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The designPLUS newsletter has been addressing Mission Critical Facilities design issues for over six years. In addition to the high reliability aspects of data center design, we are now seeing an increased concern in the energy efficiency of these facilities not only due to environmental concerns but also because data centers are huge consumers of energy resulting in high energy costs.

The adjacent article on this page discusses the fact that the large amounts of energy that data centers consume has attracted the attention of Congress and the EPA.

There is also an article in this issue about powering data center equipment with DC power. This is a fairly new application of an old technology that shows great potential to save significant amounts of energy.

We hope you find this issue of the newsletter interesting and informative.

DATA CENTER ENERGY EFFICIENCY

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

As data centers become more energy intensive, it is becoming a requirement to develop the best use of energy. In 2005 the EPA started taking an interest in data center energy issues and recently issued a report that focuses on three issues: the problem of rising energy costs in data centers, how data centers can minimize energy consumption, and how the EPA and the industry can develop efficiency benchmarks for servers and data centers.

Their initial findings were, if present practices continue, data centers will consume 100 billion kWh at a total annual cost of \$7.4 billion. The EPA reviewed three energy-efficient guidelines that data centers can use to help reduce energy usage: 1) Operational changes such as shutting down idle equipment, implementing power management features on computer equipment and improving the cooling systems, 2) Adopting energy efficient computer equipment, installing more efficient uninterruptible power supplies and adopting free cooling techniques, and 3) State-of-the-art aggressive consolidation of servers and storage equipment, enabling advanced power management features throughout the data center and implementing liquid cooling.

These three guidelines have the potential of providing a 65% reduction of energy. This amount of savings is impressive, but it needs to be evaluated

against the primary objective of providing data centers with the highest resilience, redundancy and fault tolerance.

FEA has found that existing equipment, when configured properly, can provide much more energy efficient systems without sacrificing the systems' resilience, redundancy or fault tolerance. Some of these strategies include cross-connected UPS systems operating at higher load factors, and cold air segregation and hot air capture for increased air conditioning equipment efficiency.

Other existing technologies that offer promise include utilizing higher service voltage, implementing DC power in the data center and eliminating STSs.

While all of these will provide increased energy efficiency, they also will require closer system monitoring, more attention to data center layout, installation of non-standard equipment and revision of existing best practices thinking.

With the completion of the EPA's report, they are now developing a method to implement the report's findings. The present thinking is to develop a "data center efficiency metric" that will provide a method to determine how efficient a data center is. The initial thought is to develop a method to evaluate how much power is actually consumed by the computer equipment as a percentage of the total power consumed by the facility. The EPA is now in the information gathering process to determine how best to proceed but it behooves everyone to be energy aware not only because the government is now involved but also because there is a tremendous potential for energy cost savings.

CONSIDERATIONS FOR DC DISTRIBUTION IN DATA CENTERS

By Rafiq Bulsara, P.E.

Recently there has been considerable interest in DC versus conventional AC power systems for data centers. This article discusses some key considerations related to DC systems.

DC is not a new technology as it has been the power of choice for the telecommunications industry since its inception over 100 years ago. Due to the increased emphasis on energy conservation, Data Centers are now taking a more serious look at the application of DC power.

Due to the fact that there are fewer power conversions in a DC system, it would seem reasonable to assume that an AC power system with UPS and batteries is less efficient than a rectifier DC power system with batteries.

Any analysis needs to look at the entire system to determine the actual overall efficiency including the following:

- ⇒ Equipment efficiencies
- ⇒ Number of power conversions (AC to AC, AC to DC, DC to DC) from the electrical service to the server power input and their attendant losses
- ⇒ Associated cooling costs.
- ⇒ Additional equipment necessary to provide the required redundancy and the associated losses.

This analysis needs to consider the overall system efficiency gain versus absolute numbers. If a system is already highly efficient, then the incremental improvement in efficiency alone may not overcome the uncertainties of the technological challenges.

There are other factors besides effi-

ciency that are even more important for owners and operators of Data Centers to consider such as:

- ⇒ Reliability
- ⇒ Initial and overall cost of ownership
- ⇒ Availability of equipment, both new systems and replacements
- ⇒ Equipment layout
- ⇒ UL or equivalent listing of equipment
- ⇒ Familiarity with technology
- ⇒ Codes, Standards and regulations

Low Voltage DC Systems:

The most readily available DC systems are the type utilized by the telecommunications industry, which utilized 480V AC input power with 48V DC output power using multiple rectifiers paralleled through blocking diodes. These are highly reliable systems with a proven track record, but being low voltage dictates that the rectifiers be installed in very close proximity to the computer equipment, which in most cases will result in the rectifiers being installed in the data center space. Options for battery back up include connecting batteries to the 48V DC bus or feeding the units from a UPS with battery back-up. The former configuration requires that the batteries be installed in the data center space along with the rectifiers with the latter configuration providing no efficiency savings as there is still a UPS. At present, raised floor space is considered too valuable to accommodate non-computer equipment such as batteries. In fact the installation of presently required power distribution and air conditioning equipment to serve the computer equipment is continually being reviewed to determine how its impact on the raised floor can be reduced.

High Voltage Systems:

Another DC power system is to develop high voltage DC (500 - 600V DC) in a central location and distrib-

ute this power to the data center floor. One system we have reviewed comprises 480 volt rectifiers with 550V DC output feeding 550V DC to the data center where a DC to DC converter converts the 550V DC to 48V DC. In this configuration the batteries are connected to the 550V DC bus so they do not take up valuable data center space. This approach may have some merit, but one main concern is that there is a limited installed base which results in a lack of information on equipment reliability, mean time between failure and mean time to repair. This system utilizes rectifiers to provide the necessary power, which replaces the conventional double conversion UPS system. Reliability of the rectifiers operating in parallel needs to be compared to that of a paralleled multi-module UPS system.

Additional Considerations:

One important issue is UL listing (or equivalent) of 550V DC equipment. Some breakers are UL listed for DC operation, but presently, there is no commercially available switchboard assemblies with a rating larger than 800A that are UL Listed. Codes and standards for safe DC systems are also limited and not widely used or accepted by designers, contractors nor the authority having jurisdiction. This aspect could pose unforeseen statutory challenges even after a DC distribution system is installed and operational. An example is arc flash analysis which is presently being actively implemented in AC system design, operation and maintenance. Arc flash standards do not exist for DC systems, thus an accident involving a high voltage (more than 50V) DC system could lead to unprecedented liability.

Future designPLUS issues will explore further DC power systems.

MASTER SERVICE AGREEMENTS

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

Over the years, numerous clients have asked **FEA** to enter into a Master Service Agreement (MSA). We find this as an ideal client/engineer relationship since it allows the engineer to provide the best possible service to the client in an immediate manner within a pre-negotiated framework. Facilities requiring 7x24x365 availability many times need immediate engineering assistance from a professional that they know and trust.

The advantage of a Master Service Agreement is that the engineer and client have put in place a pre-existing agreement from which to work when the client has a need for consulting engineering assistance. Such agreements can offer many advantages such as:

- ⇒ Establishment of a continuing relationship based on mutual trust and past results rather than on the lowest competitive bid.
- ⇒ The engineer and client become a Team with the common goal of providing the best solutions for the betterment of the client.
- ⇒ Standardization of system configuration, maintenance practices and testing.
- ⇒ Providing a sounding board for the client to discuss possible future projects with a professional familiar with the clients' facilities and future goals.
- ⇒ Provide a capable resource that can be called upon during planned maintenance periods to assure management that all precautions have been taken to eliminate unintended

outages.

⇒ Learning curve difficulties concerning highly technical projects such as UPS and generator systems and high density cooling can be avoided when the same engineer is used for follow-up projects.

⇒ Maintenance of Master Drawings that assure the latest facilities changes have been documented for future reference.

⇒ Pre-approved hourly rates to be used when work on small projects is needed immediately.

The main advantage of the Master Service Agreement is the ongoing relationship insuring continuity in the design and operation of the facility.

Many of the clients that we have Master Service Agreements with also have agreements with the critical subcontractors. This provides ongoing continuity of the entire team working towards the common goal of providing the best for the mission critical facility.

FEA presently has MSA's with numerous clients and some of these relationships we have continued for over 20 years. With these clients we are involved in all phases of their facility operations including preliminary discussions and development of system upgrades, capital planning, the presentation of proposed system upgrades to upper management, system design, equipment and full integration testing. We are also involved in the operation of the facility including reviewing maintenance requirements and providing on-site assistance during the maintenance of critical equipment. The extent of the services may involve any area where the client feels that we can provide a cost effective benefit to the facility.

Low-Sulfur Diesel Fuel

This past June, a new Environmental Protection Agency requirement took effect that limits the amount of sulfur in off-road diesel engines, including standby and emergency generators. Diesel fuel sulfur content must be less than 500ppm and further decreased to 15ppm in 2010. Some States have already adopted the more stringent 2010 EPA requirement for generators and it is important to check with local regulations.

From an operational standpoint low-sulfur fuel will cost slightly more per gallon, contain less lubrication and burn less efficiently; however, general overall performance and capacity will not be significantly effected. Your engine manufacturer's representative can provide more information and your diesel fuel supplier can help translate your State's specific requirements.

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

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