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Professional Engineering Services
For Mission Critical Industries

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Summer 2007

The designPLUS newsletter has been addressing Mission Critical Facility design issues for over five years. One area that has received increased attention is the requirement for cooling high density loads, which has been addressed numerous times in this newsletter. Not only is this becoming an industry concern, it now rates as the greatest single challenge in designing a Mission Critical Facility. There are many innovative solutions to address this problem, but they require extensive engineering analysis.

We are finding clients that are implementing equipment solutions that are not consistent with the design of the existing cooling system. The cooling of high density loads requires not only specialized equipment, but also an integrated system design necessitating a computational fluid dynamic (CFD) analysis. Bill Flaherty has provided an excellent overview of this problem in this issue.

PROJECT BUSINESS OBJECTIVE

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

Many clients are unsure of exactly what they want or need in a 7x24xforever mission critical facility. Some clients have an existing facility that may need updating while others are in need of a new facility. Many of our clients have found it very helpful to commission a study before actually requesting any design services. A study can help them plan for future updates or expansions as well as look at estimates of probable costs for budgeting purposes.

We have found that the first step in commissioning a study should be to prepare a Project Business Objective. A Project Business Objective is a written description prepared by a client that states in a few sentences what the client expects from the present or future facility and how it will affect their mission. This description provides a criteria or a mission statement to which an evaluation can be compared when reviewing a facility. In the case of a new facility, design goals will be reflected by the contents of the Project Business Objective. ***FEA*** can aid clients with the preparation of the Project Business Objective, but only the client can determine what the requirements will be.

Most Project Business Objectives identify a facility that requires a high level of system hardening and redundancy. Recently ***FEA*** has conducted reliability assessments of facilities where the Project Business Objective stated that the highest level of hardening was not necessary. It is important that an Owner is fully aware of the constraints that will be imposed on the facility if a less hardened facility is installed. Some of the constraints that the Owner has agreed to but may not be aware of include:

- Little added capacity for future growth.
- No capability to perform maintenance on systems, which could eventually result in their catastrophic failure.
- Requirement to shutdown the facility to implement system upgrades.
- Failure of a single device or piece of equipment can severely affect the mission critical facility.

The reason most cited for accepting less hardened systems is that the facility is backed up remotely allowing for shutdown of the facility for maintenance or upgrade. Although this is a valid argument, it is important to note that in order to take advantage of this capability, it requires implementing the disaster recovery plan (i.e., operate solely from the backup facility). This normally requires upper management approval, is not an easy process and requires considerable effort and coordination to accomplish. ***FEA*** will design the level of hardness necessary to meet the Owner's Project Business Objective. Our only concern is that the Owner fully understands the constraints that the mission critical facility will be operating under if the systems are not fully redundant or hardened.

MULTIDENSITY MIXED LOADS

By William H. Flaherty, Jr., P.E.

The cooling of data centers is becoming increasingly complex with the advent of high density cooling loads. It is now commonplace to find several or even dozens of equipment racks having heat outputs in the range of 10 to 15 kW. Gone are the days of providing a few Computer Room Air Conditioning units (CRACs) around the perimeter of the room and distributing cool air through raised floor perforated tiles located in the aisles.

The first response to the increased cooling loads was to arrange equipment in hot and cold aisles. This configuration was satisfactory for data centers with some heat loads in the 3 to 5 kW per rack range as well as other lower loads; but as loads increase, additional design is needed to assure proper equipment cooling. Many techniques are being tried and proper engineering design is increasingly required to provide a system tailored to the specific configuration and need of clients. The key to efficient and effective cooling is to direct cooling air to where the load is and direct the warmed air back to the cooling equipment without mixing it with the cooling air. There are several techniques that can be employed to do this and cooling equipment and rack manufacturers have responded to the need by tailoring new products to meet these requirements. That being said, it is dangerous to assume that simply purchasing this equipment and installing it will provide a satisfactory answer to a complicated problem.

Data centers we have seen to date contain a mixture of high density loads (15 kW / rack and up) and lower density loads including patch panels with no heat output at all. A specific example of utilizing a product without proper engineering is the application of chimney racks. There is high interest in racks with chimneys that will direct heat into a ceiling plenum that is also connected to the inlet of CRAC units. This appears to be a simple and effective solution, but on closer scrutiny some problems can be identified that must be addressed or the system simply will not work. Some of the problems that need to be solved are as follows:

- How is midrange high heat output equipment handled that is self-contained and cannot be rack mounted?
- How do you handle servers that vary the CFM required, depending on processing activity?
- How should high density and low density loads be disbursed throughout the data center to assure that high density loads will not "rob" needed inlet air from lower density loads?

As can be seen from the above issues, careful engineering is required to consider these and other potential problems to provide a satisfactory design that will provide adequate cooling to the mixed loads in a modern data center. One of the most powerful tools available to engineers today is Computational Fluid Dynamic (CFD) analysis. This technique allows the user to model the room configuration being considered and to accurately predict how air will flow and what the resultant temperatures will be at critical locations. Using CFD allows engineers to investigate various configurations of rack layout and air supply and return methods to provide confidence to the client that the final design will perform as required.

SECURING PROFESSIONAL DESIGN SERVICES

by Leo P. Soucy, Jr., P.E.

FEA has been asked to provide professional design services for mission critical facilities in a number of different arrangements including competitively bid to the Owner, competitively bid to an architect and negotiated directly with the Owner. It is very difficult to competitively bid professional design services as it is not a defined product or piece of equipment but a service. Most of the mission critical facilities' Request For Proposals (RFPs) include a single page of service requirements and sometimes there is only a single paragraph. It normally will indicate that a facility meet "Tier III or Tier IV" design requirements which does not define the extent of necessary services.

There are a number of ways to respond to these types of RFPs, none of which are completely satisfactory.

RESPOND IN KIND:

In this proposal the professional responds to the request knowing full well that the scope of services requested is not specific. The proposal will try to put constraints around the services to be provided with the idea that if there is a change in scope, a change order for the added services will be requested. Oftentimes the Owner may not be aware of the complexities of the services required, and is surprised when a change order is requested. This can result in an adversarial relationship, which is very detrimental to the project outcome.

Develop Project Details:

Here the design professional requests further detail during the bid process than was provided in the RFP to try to further define the scope of services so everyone is providing a proposal for the same services. This results in a proposal for a specific scope of services. As the design professional is trying to eliminate any ambiguity, it does not include any added services to cover unexpected situations or services that are uniquely known by the design professional but are difficult to define. This can also result in the same change order process as outlined in the "Respond In Kind" proposal with the same attendant problems.

Propose the Necessary Services:

With this proposal the professional design firm has extensive experience in these types of projects and proposes what they feel is required regardless of the criteria stated in the RFP. A proposal of this type includes additional hours to cover unexpected situations and is all encompassing. Obviously this type of proposal works best with a client that is aware of the design professional's capabilities and their approach to project execution. This type of proposal results in the best project relationship, but may disqualify a viable design professional, as their proposal may include more hours than other proposals due to unique insights including familiarity with client preferences or the client's facility. Such insights put that design professional in a difficult position since the unique knowledge, which cannot be specifically stated in the RFP, will cause the design professional to include additional services or allowances beyond what other design professionals may provide.

It is important to remember that a proposal for professional design services is normally based on the number of hours that the design firm estimates it will take to complete a project. Most clients do not want to minimize the effort to the extent that the project suffers, but only to ensure that they are getting the best value for the services provided. With this in mind the cost reflects design effort with a higher proposed cost resulting in more hours expended to ensure project success. ***FEA*** normally provides a "Not-To-Exceed" proposal and charges for the actual hours expended on the project. We have found this relationship provides the best project outcome and best client satisfaction. In this manner the Owner pays for only the services provided with ***FEA*** maintaining the flexibility to provide the services necessary for project success.

Design services are normally 4-6% of the overall project cost. Even if the design services are substantially more than the norm, the added cost is but a small percentage of the overall project costs and the benefits to the project can far exceed this added cost.

PROJECT PLANNING & EQUIPMENT LEAD TIMES

The lead times for generators, substations, sophisticated generator paralleling switchgear and UPS systems remains extensive with generators over a year and the other electrical equipment in excess of 40 weeks. In addition to these long lead times, you need to add design time, bidding and bid review. The lead times are normally quoted as "after drawing approval" which can be 4 - 6 weeks after receipt of the order. With project time lines being compressed, equipment delivery lead times are a major concern in project completion. It is imperative that long lead equipment be specified and purchased very early in the design cycle.

Policy

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

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