# Keeping Whistler/Blackcomb up and running

## Application Note

Testing Functions
**Case Study**

**Tools:** 199C Color ScopeMeter, Ti25 Thermal Imager, multimeters

**Operator:** Laird Brown, Electrician Maintenance Manager; Rob Withey, Electrician; Ian Dennis, Electrician; Extended W/B electrical team

**Measurements:** Output waveforms and firing patterns on ac and dc drives, motor current startup waveforms, tracing intermittent dips, spikes and transients, standard ac and dc voltage and current. Electro-mechanical and concrete thermal scans

### Ride up, ski down, and check everything in-between

Whistler-Blackcomb ski resort is the largest ski area in North America, with 8171 acres of skiable area, slopes ranging from beginner to expert, and literally dozens of lifts. Located in Canada's Coast Mountain Range a two-hour drive (about 70 miles) north of Vancouver, it will be the site of the 2010 Winter Olympic and Paralympic Winter Games.

The resort covers two entire mountains—Whistler Mountain and Blackcomb Mountain—with lifts ranging from T-bars, handle tows, and carpets, to fixed grip triple chairlifts, detachable quads and gondolas. In all, the mountains have a total of thirty-eight lifts plus a unique attraction: the Peak 2 Peak gondola. The first of its kind in North America, the P2P is longer and higher than any other similar lift in the world.

The Peak 2 Peak travels 4.4 km (2.73 miles) back and forth between the tops of the two mountains. The trip takes 11 minutes at 7.5 meters/s (just under 17 mph) and reaches a height of 436 m/1427 feet above the ground. Each of the 28 gondola cabins can hold 28 people, transporting as many as 2,050 people per hour each way.

Each P2P track rope weighs over 85 metric tons—and there are four of them. Just imagine the twin 335 kW, (450 hp) motors driving the lift. Imagine the controls and sensitive electronic equipment involved. Imagine being the electrician who gets to ride on top of the gondolas to the towers, to maintain the electrical equipment....

Along with the lifts, the resort also has 200 buildings to maintain and 15,000 hp of snowmaking capability. Power comes from fifty-five (yes, fifty-five) 25 kV substations.

All of this equipment is maintained by a department of 20 full-time electricians and supervised by electrical maintenance manager Laird Brown.

The environment in which this team works is cold, harsh and difficult to get around. The electricians use snowmobiles to travel between sites, so that they're never stuck on the lift should it stop. If a problem occurs in a hard-to-access area, they ski in. Each electrician carries a 30 lb tool backpack at all times, and those tools get used.

Even with all of this hardiness, response times can still be challenging. Their solution? Among others, extensive training, best maintenance practices, rugged tools, and getting the job done right the first time. Electrician Rob Withey gave us the rundown on what's involved in keeping it all up and running.

## Lots of equipment

The smaller lifts, like the handle tows and Magic Carpet, have variable-speed ac drives, ranging up to 40 hp for the Magic Carpet, which at 600 feet long is the largest. "All the larger lifts use dc drives; the five triple chair lifts, built by Yan, are rated for 100 hp, 250 hp, and 400 hp, while the Doppelmayr and Poma detachable lifts are rated up to 900 hp," says Withey. All the Doppelmayr lifts, with the exception of the Peak 2 Peak, use ABB drives and motors.

The Peak 2 Peak gondola was built by the Doppelmayr/Garaventa Group. When the team commissioned it, they used their Fluke ScopeMeter® test tool to record motor currents, all of the start-up parameters, how long it took the brake to lift, and what the acceleration and deceleration ramps were. All of those baselines are now saved on the scope, for comparison at annual inspections.

Most lift maintenance involves routine electrical measurements, mainly with Fluke digital multimeters. "We look at dc field currents, to make sure they're within spec, and the voltage so that we can keep track of the winding resistances." says Withey. "We also measure the ac voltage and current of the cooling fans." Field voltage and current readings, together with insulation resistance measurements, provide a good picture of overall motor health, and have the advantage of being more constant than armature current, which depending on the load on the system may vary. Of course that gets checked too.

They use their scope to examine the output waveforms of the ac and dc drives on an annual basis adds Withey, which provides information on the drives' output devices, "thyristors and transistors and IGBTs, whatever the particular drive happens to have." The ScopeMeter also helps in troubleshooting, he says, "trying to find spurious signals or maybe a signal drop, or something that is somewhere it shouldn't be." They also use the scope to check firing patterns on the drives on their snow making machines. In general, the scope can trace problems on faster operating devices where multimeter bandwidth just doesn't suffice.

Rob Withey uses a Fluke thermal imager to check temperature on bearings and gearbox housings on the 335 kW (450 hp) motors in the Peak 2 Peak main drive room.

## A mysterious glitch

Once in a while a problem comes up that takes some ingenuity to solve. An example came on the Peak 2 Peak Gondola. As you might imagine, this equipment was built with considerable redundancy and backups. A diesel engine takes over in the case of primary drive failure. If there is a power outage, the diesel evacuation drive and two generators can run the lift to evacuate the line. All bullwheels have emergency bearings. If there is a primary bearing system failure, the backup bearings will allow the lift to be evacuated. Acoustic sensors monitor bearings on all the bullwheels to detect problems early, and the list goes on.

Rob Withey uses a Fluke thermal imager to look at gondola cable support towers for differences in temperature that could indicate moisture intrusion.

There are two dc tachogenerators on the return bull wheel that provide speed feedback to the controls. A programmable logic controller (PLC) in the system constantly compares the outputs of the two tachogenerators and will trip if they differ by more than 10 percent.

But there was a troublesome problem: Shortly after being put into service the system would produce a "reference-actual deviation" fault at random intervals and shut down, but nothing seemed to be wrong with the tachogenerators. What was going on?

Using the ScopeMeter on the outputs of the two tachogenerators showed that the output on one of them would sometimes dip momentarily and then recover. Further investigation showed that the dip was just the nature of the system (it could even have been noise), and there wasn't really a problem—except that the PLC didn't understand that, and would trip whenever it happened.

Still under an on-site service agreement with Doppelmayr, one of their engineers came up with a simple solution for the system. Since the dips were only momentary, add a small time delay to the PLC. Then, instead of tripping the instant the output of a tachogenerator showed a dip, it would keep watching for three of four scan cycles. Problem solved.


Ian Dennis arrives at the Peak 2 Peak gondola with his tools. Whistler/Blackcomb Electrical Maintenance staff use snowmobiles to move from location to location on the mountain.

## Another mystery

One of the tests required for the Peak 2 Peak gondolas is a simulated power failure: kill the power and make sure the backup diesel generator comes on and re-establishes the power to the system. This was done soon after the system was installed, and there was a failure on a PLC distributed I/O block on each mountain.

The electrical crew immediately suspected that the shutdown was causing some kind of voltage transient that was taking out the cards. A power loss not only cuts power to motors, it causes highly inductive electrical brakes to operate. "So we put the Scope on there … to try to see if there was a voltage transient or a spike at the moment of shutoff that we thought may be causing that," Withey explains. The result: there was no spike big enough to cause a problem. "Our conclusion was the cards were faulty out of the factory, and were probably just doomed to fail, fairly quickly." Rather than leave it at that, they also changed the dc power supply, "so there is now an isolated 24 V supply feeding those two cards." Withey says. If a spike should come along in the future, it will be filtered out.

The doomed-to-fail diagnosis has been verified by experience, he points out: "Every month we do the power cycle on the lift to make sure everything is working right, and we haven't had a problem with it since."

Rob Withey uses a Fluke ScopeMeter to check the output voltage that drives Peak 2 Peak conveyor motors.

## Looking for hot spots—and cold ones

The resort has 55 buildings, including staff housing, and once a year people are sent out to check the electrical panels, including the high voltage switching gear and transformers. Part of the checking process is to look for hot spots, which can indicate localized overloads or high-resistance connections. The tool of choice for this is a Fluke thermal imager. It can pick out a hot spot quickly, without anyone having to touch anything. The imager is also useful in other areas, says Withey. On dc motors, for example, it can spot cold tracks or hot tracks on commutators; it's also handy for quickly checking things like bearings and housings. The new P2P even has a fully isolated primary feeder, specially designed for thermal inspection without personal protective equipment gear.

Towers are important parts of the ski lifts, and it's vital to make sure they're kept in good condition; here again the thermal imager proves its worth. Some towers are partly filled with concrete, and if water were to find its way inside and then freeze it could cause damage. A concrete-filled tower shows a different thermal signature compared to an empty one, so one routine maintenance check is to take a thermal image of each tower. As long as a tower has all the same thermal "color" it means that it's okay. This kind of measurement would be difficult and quite time-consuming by any other method; with the thermal imager it's a snap.

## What happened to that fuse?

Most measurements can be done in real time, but there was one that required some recording. One night a panel in the alpine shop started smoking. The lift mechanics on the night shift called it in, and were told to shut it down and get out of there, which they did. In the morning the electricians arrived, opened the panel, and found that one of the fuses was simply gone. The end tabs were still there, but the fiberglass fuse body had disintegrated, leaving a pile of sand sitting in the bottom of the panel.

Nothing else seemed wrong, so after putting in a new fuse Withey hooked a Fluke digital multimeter with a current probe up to the panel, set it to the min/max function, and let it run for several days. The cause of the problem was soon apparent: The panel was rated for 600 amps, but over the years the building had been extended and new equipment added; there were times in the day when the load on the panel exceeded 600 amps. "We added another whole 600 amp service to the building," says Withey, "so now it has two." Problem solved.

## A dedicated Fluke user

Withey has been using Fluke instruments for a long time. "I've been in the trade 23 years now," he says, "and the first meter I bought was a Fluke, and every meter I've owned since is a Fluke." He's not alone in this, he adds: "Most of us here at the hill have Fluke tools."

And with Fluke equipment's well-known reliability, Withey has only had three in all that time, although he bought one of those to replace one he lost on the mountain.

Sorry, Rob, the warranty doesn't cover meters lost in the snow.

The Whistler/Blackcomb Peak 2 Peak gondola has many safety and redundant electrical systems. Rob Withey uses a Fluke ScopeMeter to look for voltage drop at a switch.

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