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Power challenges for the Cirque du Soleil Theatre at Vidanta Riviera Maya

BY TYRONE MELLON AND PATRICK O'KEEFE

IN DECEMBER OF 2016, Lex Products was approached by representatives of Cirque du Soleil regarding a line power issue with their Theatre at Vidanta Riviera Maya in Mexico. As their main power expert was not immediately available to address the matter, Lex Products was asked if we had the expertise and interest in researching the problem, discovering the cause, and developing a solution.

History

JOYÀ, the first permanent Cirque du Soleil resident show in Mexico, combines culinary and performing arts in an intimate theatre setting to engage the audience's five senses. This whimsical show is performed year-round at the Cirque du Soleil Theatre at Vidanta Riviera Maya located on the east coast of the Yucatan Peninsula near Cancun and Playa del Carmen.

At the time of its construction, power for the facility's lighting was designed to be provided by three 2,000 kW generators. As

time passed, the fuel costs required to keep the generators running became an unacceptable drain on the bottom line. The decision was made to use local utility power as the primary source and to reallocate the generators as backup power through the use of a transfer switch.

The drawback with this design was the time required to transfer from utility to generator power. Thirty seconds was needed to allow the generators to restore show power. This half-minute transfer time was unacceptable, as this would mean a complete show stop with no lights and a complete reset prior to resuming the performance.

The solution was to employ an uninterruptible power supply (UPS) system to ensure show power quality and consistency. In simple terms, a UPS is a device that accepts alternating current (AC), converts it to direct current (DC) and then produces clean AC. The full or double conversion UPS system chosen would not only clean up dirty power, it would supply five minutes of emergency power from back-up batteries to bridge the gap between

loss of utility power and establishment of generator power.

The JOYÀ UPS system was designed to meet the anticipated show needs. During performances independent management monitoring software showed the power demand to be drawing only 60% of the system rating.

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Issue

The issue that was brought to Lex Products involved the UPS system going into bypass mode. When it senses that the demands being placed on it exceed its capacity, a UPS will protect itself from damage by allowing the incoming power to pass through directly. However, in bypass mode the power functions that the UPS system would normally perform are suspended until the load profile lowers to acceptable limits. While this prevents harm to the UPS, utility voltage spikes are also allowed to pass with the potential to damage downstream devices and, should there be a power outage, the lights are off until emergency power takes over or utility power is restored.

Investigation

At the request of Cirque du Soleil, Tyrone “Ty” Mellon, Director of Engineering for Lex Products, traveled to Mexico to get a big picture understanding of the electrical installation. Together with Omar Landa, Operations Director, Ty reviewed the site conditions, spoke to representatives of individual departments, and watched a performance to get a feel for the dynamic show power demands.

What Ty discovered was a polished facility that was well done, well labeled and, most importantly, well documented. With over 150 construction drawings to review, any delays in forming a comprehensive understanding of the power system would have hindered finding a solution.

A technical walk-through was performed while voltage data was monitored. While this step-by-step review included all technical aspects of the performance, particular attention was paid to the lighting component, as it appeared to generate the most problems. Though lack of access to the utility neutrals and the inability to



Relay panels to control non-dimmable loads at the venue.

monitor the system under actual performance load created an incomplete picture, useful information was gathered during these trials.

Owing to the show’s design, the production lighting spent a majority of the performance within the 40% to 60% level range. While this speaks to the efficiency of the light plot, it also happens to be the sweet spot for neutral currents.

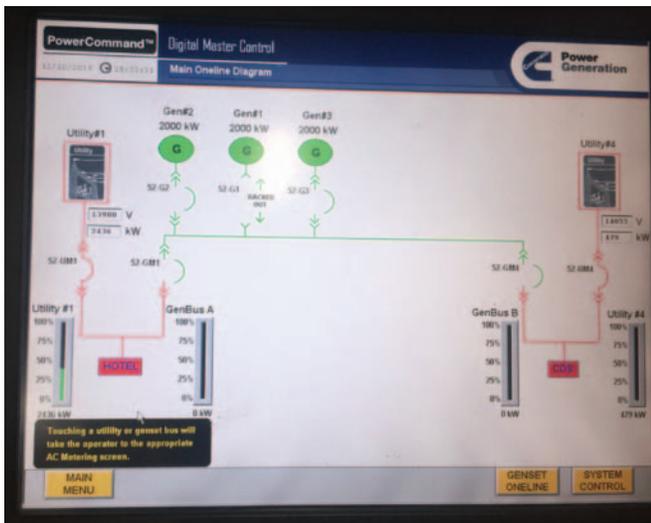
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Neutral currents

The Cirque du Soleil Theatre at Vidanta Riviera Maya, much like most of North America, is run on three-phase power. In a three-phase system, power will flow up one phase and down the other two. If you were to monitor the current level on phase A, you will see the same current split between phase B and phase C. In a perfectly balanced system, the neutral will not see any power flow. It is when phases are unbalanced or switching loads are employed that neutral



Main breaker for one of the venue's 96-dimming racks.



Operator interface for transfer switch for generators, resort, and Cirque du Soleil Theatre at Vidanta Riviera Maya.

currents will occur.

An SCR-type dimmer operates as a valve controlling the flow of electricity allowing it to pass at levels according to need. When the level is set to 100%, the gate is fully open and power is allowed to flow between the phases. When it is at any other level, however, the gate is either partially or fully closed. Current flowing up phase A can't go down phase B or C and has no other path than to flow down the neutral. When all three phases are gating the power, the neutral becomes the only path for the power to return. During these times the neutral may be passing more current than any one single phase, since it is seeing the dump of all three phases.

When dimmers are at levels between 40% and 60%, the neutral

may be seeing upwards to 140% of the nominal current. This gating is not only seen with SCR dimmers but also with power supplies commonly used for LEDs and moving lights. It is for this reason that *National Electrical Code (NEC)* has a callout for neutrals to be sized at least 30% larger than the rating of the phases to accommodate the added flow and reduce the potential for overheating the wire.

JOYÀ is an example of a normal occurrence in entertainment where, owing to the gating nature of the dimmers and power supplies, a significant amount of current is flowing down the neutrals. A UPS is usually designed to handle 100% of rating of normal power loads. With gating loads, they are maybe capable of supporting 50% of the rating owing to the amount of current flowing through the neutral.

Oversizing neutrals, installing discrete neutrals . . . are just some of the considerations that occur with designing an entertainment space.

The monitoring software, which allows the operator to check the power demand remotely, was **only** looking at what the line phases were drawing. The UPS system was monitoring both the phases **and** the neutrals. Both were accurate, but only for that portion for which they were responsible. This difference in sources monitored caused the initial confusion. The amount of current the UPS system was seeing on the neutral indicated an overload and sent it into bypass.

While known, this neutral current behavior rarely occurs outside the entertainment arena. Oversizing neutrals, installing discrete neutrals, and matching transformer types with those that work well with switching devices are just some of the considerations that occur with designing an entertainment space. Those who design buildings for factory or general use are also getting into designing portions of theatrical buildings, and they may not have these considerations foremost in their minds.

As a result of this investigation and the subsequent conclusions, Cirque du Soleil has identified a new UPS system. Installation of the new UPS system was expected to be completed during a scheduled dark period in the late summer. A white paper was prepared and is available for review at http://www.lexproducts.com/content/upload_general/Vidanta_Findings.pdf that goes into greater detail about these conditions.

(We gratefully acknowledge information and images gathered from the Cirque du Soleil website at <https://www.cirquedusoleil.com/joya>). ■



Medium voltage (13.8 kV) to low voltage transformer vault.



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Patrick (Pat) O'Keefe is the Market Manager, Entertainment for Lex Products. He has been involved in the specification, sale, installation, and training of entertainment market equipment since his days in high school. He has a BA from the University of Maryland-College Park and an MFA from the University of Iowa.

Lex Products is a leading North American manufacturer of power distribution solutions for demanding markets, including entertainment, industrial, and the military. Founded in 1989, the company specializes in products designed to withstand rough use and harsh environments. Headquartered in Connecticut, the company also has offices in California, Florida, and Scotland.