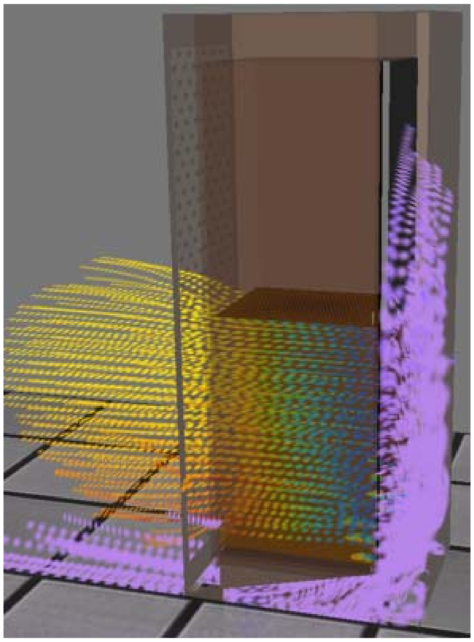


Figure 1. Direct cooling of 5kW

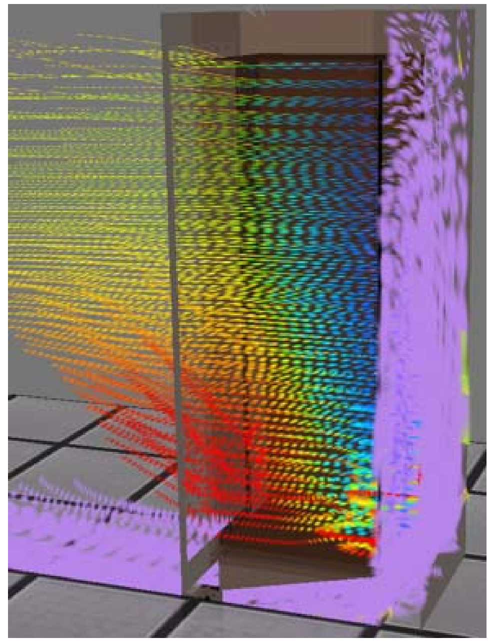


Figure 2. Direct Cooling of 10kW

In the latter case the flow rate has been doubled through the rack to accommodate twice as much equipment. The high temperatures in the rack for equipment lower down almost certainly mean that this approach cannot be successfully used for higher power equipment.

Cabinet Configuration

The high heat load has resulted in blade server manufacturers specifying that the blades servers are installed in a cabinet in a certain way. The key features of the installation are:

- The cabinet doors have at least a specified minimum free area ratio often in the region of 60% to 65% to allow a relatively free flow of air from the room into the cabinet;
- The equipment is mounted no closer than a specified distance from the front of the cabinet typically the order of 75mm to 100mm. This allows the cool air entering the perforated front door to be redistributed as needed to the equipment;
- The cabinet is deep enough for the rear perforated door to be at least a specified distance from the back of the equipment. This allows the high velocity air flows from the back of the equipment to mix out minimising the resistance to the hot air leaving through the back door;
- Ensuring that the cabinet is effectively blanked (Figures 3 & 4) in order to prevent internal hot air recirculation from the rear of the equipment into the inlets at the front.

The good thing about these requirements is that they are clearly quantifiable and once the racked equipment has been configured the compliance should remain in place given reasonable operation and maintenance procedures.

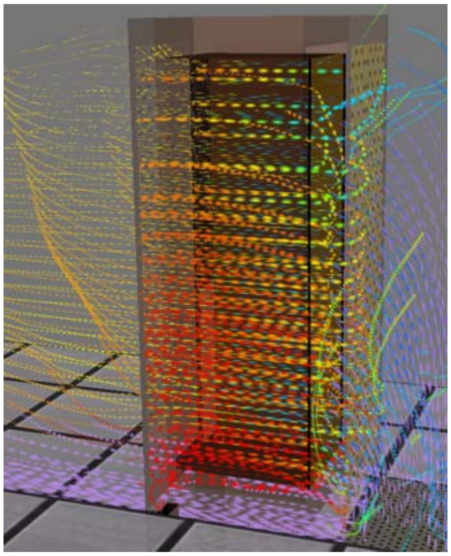


Figure 3. SideView of recirculation with no side blanking

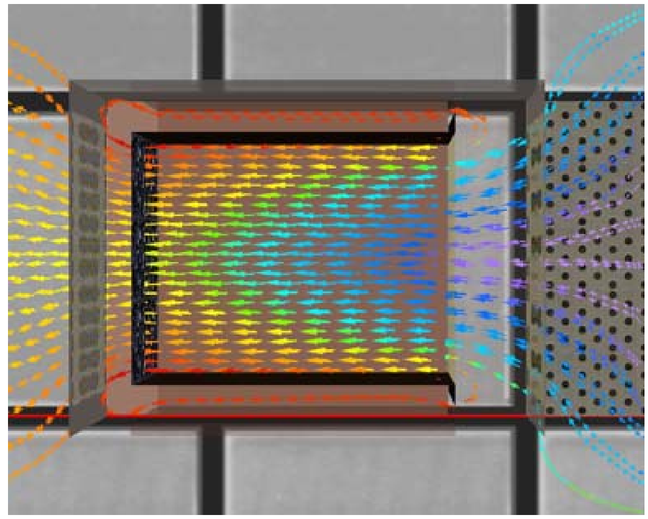


Figure 4. Recirculation with no side blanking viewed from above

Having established a configuration in the cabinet that complies with the manufacturer's requirements from an environmental perspective the next challenge is to ensure that the environment outside the cabinet is also sufficiently controlled for the equipment to function as designed. This is a far less clear-cut issue. In principle, the issue is simply providing sufficient cool air to meet the needs of the equipment. Although traditional equipment is often design with a temperature rise of around 10°C from inlet to exhaust blades often exhibit higher temperature rises of the order of 15°C or more. This results in a lower air volume requirement but with a heat load of 10kW the airflow requirement is of the order of 0.55m^3/s equivalent to a face velocity of around 3m/s from a typical floor grille and requiring a floor void pressure of approaching 30Pa from a typical open floor grille (Figure 5).

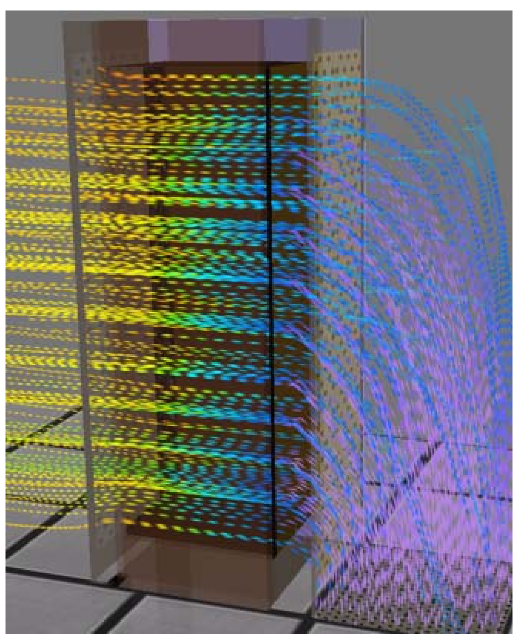


Figure 5. Blanked 10kW adequately ventilated from front

Getting the Air to the Right Place

Increasing the heat load above more conventional heat loads of 5kW results in a proportionate increase in air volume requirement to maintain the same temperature rise. Often a single floor grille will be insufficient given a lower static pressure in the raised floor void. The consequence is that these high power systems often require more than one ventilated floor tile each.

However, as well as providing sufficient airflow it is important that the air is projected right to the top of the cabinet. Failure to do so is likely to result in warm air at high level being drawn in to ventilate the upper blade sub-racks (Figure 6). This may result in inefficiency in the cooling system if the air has to be over-cooled to mitigate the effect of this higher temperature air. On the other hand, projecting the air too far above the cabinets can cause other inefficiencies as it is likely to mix with the hot air layer at high level thus cooling it before return to the Air Cooling Unit (ACU).

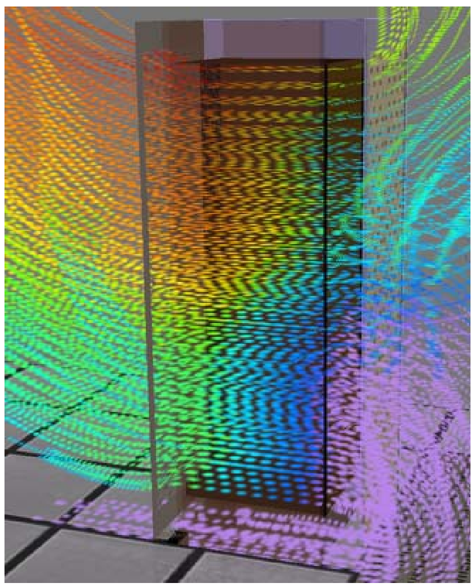
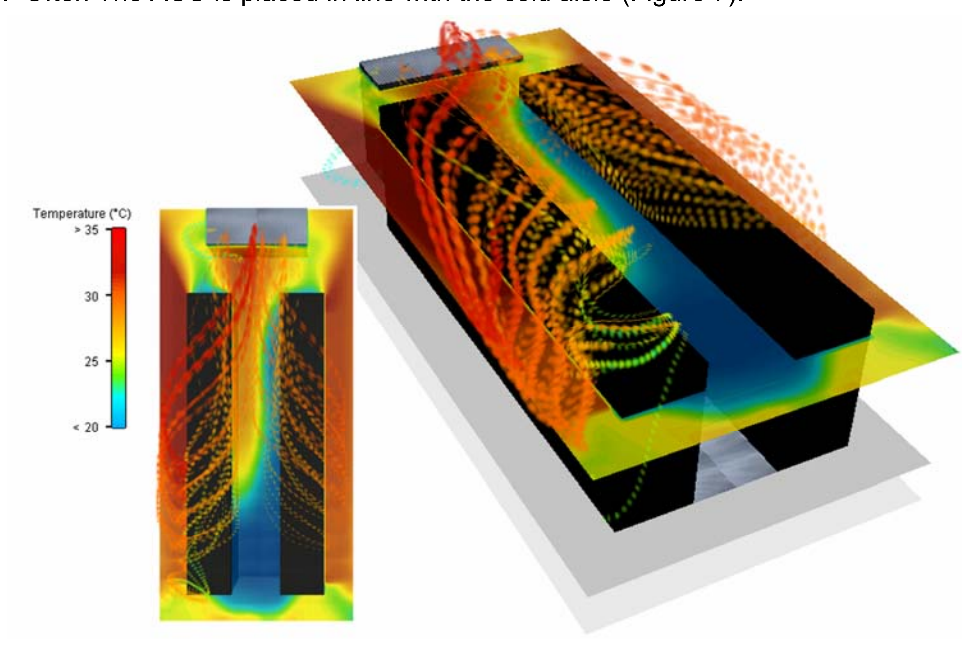


Figure 2. Air Too Slow Leaving the Floor Void

The final issue to be addressed is that way in which these high air volumes affect the remainder of the equipment in the facility. As the hot air exits the equipment with significant velocity it is prone to travelling some distance and thereby creating hot-spots around equipment in other areas. Often The ACU is placed in line with the cold aisle (Figure 7).



This is normally a mistake as it creates lower floor void pressure under the grilles nearest the ACU and draws air back from the hot aisles resulting in warm air being reentrained into the tops of the racks. This effect is further exaggerated when the ACU is shorter than the equipment it serves. It is therefore important to minimise this by effective scavenging of the hot air by the ACU's. This good scavenging is normally best achieved by placing the ACU as close to the hot aisle as possible. One solution for doing this is to employ emerging in-row cooling strategies.

Another design / layout characteristic that exacerbates this problem is that of gaps between cabinets or short equipment rows. These make it easy for the hot air from the hot aisle to penetrate through into adjacent cold aisles. Hot air return to the cold aisle in this manner can be minimised by ensuring that cabinet rows are not only a few cabinets long, or where a break is inevitable, say adjacent to a building column then the gap is blanked to prevent re-circulation just as we might blank open U slots or the gaps at the sides of the mounting rails inside a cabinet.

In Summary

From these illustrations it is clear that it is no longer sufficient to simply provide adequate cooling capacity with a measure of contingency. The careful planning of the cabinet configuration its location and orientation relative to the cooling system and what that system can deliver is critical to achieving a balance in the complicated world of airflow.

Airflow modelling is becoming increasingly important as a scientific way of seeing what we can't otherwise visualise in the clean environment of a Mission Critical Facility. Importantly the approach can give us an insight even when a facility doesn't yet exist!