in this ISSUE:

Professional Engineering Services
For Mission Critical Industries

FEA

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Winter 2007

As ***FEA*** approaches our 20th year, it is interesting to note some of the changes that have occurred in the data processing industry over that period:

- DotCom - Boom/Bust/ Maturation
- Dual power cord technology
- Email proliferation
- Universal hi-speed communication
- Shift from Legacy Mainframes to Enterprise Servers
- Blade Servers
- Virtual tape
- Outsourcing
- Co-Location
- Proliferation of digital processing in other industries including broadcast and medical

FEA has been fortunate to be involved in the industry during this period and has developed an expertise in applying innovative solutions to meet our clients' business requirements. As we look to the future, it is very evident that there will be considerable ongoing evolution in the industry, and we look forward to continuing to provide innovative solutions.

Project Team Dynamics

by Brian Soucy, P.E.

What is the definition of 'effective teamwork'? Ask ten people and you are likely to receive ten different responses. Over the years, ***FEA*** has been a member of many high performing, mission critical project teams . The purpose of this article is to share our experience and what factors helped contribute to the team's and ultimately the project's success.

In reviewing several effective teams ***FEA*** has been a part of, it was clear that each team shared similar attributes, including:

- A level of experience that matched the project requirements
- Effective and proactive communication
- Defined and shared expectations
- A common goal

It has been our experience that the highest performing teams included contractors that had experience working in mission critical environments and, if possible, intimate knowledge of the subject facility. This often meant pre-qualifying contractors when a competitive bid process was required or, when possible, directly negotiating contract terms so that all parties understood what was expected. We have seen cases where a competitive bid situation gave the contractor the impression that price is the driving factor at the expense of quality or system reliability. The result was a contractor less than willing to work with the owner and project team as a whole.

We have found that selecting vendors based on mission critical qualifications is likewise important; as is pre-purchasing equipment. One advantage of the pre-purchase process is that a relationship between the owner, engineer and vendor is established through which equipment performance, factory witness and integration testing expectations are defined and surprises are mitigated.

Involving both the vendors and contractors early has helped develop communication channels required for a successful project. It has also allowed the design professional to design for the specifics of known equipment and the contractor to become familiar with the equipment in terms of shipping splits, rigging, delivery schedules and other pertinent information.

Ultimately, it has been the buy-in of all parties to the team concept that enabled a high level of performance. Having shared expectations and a common goal made sure all team members were pulling on the same end of the rope.

Arc Flash Hazard - Part II of II: Performing Arc Flash Analyses

by Rafiq G. Bulsara, P.E.

We reviewed what an arc flash hazard is in our Fall 2006 newsletter. This article reviews resources available to help perform an arc flash analysis and key points to watch out for. There are two official publications available today to help perform an arc flash analysis, NFPA 70E and IEEE Standard 1584. These two documents complement each other and both are needed to perform a proper arc flash analysis.

The equations in NFPA 70E and IEEE 1584 standards are derived from the empirical data of several tests, which were plotted as curves and then the equations to fit those curves were developed. These equations and tables are not intended for blind interpolation or extrapolation for conditions and system ratings beyond those mentioned in the standards. This means that there could be many scenarios and systems that cannot be properly evaluated for arc flash hazards with what we know today. The development of an arc flash hazard analysis standard is a work in progress.

NFPA 70E and IEEE 1584 guidelines are applicable only for 3 phase AC systems. They are not to be used for single-phase AC systems or DC systems. No recognized standards exist today for those systems.

While NFPA 70E contains tables that can be used to quickly estimate the arc flash hazard category for some installations without the need for detailed engineering calculations, they mostly tend to yield conservative PPE requirements compared to those based on a detailed analysis per IEEE 1584.

Considerations for Calculating Incident Energy for an Arc Flash Study: The two most important parameters required to calculate incident energy of an arc flash are the available short circuit current and settings (time current curve) of the protective device protecting the equipment in question. The rest is a matter of entering the data in the formulas in IEEE 1584 or NFPA 70E standard. The use of software is recommended.

However, the final analysis is not as simple as it seems. Because most short circuit current analyses are performed to verify the highest available short circuit current at the equipment bus to determine the short circuit current rating (withstand rating) of the equipment. The worst case for determining the withstand rating may not be the worst case for an arc flash hazard analysis. Protective devices in general have inverse time characteristics meaning they open faster at higher fault current and slower at lower fault current. More often than not, lower fault currents lasting longer can release more energy than higher currents lasting for a shorter time.

Therefore, it is important to use more realistic short circuit current data for an arc flash analysis. Available short circuit current also varies greatly by the configuration of the distribution system. For example, fault currents can be much different when fed by a generator plant than when fed by the utility supply. It is possible that two different configurations could result in two different categories of PPE requirement, which could make a difference in deciding whether or not to proceed with the work. This also means that it may not be adequate just to apply one hazard label on the equipment. It may even be prudent to direct personnel to a manual that describes available incident energy for different system configurations and also advises the most appropriate configuration that results in the least incident energy and PPE requirement.

Another means to reduce the exposure is to temporarily change the trip settings of the protective devices for the period of maintenance that results in faster operation of the protective device should a fault occur during maintenance, but once the maintenance is over the original settings can be restored. Some manufactures are making an effort to provide this flexibility. This approach however has its own risk of losing coordination of protective devices during normal operation should the original settings not be restored for some reason.

It can also be counter productive to adjust the protective device settings just to minimize the arc flash hazard exposure and thus compromising the selective device coordination in normal operation.

It is therefore critical that the professional performing an arc flash hazard analysis is intimately familiar with the electrical system configuration and operation and also knows the rationale behind the original protective device settings and assumptions made during a short circuit analysis.

Mission Critical System Load vs Rating

By Marc Soucy

A system's rating is based on operation at 100% of capacity. While it is acceptable to operate at this level, mission critical facilities normally use 80% of the system capacity as the system's rating. This article will help to explain the reasons why it is necessary in a data center environment to operate below 80% capacity (80% Load

Factor), the appropriate times to implement system upgrades (80% Rule), how equipment redundancy is handled using the 80% Load Factor, and various lead times for critical equipment.

80% Load Factor: The reasons for operating mission critical systems at 80% of their design capacity are as follows:

- It is desirable to maintain some reserve capacity for unexpected load increases.
- The steady state load does not include normal load fluctuations. If operating near 100% of the system capacity, these load fluctuations could result in overload of the system.
- Whereas systems are rated to operate at 100% capacity, they are not designed for operation above 100%. It is a fine line between 100% and 101% load. Exceeding the 100% capacity results in operation beyond its design capabilities, which in some equipment such as UPS systems, can result in adverse system performance.
- The National Electrical Code recommends that electrical equipment and feeders be sized to operate at 80% of their rating. This is based on the fact that electrical equipment ratings are not precise due to material and manufacturing tolerances, so the code recommends a safety factor of 20% to compensate for these inconsistencies.
- Ambient temperature also affects a systems capacity with system de-rating necessary in elevated temperatures.

80% Rule: In mission critical environments we apply the "80% Rule" because it provides management with a means to identify and implement system upgrades on a timely basis. The "80% Rule" is based on the concept that a system is considered fully loaded at 80% of its design capacity with this level triggering the approval process for a system capacity increase. The following outlines the different system capacity levels and the actions that are recommended.

Below 80% - Educate management regarding the need for added capacity.
80 - 85% - Secure approval for the system capacity upgrade.
85 - 95% - Install added capacity and integrate with existing system.
Prior to 100% - Bring the system on-line.

N+N Design: N+N system redundancy requires that the systems be operated at a maximum of 40% of design capacity. It is important to note that not only the major equipment needs to operate below the 40% level, but all sub-systems. This requires constant formal monitoring of the load and performance of all elements of a system to ensure that the failure of any piece of equipment does not result in overload of the remaining redundant system or sub-system.

With most corporations it takes time from the recognition stage to final system installation. It is imperative to start this process early enough to ensure completion before the system load exceeds the present capacity. Depending on the size of the project, a large mission critical upgrade project can take up to 2½ years to complete from initial project approval.

In addition to the internal corporate lead times, equipment deliveries can adversely affect the time required to implement a capacity increase project. While lead times vary depending on the equipment and construction activity, some of the long lead times of different equipment over the past five years have been:

UPS - 16 to 40 weeks
Generator - 20 to 60 weeks
Batteries - 10 to 52 weeks
Floor tile - 8 to 52 weeks
Switchgear - 16 to 40 weeks

It is important to note that data centers are dynamic environments with increasing data processing requirements resulting in the need for more computer equipment. It is critical that there is sufficient long-term planning to ensure that the facility can meet the company's business objectives without exceeding a system's capacity.

Oh! By the Way

Generator Testing

Recent weather conditions (heavy snow; wind and ice) have required long term operation of standby generators. Annual testing should include a minimum 24-hour continuous operation at 100% load during the hottest part of the year to ensure that the system can operate for long periods of time. If any problems are uncovered, this is the time to discover them when utility power is available.

Hot/Cold Aisles

In addition to proper equipment orientation and supply/return air configuration, the installation of blanking plates in all racks are mandatory to eliminate short-circuiting the cold/hot design criteria.

kW vs kVA

Present computer equipment operates at near 1.0 power factor. When analyzing UPS capacity always use the UPS kW rating and not kVA.

Policy
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