Fault Tolerance Is an Indicator of Reliability

In engineering parlance, tolerance is defined as the permissible range of variation in a dimension of an object. Different industries require varying levels of tolerance in their manufacturing and operational processes. For example, the allowable variation in the manufacturing of lawn equipment is significantly higher than what high-performance sports car engineers require to meet their quality standards. In the arena of emergency standby power generation, a facility’s ability to maintain normal operations regardless of the situation is the true measure of tolerance. For data center managers, this concept is often referred to as uptime reliability — an indicator that is the true measure of the data center’s success and the verification of their operational capacity.

Like the sports car engineer in the automotive industry, data center managers and operators have the most exacting expectations. The term five nines describes the highest standard for uptime reliability in data centers, equating to 99.999 percent uptime. While five nines is largely unattainable, the guidelines many data centers follow when establishing best practices are the Uptime Institute’s industry standard Tier III and Tier IV recommendations. This benchmarking system establishes a data center’s maintainability and fault tolerance, or the degree to which the facility can assure continued performance of the overall system in the event of a component failure.

Tier III and Tier IV Accreditation Help Define Data Center Uptime Standards

Tier III accreditation refers to data centers that achieve the expected availability — based on

Consideration 1: Ensure Redundancy, Avoid Duplicity

Data center consulting engineers/designers must have a thorough understanding of the entire power system, from generation to distribution and protection, to configure an architecture that meets their specific power needs.

Tier IV is the Uptime Institute’s highest ranking for data centers and represents full fault tolerance, allowing for the occurrence of any unplanned activity while providing the expected availability of 99.995 percent uptime operations. Essentially, Tier IV data centers require 2N redundancy throughout the architecture to prevent a single point of failure. A Tier IV design is reinforced by a wholly redundant power system and supporting architecture to achieve true fault tolerance. If one generator set is deployed to supply backup power, then eight are needed (and must be separately compartmentalized in sets of four) to achieve 2N redundancy.

Fault tolerance means that in the event of a single failure in any part of the power system (from switch, generator set or ground fault), the system is equipped to compensate and remain fully functional. Although the difference between Tier III and Tier IV uptime percentage seems negligible (a 0.17 difference), financial institutions and other critical data center sectors that have more at stake demand maximum reliability. Here, zero downtime is desired. Although many data center operators consider compliance with Tier III and Tier IV as a necessity, others see the Uptime Institute’s standards as guidelines, choosing to follow their own institutional best practices. With this in mind, selecting a standby power system for a data center is critical. This white paper will explore the top considerations that data center operators must take into account to achieve maximum uptime reliability.

Consideration 2: Seek Long-term Reliability to Maximize Uptime

In the data center industry, the uptime clock starts ticking once the equipment has been commissioned and the vendors have turned over the power system keys to the operator. Obviously, this is not the time for data center operators to begin thinking about long-term reliability. Those seeking the greatest possible uptime and long-term reliability should choose a proven power system with rugged equipment that’s undergone prototype testing by the manufacturer as well as repeated field testing in similar real-world applications. Power system reliability depends on the components—designed, prototyped and tested as part of an integrated system—significantly minimize single points of failure and promise improved reliability throughout the life cycle. On the contrary, when power systems are pieced together from multiple vendors, and the requirements and life expectancy of each component are not aligned, the risks of power system failure only increase.

Consideration 3: Limit Vendor Sources for Ease of Installation

Assigning a single vendor greatly improves a power system’s life expectancy of each component are not aligned, and potentially loses control of the voltage and cause damage to the system. Newer generators have microprocessor-based controls that react more appropriately, quickly analyzing the waveforms and accurately compensating for non-linear loads. Those seeking the greatest possible uptime and long-term reliability should choose a proven power system with rugged equipment that’s undergone prototype testing by the manufacturer as well as repeated field testing in similar real-world applications. Power system reliability depends on the components—designed, prototyped and tested as part of an integrated system—significantly minimize single points of failure and promise improved reliability throughout the life cycle. On the contrary, when power systems are pieced together from multiple vendors, and the requirements and life expectancy of each component are not aligned, the risks of power system failure only increase.

Consideration 4: Select a Vendor With a Reputation for Exceptional Service

Data center operators understand the inevitability that eventually the power system equipment will fail. They recognize that it’s not a matter of if this will happen, but when. This is precisely why savvy operators build redundant methods into power systems. But, when the equipment does go down, operators must have ready access to reliable service for accurate diagnostics and quick, cost-effective system repairs. A single-source system offers the greatest advantage to owners dealing with only one manufacturer’s service technician to troubleshoot the entire system, from the generator set to the switchgear. Operators can drastically reduce the number of service calls and overall time spent on-site with down equipment, and the technician has the advantage of having intimate knowledge of, and complete visibility to, the complete power system.

Consideration 5: Deploy a Focused Product Portfolio

Data centers are notorious for having unique power product portfolios because of the nature of equipment they house. A typical data center has an average proportion of non-linear loads (servers, computers, UPS systems and digital controls) as part of its electrical load profile. As a result, owners and operators must choose equipment specifically designed to handle these non-linear waveforms and maintain reliable operations. Many older, legacy power generation products are unable to compensate for these irregular sine waves and have the potential to lose control of the voltage and cause damage to the system. Newer generators have microprocessor-based controls that react more appropriately, quickly analyzing the waveforms and accurately compensating for the non-linear load. It is up to operators to understand that manufacturers that build products specifically focused on data center applications can truly optimize power delivery for complex non-linear loads.

Note that some manufacturers have begun to take notice of the data center industry’s unique requirements by issuing application-specific ratings, particularly with respect to their high-horsepower product lines. For example, some manufacturers have adjusted their generator set ratings to better match the power profile of the data center industry.

Partner Selection Is Critical to Achieving Uptime Reliability

With the rise of the data center industry in the last two decades, power generation providers were forced to tailor systems to respond to the industry’s unique needs, and extremely challenging set of requirements. Although the majority of data center operators today are content with adhering to Tier III guidelines, the standards of uptime reliability and redundant availability will only get stricter in the future. But standby power systems, like any mechanical or electrical infrastructure, are susceptible to inevitable failure, and data center operators must be prepared to mitigate these risks. Minimizing the number of power generation vendors involved in the battle of the bidders for a data center is critical. Partnering with a vendor who understands the unique complexities that data centers face today is the other half.

Data center operators who want to maximize their power system life cycle should select vendors who understand the true value of integrated power systems. Integration starts in the manufacturing phase—designing, prototyping and testing each component of the power system to minimize points of failure—but is not limited to the equipment level. Integration is also measured in the long-term reliability that is achieved through seamless program management, installation, commissioning and ongoing commitment to service.
About the author
Rich Scroggins is a Technical Specialist in the Application Engineering group at Cummins Power Generation. Rich has been with Cummins for 18 years in a variety of engineering and product management roles. Rich has led product development and application work with transfer switches, switchgear controls and networking and remote monitoring products and has developed and conducted seminars and sales and service training internationally on several products. Rich received his bachelor's degree in electrical engineering from the University of Minnesota and an MBA from the University of St. Thomas.

About the author
Matthew is a graduate of the University of Minnesota with a Bachelor's of Mechanical Engineering. He has been with Cummins Power Generation since 2008 in various roles within Application Engineering. Matthew's primary focus is assisting clients and distributors with technical guidance on application specific issues concerning fueling, cooling, ventilation, sound attenuation, vibration transmission, and emissions issues. He is actively engaged in the Power Seminar program as well as providing technical training content to support distribution teams in the North American market.