

From dinosaurs to roller coasters

Application Note



Testing Functions
Case Study

Tools: Fluke 87V Industrial Multimeter; Fluke 435 Series II Power Quality and Energy Analyzer, Fluke ScopeMeter® Portable Oscilloscope

Operator: Ralph Gioielli, Electrical Manager, and electrical crew of Dorney Park and Wildwater Kingdom

Applications: Testing and maintenance of amusement park electrical system

Keeping the fun going at Dorney Park

Whether it's barreling down the thrilling twists and turns of a roller coaster, skimming down waterslides, or mingling in the forest with life-size dinosaurs, Dorney Park and Wildwater Kingdom attracts fun seekers of all ages. It is one of the largest amusement parks in the north-eastern United States, with more than 50 rides (including 6 roller coasters) and a spectacular water park with 11 waterslides. Mostly it is just an incredibly fun way to spend a day.

Located near Allentown, Pennsylvania, Dorney Park was first developed as a summer resort in 1884. It evolved over the decades into a major amusement park and in 1992 was acquired by Cedar Fair, one of the largest regional amusement park operators in the world. Today Dorney Park attracts upwards of 1.5 million people each year between the end of April and Halloween.

Understandably, between the rides, the slides, the food concessions, and the theaters, the facility electrical crew has their hands full. The year-round crew consists of Electrical Manager Ralph Gioielli—who has been with Dorney Park for 20 of his nearly 30 year career as an electrician—and five other electricians who troubleshoot and maintain a variety of electrical and electronic components. During the park's guest season that staff is joined by three additional electricians.

In the off season—from November to the end of April—the electrical crew focuses on periodic maintenance of a variety of electrical and

electronic components. During the operating season, they focus their attention on keeping the rides and other attractions running at peak performance.

The electrical distribution system for the park starts with a primary 12,000 V line that is divided among about 47 distribution points—typically 480 V or 208 V. That voltage is then distributed among hundreds of electrical panels used for rides, merchandise buildings, food concession buildings, and entertainment venues. Some rides have their own dedicated transformer. In other cases several smaller rides are powered through the same transformer.



Ralph and fellow maintenance electrician Mike Hartkorn use the Fluke 435 Series II Power Quality and Energy Analyzer to assess the stability of incoming power at the park's administration building.



It's not frozen in time—it moves! Ralph Gioielli, Electrical Manager, makes certain the animatronic dinosaur keeps moving. Here he checks current loads with his Fluke meter and i1010 current clamp.

Maximizing the guest experience

During the season the electrical crew runs two shifts. Three electricians and a games technician handle the morning shift, which starts at 6 am. One electrician and one game tech handle the night shift from about 3 to 11 pm. The first priority for the morning shift is to get everything up and running so the park is ready when the guests start arriving at 10 am. "Rides are the number-one priority because we want every guest to have the best day they've ever had," says Gioielli.

Each morning, the park's mechanics go out and inspect every ride. "If they find an issue with a sensor or some other electrical component, they call my foreman and he either goes himself or dispatches somebody to troubleshoot the problem," says Gioielli. "A lot of the major rides have two PLCs [programmable logic controllers] and computers for redundancy. Sometimes the problem is very simple and sometimes it's more difficult to diagnose."

Choosing the right tools

Each ride is a somewhat unique collection of components, including proximity sensors, capacitance sensors, photo eyes, gate locks, frequency drives, and ac and dc motors. "All the rides may have the same type of components, but they're really very different and they operate differently so you have to understand exactly how each ride works," says Gioielli.

To be prepared for anything, the electricians carry essential electrician's tools as well as wrenches and other tools in case they have to pull off a motor. Their essential tools almost always include a digital multimeter (DMM). Gioielli carries a Fluke 87V DMM with an i1010 AC/DC Current Clamp. "I don't go anywhere without my Fluke DMM. I don't usually know whether we're going to be measuring ac or dc, so with these tools I'm ready to measure current, voltage, or resistance."

If the trouble call involves an intermittent problem, the electrician typically use a Fluke

ScopeMeter® portable oscilloscope to determine the order of events, which helps pinpoint the problem faster. "Some problems come and go and never happen when you're standing there, so it's good to have something that can record or monitor relays, for example," says Gioielli. "Our systems are redundant, so with ScopeMeter® we can easily detect that one relay is activating a fraction of a second before the other one, which tells us which component is failing based on the operation sequence of the ride," says Gioielli.

Troubleshooting speed switches

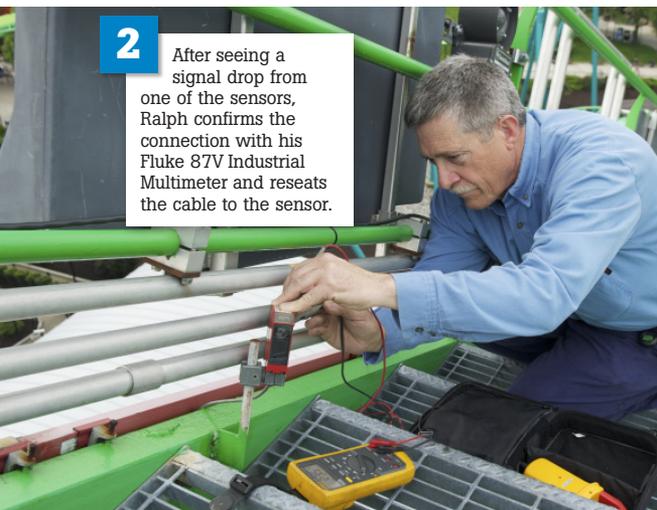
Most of the roller coasters at Dorney Park run more than one train, so proximity (prox) switches act as a kind of traffic control mechanism to determine the location of each train and ensure that all the trains keep their distance. The proximity switches are used to check speed. Each car in a train has a flag, so that as the train goes over the proximity sensor, the PLC monitors the time the sensor is flagged. This determines how fast the train is going and then calibrates the speed, gently applying the brakes if necessary.

Gioielli uses his ScopeMeter® to troubleshoot the proximity switches. "You get fast pulses as the train passes over the PLC," says Gioielli. "If the pulses aren't consistent because a prox is flaking out or one train car has a bent or broken flag, a visual inspection may miss it altogether. The ScopeMeter® picks up each of those pulses and can tell you immediately if you have a problem with the prox, the wiring, the input to the PLC, or something else your eyes can't see," says Gioielli.

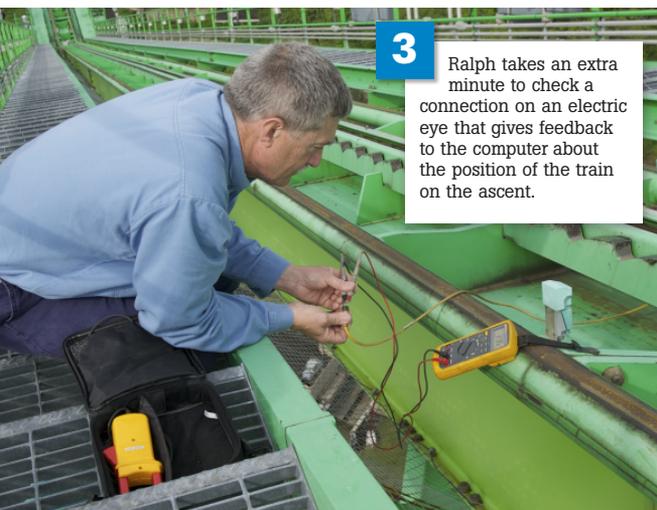
After the ride issues are addressed at the beginning of each day, the electricians move on to problems with lighting, sound, or water pumps. Once the park opens, the electricians continue with minor routine repairs and are available by radio communication to immediately move



1 In the electrical room of the Hydra roller coaster, Ralph uses his ScopeMeter® portable oscilloscope to test the 24-volt signals coming from the numerous safety sensors along the track.



2 After seeing a signal drop from one of the sensors, Ralph confirms the connection with his Fluke 87V Industrial Multimeter and reseats the cable to the sensor.



3 Ralph takes an extra minute to check a connection on an electric eye that gives feedback to the computer about the position of the train on the ascent.

to any ride if a problem occurs. “From the moment the park opens the downtime clock starts, so we have to find problems and fix them fast,” says Gioielli.

Analyzing and balancing power

Gioielli periodically analyzes the overall power usage across the distribution points to make sure there is adequate capacity. He uses the Fluke 435 Series II Power Quality and Energy Analyzer to record and monitor activity on various distribution points to make sure the loads are within a safe level. “I monitor those loads for about 24 hours, once every season,” says Gioielli. “It gives me a record of the regular and peak loads so that I can determine how much capacity is being used and where there’s room to grow.” He prints out a chart and keeps it in the file so that he can refer to it to determine whether there is adequate power capacity for expansion at that particular point or whether additional capacity needs to be added.

“Like most amusement parks we’re changing every year, adding things here and there, which means the loads are constantly changing,” says Gioielli. In 2012 Dorney Park added two exciting new offerings. Guests can now roam through a life-size dinosaur attraction or ride the new Stinger roller coaster up a 138-foot lift hill and race down the other side up to 55 miles per hour through three inversions.

“I used my power analyzer to monitor the regular and peak loads for those attractions to make sure we have plenty of capacity,” says Gioielli.

Avoiding unnecessary costs

In 2009, the information provided by the power analyzer actually saved Dorney Park some money when it built a new theater for ice shows. When Gioielli started designing the electrical system for the theater, he sized the transformer according to the National Electrical Code (NEC)

specification, which called for a 2000 kVA transformer based on the projected loads of the facility. However, the actual projected load was much smaller than that specification called for, so he contacted a consulting electrical engineer to review that requirement. The consulting engineer estimated that, based on the type of venue for which the building was to be used, the actual load would be much lower. Theaters, which are not in use all the time, are typically designed for very flexible power requirements.

The engineering team presented the engineer’s estimate to the electrical inspector and got approval to use a smaller 750 kVA transformer. After the theater was up and running, Gioielli recorded 24 hours of operation during peak use with the power analyzer and was able to document that it did in fact use only 25 percent of the power that the original NEC requirement called for. “Thanks to that information, we were able to use a transformer one third the size of what it would have been. We saved on the transformer purchase and operating costs and avoided the cost of having to add a larger cable feeder and panelboard, which would be fed from the larger transformer,” says Gioielli.

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