

# Alternating Cold and Hot Aisles Provides More Reliable Cooling for Server Farms

By Robert F. Sullivan, Ph.D.

**The creation of “server farms” comprising hundreds of individual file servers has become quite commonplace in the new e-commerce economy, while other businesses spawn farms by moving equipment previously in closets or under desktops into a centralized data center environment. However, many of these farms are hastily planned and implemented as the needed equipment must be quickly installed on a rush schedule. The typical result is a somewhat haphazard layout on the raised floor that can have disastrous consequences due to environmental temperature disparities. Unfortunately, this lack of floor-layout planning is not apparent until after serious reliability problems have already occurred.**

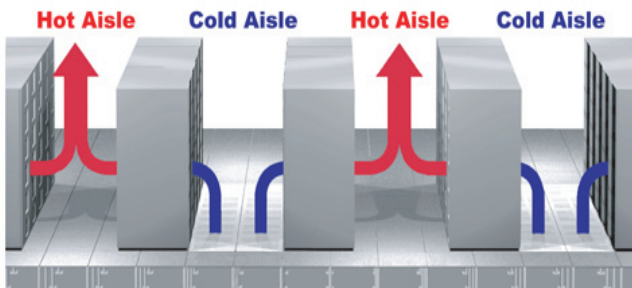
Remediating environmental temperature problems in a data center having no downtime windows can be extremely painful. In large areas, the only remedy may be a new physical layout of the equipment racks. This changeover may take several years to complete because the work can only be done when computer technology rolls over. During this period of delay, the potential for an increased rate of hardware failures is very high, and unplanned downtime due to heat problems should be expected.

One solution for avoiding downtime is to have a strategic plan for how the server farm will be implemented. A Best Practice is to use rows of equipment racks in an alternating arrangement of “cold aisles” and “hot aisles.” This is best accomplished when the layout of the file-server farm area is first being planned, and it is exceedingly more

difficult to accomplish when the computer room is already populated with operating hardware.

A cold aisle is defined as having perforated floor tiles that allow cooling air to come up from the plenum under the raised floor, and a hot aisle has no perforated tiles. In the cold aisle, the equipment racks are arranged face to face so the cooling air discharged up through the perforated floor tiles is sucked into the face of the computer hardware and exhausted out the back of the equipment rack onto the adjacent hot aisles.

Hot aisles are literally hot because the objective of the alternating cold and hot aisle design is to separate the source of cooling air from hot air discharge which returns to the computer room cooling unit. Therefore, no perforated tiles should be placed in the hot aisles, as this would mix hot and cold air and thereby lower the temperature of the air returning to the cooling units, which reduces their usable capacity. Hot aisles should be hot! Cold aisles should be cold!



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This system is not perfect because some equipment manufacturers bring cooling air in from the bottom of their equipment and exhaust out through the top and/or sides. And some equipment is designed to bring air in from the sides and exhaust out the top, or



bring air in from the top and exhaust out the bottom. (The Uptime Institute, Inc. is currently working with hardware manufacturers to develop an industry standard.)

For this system to work well, especially for loads exceeding 50 watts/ft<sup>2</sup> gross, the following practices must be observed:

- The cold aisle must be two tiles wide with the rack faces on tile seams (aisle must allow both tiles to be removable so two perforated tiles or grates can be installed and their airflow not be obstructed) with only the number of perforated tiles installed as required by the load. Perforated tiles should never be located in the hot aisle as this wastes cooling.
- Depending upon static pressure, grates instead of perforated tiles will be required for loads above 3 to 4 kW per rack or frame.
- Unobstructed space around free standing equipment must not allow bypass of air flow between the cold and hot aisle.
- Cable cutouts must be sealed to increase static pressure and prevent cold air bypass.
- Rows of equipment must be laid out perpendicular to the face of cooling units to minimize the recirculation of exhaust air returning over the top of the racks.
- Under-floor power cabling should be routed down the cold aisle and communications cabling should be routed down the hot aisle (no more than six floor tiles should be temporarily removed to prevent a dramatic loss of static pressure and disruption of cooling).
- There must be at least three feet of unobstructed clearance between the top of the rack and the top of the return air path back to the cooling units.

Four-post type racks without doors are preferred. Fans in the top of racks are generally ineffective. If doors are used, solid doors are not recommended. Door perforations for cooling air entry and exhaust must be determined by the required CFM of the heat load inside. Generally this involves a uniform opening across the entire face of the door with the cross-sectional area in the front being 1.25 times more than that required and 1.5 times more than that required in the rear to compensate for blockages and static impedances to assure more than sufficient cooling air flow. Blanking plates must be installed between adjacent racks and within racks to prevent internal recirculation of hot exhaust air.

## White Paper Authorship

**Robert F. “Dr. Bob” Sullivan** is a Distinguished Fellow of The Uptime Institute, Inc. He invented the Hot/Cold Aisle concept in 1992 while working for IBM as their senior environmental troubleshooter. Over the years, Dr. Bob has probably helped diagnose and resolve more data center cooling problems than anyone else in the industry. Dr. Bob is a Stanford University Ph.D. mechanical engineer.

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