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facilities engineering associates
128 Garden Street, Farmington, CT 06032

Professional Engineering Services
For Mission Critical Industries

designPLUS

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Facilities Engineering Associates publishes the designPLUS Newsletter quarterly to keep our clients current on trends in the mission critical industry.

Each newsletter provides articles of general interest, management topics, technical areas and interesting facts. Over the years we have had articles on project management, design concepts, new equipment trends, redundancy, system operation and maintenance.

As a professional engineering firm specializing in the design of mission critical facilities, we feel that providing this educational information allows our clients to make more informed decisions regarding their mission critical facilities.

The Fall 2005 designPLUS Newsletter includes an article on Reliability Analyses and Data Center Cooling Concepts (watts per square foot is passé).

We hope you find this issue interesting and informative, and we encourage you to email us with suggestions for topics that you would be interested in seeing in the future.

RELIABILITY ANALYSES: PROVIDE COST FOR ULTIMATE SYSTEM

By Leo P. Soucy, Jr., P.E.

Over the years, Facilities Engineering Associates has performed numerous Reliability Analyses reviewing the mission critical utility infrastructure supporting data centers, broadcast operations and other critical facilities. The review normally assesses the existing infrastructure with regard to the following design criteria with the results presented as color-coded bar charts, which visually shows areas of concern:

- Redundancy - The number and configuration of additional capacity ensuring that the critical load is always served by the hardened system.

- 7x24xForever - Maintainability - The system's configuration that allows upgrade and preventative and emergency maintenance to be performed without a shutdown of the critical load.

- Fault Tolerance - The capability of a system to continue serving the critical load even if an inadvertent, unplanned event occurs.

- Capacity - The capability of the system to be easily expanded to meet future load increases.

The Reliability Analysis normally includes developing "Probable Cost of Construction" for the recommended system upgrades.

System upgrades can easily be in the millions of dollars so upper management will automatically assume that any proposals will provide the most robust system design regardless of any limitations included in the report. Even though the Reliability Analysis includes detailed descriptions of each design criteria and the recommended upgrades, upper management may not fully grasp these concepts. Upper management continually evaluates business "opportunities" based on financial data, so it is imperative that the costs presented to upper management provide for the most robust system design. Since upper management is accustomed to evaluating financial data, they realize that any cost reduction will result in a less robust system. Once they know the "Probable Cost of Construction" for the most robust upgrade, they can then evaluate other less robust system designs, knowing full well that these alternates do not provide the recommended or most robust system.

UPDATING DATA CENTER COOLING CONCEPTS

By Francis Escott, P.E.

Providing sufficient cooling to modern data centers continues to be a hot topic for the HVAC professional. Overall data center heat loads continue to increase as the modern high performance data center incorporates items of equipment with highly concentrated heat loads. With the incorporation of racks filled with blade servers and high-density computing units, heat loads in excess of 20 kW per rack are now becoming possible. Locating all the items of similar computing functionality in tightly packed areas appears to be a good idea from an Information Technology standpoint; however, this tends to create islands of high density heat loads that are difficult and at times impossible to cool.

Many of today's data centers are designed around the traditional architectural concepts, which were generated in the main frame computer room era and continue into today. Things like exterior walls, ceilings and floors are not going to change; however, items such as raised floors and suspended ceilings are debatable. Many data centers today have a raised floor comprised of 2' x 2' tiles and a 2' x 2' or 2' x 4' suspended ceiling grid. Air conditioning is traditionally supplied by specialized computer room air conditioners (CRACs) through the plenum space under the raised floor and through perforated floor tiles into the computer room. At the same time, the under floor space is used for chilled water distribution piping, condensate drains, power wiring and communications cabling. Converting main frame computers to midrange and server based data centers was an easy task as most of the infrastructure was already in place and the new data center racks are designed to fit very nicely on the raised floor. The modern data center is laid out based upon using rack configurations of 24" to 30" wide, 36" to 44" deep and 76" high, which dimensionally mesh very nicely within the existing 24" x 24" raised floor tile configuration.

That was yesterday and yesterday is past. We now know that what worked yesterday does not necessarily work today and surely will not work tomorrow. A 42U cabinet installed in 2000 used 34 servers and generated a heat load of 3 kW (10,239 BTUH) to 4 kW (13,652 BTUH). This same size 42U cabinet installed in 2005 now can accommodate 74 blade servers and generates a heat load of over 20 kW (68,260 BTUH), a 500% increase in heat generation from the same size cabinet. The original 2' x 2' perforated floor tile that supplied cold air to the computer room has only 25% free area and a capability of providing 550 CFM amounting to 11,880 BTUH of cooling which is adequate to cover a 3.5kW heat load. The maximum airflow that the perforated floor tile can accommodate without major changes to the mechanical infrastructure is about 550 CFM. Overall data center heat loads will continue to rise. How fast the overall heat load will rise will be directly related to the amount of highly concentrated heat loads that populate the data center floor. The objective in providing adequate cooling to the overall data center floor is to satisfactorily maintain the desired internal and external environmental conditions of the racks regardless of whose hardware is sitting next to, in front of, behind or contained within the same rack. This can most efficiently be accomplished by arranging the racks in a hot aisle/cold aisle configuration and by considering the heat load generated and airflow required for each rack. Cold aisles must be a minimum of four (4) feet wide and contain two (2) FULL perforated floor tiles. This is an absolute necessity in order to take full advantage of the limitation of the airflow from the floor tiles. The airflow from a 2' square perforated floor tile maximizes at 550 CFM of cold air with the damper in the full open position. This amounts to 11,880 BTUH (3.5 kW) of air conditioning. Once this cooling limitation is realized, the rule of thumb of providing cooling based upon a watts-per-square-foot solution is no longer valid. The capacity of the perforated floor tiles that supply cold air to the racks is maximized when the heat load exceeds 3.5 kW per rack. By upgrading the rack with new servers, the heat load can now easily increase from the 3 kW to 20 kW in the same physical space. Servers are designed to maintain their own internal temperature by circulating cold air through them. The upgraded rack requires more cooling air and it will obtain that air from the surrounding area. This will cause hot spots to form on the data center floor due to servers 'stealing' air from each other. Increasing airflow above 300 CFM (to a maximum of 550 CFM) per perforated floor tile requires a special effort including prudent raised floor design and equipment layout. Achieving airflow per tile above 550 CFM requires the use of special floor tiles called floor grates. The use of floor grates dramatically changes the airflow patterns and static pressure gradients within the raised floor plenum of the immediate area surrounding the floor grate. Simply changing from a perforated floor tile to a floor grate of the same size will increase the free area to 56% and a capability of providing 2,000 CFM of cold air. Part of the solution to re-establish predictable under floor airflow patterns and pressure gradients would be to increase the depth of the raised floor. Studies of this proposed solution indicate that a minimum clearance of 24" under the raised floor is required for predictable airflow. This is all predicated on the fact that the raised floor plenum area is not subject to conflicting purposes (i.e. simultaneous installation of chilled water piping, power wiring and communications cabling).

What this all boils down to is the fact that BOTH Facilities personnel and Information Technology personnel must work together at the earliest possible stage of either upgrading an existing data center or the creation of a new data center. The usual shortcuts and anecdotal answers such as calculating cooling on a W/SF basis and using a raised floor with perforated tiles to deliver the cooling leads to data centers that cannot handle the now prevalent high density heat loads. Other methods must be seriously considered when designing the overall cooling system

- First and foremost, high-density rack equipment must be identified and incorporated into the floor plan in a distributed manner.
- Racks should be arranged in hot and cold aisles.
- Different paths and methods of cool air delivery must be evaluated.
- The physical constraints encountered when upgrading an existing area plays a major role in determining the method of providing the cooling required.
- Overhead power and data distribution can eliminate under floor congestion
- Elimination of the raised floor
- Use of a larger temperature differential between hot aisles and cold aisles (instead of the prevalent 15ºF)
- Incorporation of Computational Fluid Dynamics (CFD) as a design tool
- Fluid cooled racks and equipment
- Overhead supply and return ducted systems in combination with under floor air distribution
- Cold aisle segregation with the use of closures on the ends of the cold aisles and air domes at the tops of racks

GENERATOR TESTING

There are many clients who perform monthly and sometimes weekly generator testing; however, we have found that a large percentage test the generator with no load. A generator should not be run unloaded for a significant amount of time because the unit never reaches normal operating temperatures. This causes unburned fuel to migrate into the valve stems causing "wet stacking". When this occurs, an unloaded generator will operate properly but will fail when a load is applied. Generators should always be tested with load and operated for a sufficient amount of time to reach normal operating temperatures.

Policy
designPLUS Newsletter is published to keep the readers current with the latest trends in mission critical systems.

Correspondence
FEA welcomes any letters, articles, reports and comments for publication. Please mail, fax or email written material to:
Facilities Engineering Associates
128 Garden Street
Farmington, CT 06032
Tel. 860-677-2285
Fax. 860-676-9433
Email LSOUCY@FEACE.COM
WWW.FEACE.COM

In lieu of
Holiday Greeting cards
Facilities Engineering Associates
will be donating to the

American
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