The Power in Your Hands: The Right Load Bank Strategy Impacts Uptime

By Clayton Taylor, President, ComRent® International

Whether you're responsible for the electrical equipment, HVAC and generators/chillers for a power plant, data center, hospital or cruise ship, the call to action is clear: Make sure you have the power capacities and capabilities necessary to keep your infrastructure up and running – or risk costly outages. That's where a comprehensive load bank strategy comes into the picture. Early and ongoing load bank testing of your high-performance infrastructure system ensures that it works properly from the first installation and continues to function at maximum efficiency.

Why Load Banks?

To effectively create electricity, you need two devices: the generator and the load. Neither works without the other. Technically, a load bank is a device that develops an electric load. It then applies that load to an electrical power source and converts the power output of the source. To understand better, it might be useful to think of a simple analogy of a magnet stuck to a refrigerator. In this case, the magnet is the generator and the refrigerator door is the load. While the magnet creates the power, it won't mean anything unless it has a place on which it can adhere. A generator and load work in much the same way.

A load bank is used to commission the electromechanical systems of high-performance buildings such as data centers and hospitals as well as utility substations and even wind farms. Its primary function is to accurately mimic the operational or "real" load that a power source will be connected to in actual application. However, unlike "real" load, which is likely to be dispersed, unpredictable and random in value, a load bank provides a contained, organized and fully controlled load. This allows commissioning engineers to safely and accurately test and measure the functionality of the electromechanical systems under a variety of load conditions.

Why mimic the power instead of using the direct source? Later, we'll discuss the problems associated with potential failures. Load banks are designed specifically to prevent that. The true load is served by the source and uses the produced energy for something productive. However, the load bank is the reserve: Using energy produced to test, support or protect the power source.

So what do we need to know? To ensure the power generator is functioning properly, it's necessary to find a load from somewhere. Your options are using the utility grid, a plant load, or load banks. However, when there is an absence of load or if there's not enough load to permit the generator from functioning properly at peak capacity – a load bank should be used.

The term "peak capacity" is important. If the generator doesn't fully meet capacity, it does not operate at optimal performance. Generally, a rating that measures peak capacity is used to determine optimal performance. For example, a 100kW generator can power a load from 1kW to a maximum of 100kW. But if you're trying to reach 125kW, you don't have enough generators to supply the load. For example, in a car with an engine designed to go 150 MPH, if you were to attempt to go 175 MPH, there just won't be enough power to get it done. To reach that peak operation, you'd need an entirely new engine (generator). Load banks are necessary to measure the performance, ensuring you've got the power to reach that optimal "speed."

At What Cost?

Are power outages as bad as all that? Just how much time and money are we talking about when we're speaking of outages? According to an article in eWeek:

"Data center managers and CTOs already know that system downtime can be very expensive for an enterprise, but it's possible they might not know the real extent of the expense when servers, networking and storage suffer a major outage."

A May 2011 study at the Uptime Institute Symposium estimated that companies can realistically lose an average of $5,000 per minute in the event of an outage. Now get out your calculators. That's $300,000 per hour! With an average outage of 90 minutes, that means the cost per downtime issue would be a whopping $505,000.

In September 2011, a major power outage impacted a large region of Washington, halting operation of the state's data center for the first time in 20 years. According the report: "The State of Washington is estimated to have lost $500,000 as a result of a power surge in August that shut off power to a state government building that housed the state's data center."

Before racks are mounted with mission-critical equipment, this newly-built data center's electromechanical systems must be commissioned using load banks. Commissioning with load banks throughout the life cycle of the data center keeps performance issues at a minimum, lowering the risk for power outages.

But the damage goes even further. For certain processes, power can simply not be interrupted. That can mean a pharmaceutical plant where interruption in the manufacture of the product due to power failure can cause the entire batch to be scrapped. Take the example of military applications. Obviously, to keep us safe, real-time information for the military is crucial. Even the remote possibility of failure is unacceptable and potentially dangerous to our critical defenses. One final example is a hospital.

Losing power for prolonged periods at a hospital can cause monitors and treatments to fail, risking lives of patients across the hospital. One such example occurred in Australia in 2009, when more than 100 hospitals experienced a 36 hour power failure due to a faulty circuit breaker. The inability to retrieve patient records and vital test results nearly crippled NSW Health. A report in the Sydney Morning Herald claims:

"Some records were lost, x-ray and pathology results could not be accessed and staff were forced to use whiteboards to keep track of emergency patients after the main server shut down at 9 am. Thousands of patients were affected, with doctors and nurses forced to take notes on paper and go to other parts of the hospital to collect hard copies of results, extending treatment times and adding to the confusion."

Despite the clear need for an effective load bank strategy, few have dedicated enough time to understand its importance. Even engineers aren't always sure how and when to use a load bank. Commissioning professionals know that load banks are quite indispensible to delivering efficient and reliable onsite power. Typically, load banks are rolled out and powered up only a few times a year at most – and usually only after a power failure has caused an issue. This type of infrequent, reactive use is a contributing factor in the types of outages described above. Because their use is regarded as an afterthought, it can be challenging to find technicians with expertise using them, and the lack of regularly scheduled load bank testing means that degradations in the electromechanical systems caused by years of wear and tear can be missed.

Harnessing the Power: Effective Load Banks

It is important to note there are many options when choosing a load bank. So how do you know which ones to consider? Really, it's all about the situation at hand as there is no "one size fits all" when it comes to load banks. It all depends on what you want to do. Many companies will tell you that low or high voltage load banks can often do the job – no matter what you need to accomplish. But that's not really the case. The load bank system you choose must be directly correlated to the type of electrical system you have. As mentioned before, a load must be directly correlated to the power produced by the generator.

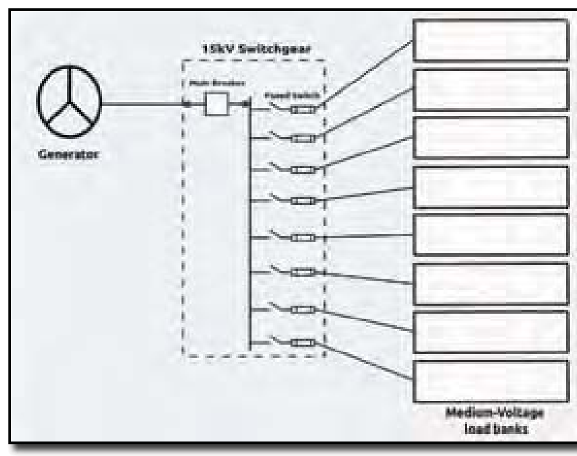
For example, when it comes to commissioning power plants, maritime electrical systems, stand-by generator systems and substations – the answer is a medium voltage load bank. Often companies turn towards low voltage load banks or a utility grid. But there are many reasons this is not the optimal solution.

A medium voltage load bank is a resistive or reactive load bank that contains resistors or reactors that operate above 600 VAC and below 69,000 VAC. The most common voltages used are kV (4160V) and 15kV (13,800V). In comparison, a low voltage load bank typically operates at 480 VAC. These systems often come as "pre-wired" containerized systems with all equipment mounted to a single trailer.

But the differences are extreme. First, medium-voltage load banks are simply more accurate. There's less equipment involved and you don't need a transformer to get the job done. This makes it easier to get a direct, more accurate picture of system performance. This high degree of accuracy and fewer components means there are not as many points of failure to monitor. And failure is just not an option.

Take for example the major power outage that darkened much of Houston just after Hurricane Ike in 2008. The Houston Chronicle reports that lost economic activity and repairs to electricity infrastructure cost the city more than $6 billion when final tallies were in. A 2005 study by Berkeley Lab took a wider view on the costs of power failure on the entire power grid. The report estimates that electronic power outages and blackouts cost the United States about $80 billion annually.

Taking this one step further, there are simply things that cannot be accomplished using a low voltage load bank. Recently we consulted on a billion-dollar mining project in Arizona. The customer wanted to commission a new 40 Megawatt low-emission natural gas turbine generator, being deployed to augment local utility power in support of expanded operations. By utilizing medium voltage load banks, project managers could rapidly commission the gas turbine's additional electrical generating capacity – eliminating long lead times and higher costs. In fact, testing on this system lasted only eight days and had limited impact on the site's day-to-day mining operations. This level of speed and dramatic cost-savings would have been nearly impossible with a low voltage system.

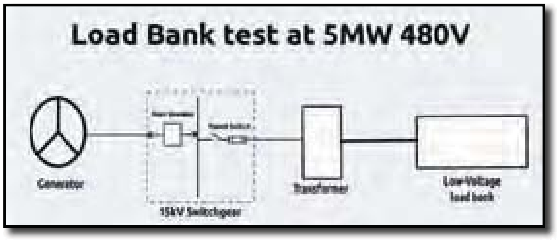


The medium-voltage load banks commissioning a 40 Megawatt high performance turbine engine. Note how the utility grid or plant load is not used, eliminating risk, saving time and placing control of loads back with the commissioning engineers and technicians.

Lower voltage systems can also cause power quality issues. In his paper "Strengths of Using Medium Voltage Load Banks," Daniel Jocelyn (Managing Partner of Critical Solutions and Innovations LLC) notes:

"When dealing with a lower voltage system, transformers being installed downstream of system components to be tested must now be evaluated for impact on power quality test results. An isolation transformer will introduce an unplanned grounding point and can induce unplanned stress on the systems tested. This is due to a dramatic inrush and magnetic resonance issues."

Another area of importance is safety. As noted earlier, some rely on the utility grid – rather than medium voltage systems – for testing. This can be problematic and quite dangerous. Quite simply, when you're using medium voltage equipment – as opposed to leveraging the utility grid for testing - you can count on fewer power surges. Power surges occur when the voltage is 110% or more above normal. These surges often introduce safety issues for the entire system. Medium voltage systems are a quick way around surges that can damage equipment.



With a low-voltage load bank, the transformer must be used, increasing risk of failure during the commissioning process.

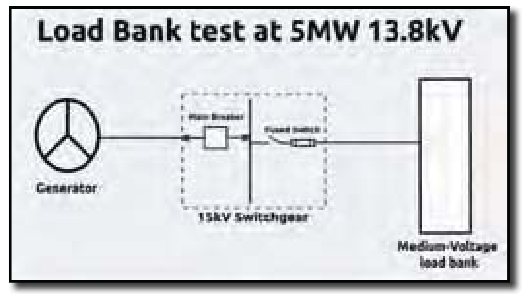
To reach the level required by medium voltage banks, low voltage load banks often require multiple transformers and multiple banks designed in containers. But quite often, load banks simply are not designed to operate in such close proximity. As "Strengths in Using Medium Voltage Load Banks" explains:

"When multiple transformers and multiple low voltage load banks are assembled in containers, trucks, on trailers or on-site, there are risks created because the proximity of the heat generating devices (load banks) were not designed by the manufacturer to be operated within certain distances from adjacent load banks and the resulting fluid mechanics of air flow may result in cooling failures or fires of the transformers, cables or load banks."

The very nature of low voltage systems poses additional challenges in terms of the volume of equipment. In addition to greater points of failure mentioned above, multiple systems introduced by low voltage infrastructures simply take up more space. We already know that – to compensate for the lower voltage – multiple containers are often used to reach optimal power needs. This means more space and a larger footprint. This can also drive higher costs.

Another factor to consider is the time it takes to test the equipment. When talking testing, timing is everything. It's necessary to conduct testing in a short amount of time to reduce costs. Due to the larger infrastructure required by low voltage systems, valuable time – and associated costs – are often created due to increased time.

A final point to consider is the planning of conductors. Additional labor, increased costs and risk are introduced when the load bank or transformer assembly is not pre-wired as low voltage conductors are designed and connected. Once again, "Strengths in Using Medium Voltage Load Banks" explains: "Multiple conductors in parallel pose fire or short circuit risk when free air circulation is not achieved by having cable laid out on top of each other and not tri-plexed. The multiple conductors in parallel must be monitored with temperature monitoring devices."



The medium voltage load bank eliminates the need for a transformer during the testing – which means fewer points of failure.

Where Do We Go from Here?

By now, you should see the benefits of medium voltage systems as opposed to stringing together multiple low voltage load banks – or by using the utility grid.

But not all medium voltage systems are created equal. When choosing your vendor partner, several areas should be strongly considered. First, you should go with a vendor that has products designed specifically to meet your needs. As we've seen, not every infrastructure is the same. A tremendous amount of damage can be done if you use the wrong system.

Additionally, many voltage infrastructures aren't nearly as complex as they were 10 years ago. There are many vendors who have streamlined the infrastructure – requiring less space and eliminating complexity. You should also go with a vendor that can minimize your reliance on the utility grid to test transformers, switches, substations, or any equipment that is critical to power generation. That means dramatically reducing the risk of outages caused by power surges and failed load tests.

Another factor to consider is design. Given the complex requirements associated with utility power plant equipment, you need a product that is custom-engineered to handle load specific to the infrastructure at hand, such as transformers, black start generators, wind turbines, solar arrays, transfer switches, and switchgear. You should go with a vendor with a large enough inventory and variety of load banks to support virtually any test or create any optimal testing environment.

Caption: Rack-mounted load banks in a new data center facility test the hot and cold air aisle containment strategy for servers.

Another area to consider is resistive and reactive test solutions. A resistive load bank follows the behavior of the electrical system closely. It copies the electrical load of the generator. With a reactive load bank, you're creating and monitoring the lagging power factor.

Again, different situations require different types of testing equipment. For this reason, what's required is a vendor that understands the difference between and value of resistive and reactive testing -- ensuring a complete and accurate test of the generator's performance. This guarantees the generator can withstand a lagging or reactive load without risk of failure and downtime to operations. A vendor must also have the ability to conduct parallel testing on medium voltage generators with no transformers necessary for faster commissioning. That's more cost-effective in the long-run.

A partner must be able to save you time in substation commissioning. What's key is a vendor with the expertise, knowledge and equipment to commission substation components for the modern smart grid – safely, quickly and with limited risk. A vendor partner should have solutions with the power to reduce the risk involved in back feed or making changes to the transformer to simulate the actual load.

Finally, any vendor with whom you choose to partner should go beyond providing equipment. Look for a partner with the technical know-how and experience to act as a valued resource. Seek out a vendor with the ability to walk your site and help you specifically plan equipment placement, access, ingress, and egress – plus end-to-end logistic coordination and roll-out and roll-up services. This is critical to ensure a safe, risk-free commissioning experience.

The End Game

By now, it should be clear there are distinct differences between using a low voltage load bank or utility grid – as opposed to a medium voltage system – to test and ensure the reliability of your critical power infrastructures. What's critical is a system that can ensure optimal efficiency of your infrastructure while minimizing costly failures. More often than not, a medium voltage solution is the way to go. From cost savings to reduced danger to minimal downtime – a medium voltage load bank can meet all these requirements. And you need to partner with a vendor that truly understands your needs – and has the medium voltage solutions to tackle your challenges. Be sure you take your time and choose someone that brings all these things to the table. Time to take the next step. The power is in your hands. ■

About the Author

Clayton Taylor is the founder and CEO of ComRent International, LLC, a load bank testing solutions provider in North America. After starting the company in 1997 with just one employee, Clay has led ComRent through continuous year-over-year growth that now includes 18 operating locations with over 100 employees in the U.S., Canada and abroad. Clay is a member of EGSA, NETA, 7X24 Exchange and IEEE. An avid sailor, Clay has restored several classic Chesapeake 20 sailboats and is an active member of the West River Sailing Club. Clay can be reached at *ctaylor@comrent.com*.