Consistent testing keeps indoor skydivers flying high

Electrical systems power an all-glass vertical wind tunnel

Application Note

Testing Functions
Case Study

Tools: Fluke CNX™ Wireless System, 87V Industrial Digital Multimeter, 1630 Earth Ground Clamp Meter, 41B Power Meter, 1745 Power Logger, 381 Clamp Meter

Operator: Zach Bryson, Project Manager for Keithley Electric and customer Bill Adams, owner of iFLY Seattle

Applications: Preventive maintenance inspection of electrical systems; troubleshooting vibration signal

Want to feel what it's like to dive from a plane more than two miles above the ground without a parachute? You can feel that and more at iFLY Seattle, and there's no hard landing.

Here at the world's first all-glass vertical wind tunnel, you and your pals can float like a butterfly for a minute or longer. iFLY Seattle is the fastest vertical wind tunnel (VWT) in the world and, at 14 feet (4.2 meters) in diameter and 90 feet (27.4 meters) top to bottom, the largest recirculating wind tunnel west of the Mississippi River.

The flight chamber is the enclosed section of the tunnel you step into. The floor of the flight chamber is a trampoline floor of aircraft-quality stainless steel. After you enter the flight chamber, the tunnel operator slowly brings the wind speed up until you and your instructor are airborne.

And it's not just for beginners, says iFLY owner Bill Adams. Spins, rolls, and precision team routines involving up to 10 fliers at a time can all be part of the experience. "There is no good skydiving team and no great skydivers that don't spend a lot of time in the wind tunnel perfecting what they're doing."

The wind is generated from above, not below, the flight chamber. Powerful, high-efficiency axial fans are mounted in the upper leg of the tunnel (the optimum location for safety and efficiency). In most of the models iFLY uses, the wind is channeled and directed down the sides of the tunnel, underneath the flight chamber, and then up through the floor of the flight chamber, lifting flyers into the air. The air then travels through the top of the flight chamber, and the cycle begins again.

"If I could, I would spend hours in there," said iFLY owner Bill Adams. "It is the closest thing to flying and the most freeing experience ever. You weigh nothing, and the turning of your hand or your head makes you go any way you want."

Inspect and test

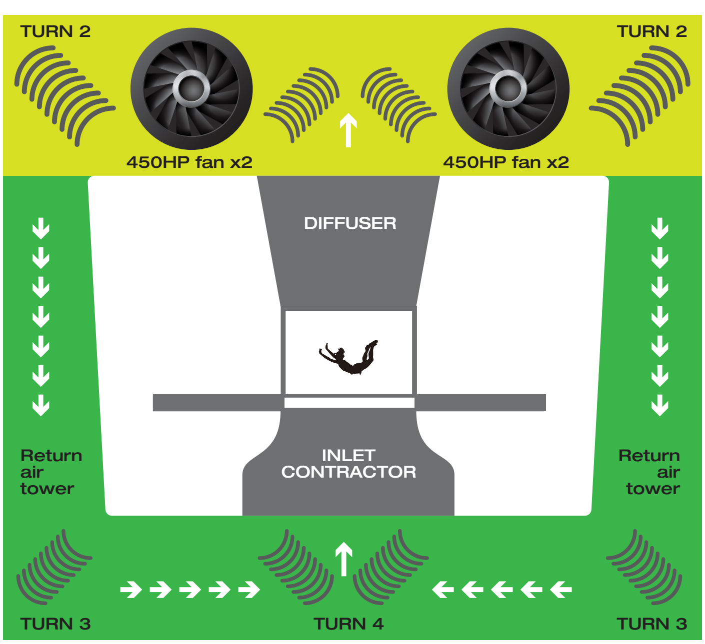
To keep those breezes blowing, Adams relies on Seattle's Keithly Electric to perform a yearly preventive maintenance inspection of the electrical systems at the heart of the facility. These include four turbine-like fans above the flight chamber, each attached to a purpose-built, air cooled 400-hp Reliance Electric AC motor rated at 900 RPM and capable of bursts to 600 hp and 1125 RPM. These motors can draw air up past the flyers at speeds up to 230 mph, though most flying happens at 90 to 150 mph. The fans move more than two million cubic feet (fifty-six thousand cubic meters) of air per minute to create a wall-to-wall vertical cushion of air—just the right flow for flyers to float on. The air then recirculates through return ducts around the chamber.

Scheduled testing at the facility, built in 2011, was programmed from the start. "If one of the fans goes down, I can't make a penny," said Adams. "I'm a military guy, and proactive maintenance is the kind of maintenance that you want to be doing to prevent the catastrophic event of fan failure, which would leave me making no money until you get it right."

When a company testing vibration in the four fan motors identified a vibration signal possibly caused by an electrical anomaly, Adams called in Keithly to examine the system, including supply circuits, harmonic filter, variable frequency drives (VFDs), and motors.

In that inspection, a scan with a Fluke infrared camera revealed that increased resistance at a loose terminal at a fuse block inside the power filter was heating the block to 139 °F (59 °C), noticeably more than the reading of less than 100 °F (37 °C) for blocks nearby. Re-torqueing the screw showed it to be a half-turn too loose.

"The solution was simple," said Keithly Project Manager Zach Bryson. "We removed power from the line filter, and the terminal was tightened. It was just a torque issue, but the bigger issue is that whole fuse holder probably would have burned up, and then it would have been a lot more work than five minutes of torqueing a terminal. It would have meant removing an entire fuse holder and re-wiring that back into the cabinet. That preventive maintenance was the ounce prevention that removed the pound of cure." Now Keithly returns to iFLY at least once a year.



What the doctor ordered

The Keithly Preventive Maintenance Program for iFLY includes visual inspections, multiple electrical tests, and infrared inspections using a Fluke infrared camera, according to Bryson. The facility even has to pass a "smell test," Bryson said. As they run their other tests, Keithly technicians are on the alert for the unmistakable scent of burned electrical components.

Step one: Power down

The work begins when the Keithly team shuts down power to the ac power filters, the VFD units downstream, and the four fan motors they power and control, then locks out and tags the power control panel. Testing with the Fluke 87V Industrial Digital Multimeter confirms that the facility has been de-energized.

Zach Bryson, Project Manager for Keithly Electric, locks out and tags the power supply at iFLY Seattle. Initial inspection will proceed with the facility de-energized.

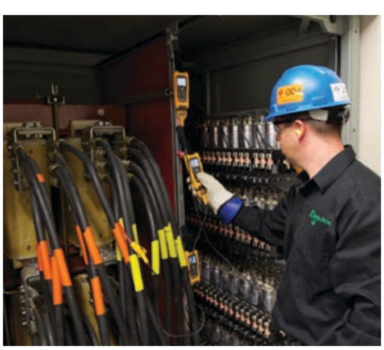
Suited up for arc flash safety, Bryson uses two separate Fluke 87V Industrial Multimeters to verify that all sources of energy were isolated by lockout. The team used two meters—checking phase-to-phase and phase-to-ground with each meter to verify all sources of energy have been discharged (capacitor bank).

Step two: See and sniff

With power out, the motor supply and control panels are opened for static tests, including visual inspection and the smell test. The team looks for visible damage, such as burned insulation or smoke damage, and ensures all components appear in good order.

After verifying that all sources of energy have been isolated, Keithly technician Greg Burdick uses the Fluke 1630 Earth Ground Clamp Meter to check grounding at the harmonics filter.

Bryson fits an iFlex current probe at the harmonics filter, in preparation for testing with the Fluke CNX ™ Wireless System. Tests will be done after covers are re-installed.



Bryson prepares for a three-phase current test using the Fluke CNX ™ Wireless System.

"We test mechanical operation of everything from circuit breakers to doors and interlocking mechanisms for doors," Bryson said. "We also check to make sure that all the covers are supposed to be in place ARE in place, and when they're removed they're put back in the same manner." Control wire terminations are tug-tested to find loose or improper terminations. Power conductor terminations on the VFDs are re-torqued—a process that revealed a non-factory bolt that had galled and had to be replaced. Relays are visually inspected as the team looks for proper seating and ensures bases are in good working order. Grounds are checked, using the Fluke 1630 Earth Ground Clamp Meter.

Step three: Power up!

Next it's time for testing under power. The team replaces covers and re-energizes the equipment. After allowing a half hour for the system to reach operating condition and temperature, the techs don the Hazard/Risk Category II personal protective equipment (PPE) required for this level of arc flash hazard, and remove the covers again to gain access.

"We do infrared and power quality testing typically at the same time, because the guys have to suit up," Bryson said. "When we remove the covers we're gloved and suited to take our pictures. At the same time we're getting our measurement data for power usage and any voltage variations, whether that be harmonic or sag."

The Keithly team uses the Fluke 41B Power Meter to assess harmonics, and connects the Fluke Power Logger 1745 to determine power consumption. They gather data on power flow using the Fluke 381 Clamp Meter with iFlex® Current Probe, matching the amperage detected against the specifications of the components involved.

Lately the Keithly inspectors have also used the Fluke CNX™ Series Wireless Test System at the iFLY facility, including the new CNX-enabled wireless infrared cameras.

Bryson uses a Fluke CNX compatible infrared camera to inspect fuses and power capacitors while the system is under load.

Working outside the limited approach boundary, Burdick (foreground) reviews readings on the Fluke CNX wireless system as Bryson works in the background.

Burdick uses a Fluke infrared camera to inspect the variable frequency drive control panel for the iFLY louver system.

Something else to watch

One factor that demands special attention at iFLY: the facility was built using aluminum power cables, instead of copper. Aluminum expands more than copper when it heats up under load, which means connectors can loosen over time, increasing resistance and the potential for trouble.

"What happens with aluminum conductors is they heat and cool with much more thermal expansion," Bryson said. "They are able to work themselves loose, and that's where your torque issues typically will come in. With each of these motors you have the potential for huge thermal expansion problems. You have to be much more careful that you're annually looking at these conductors, and that everything's aboveboard." Infrared inspections help spot any problems that might be developing with these connections.

With the cable terminations and other electrical systems inspected and running right, it's time to write up a final report on what elements were inspected, how inspections and tests were done, and what anomalies, if any, were addressed. These reports become key records for Bill Adams, as well as for the Keithly team that will return in a year—to keep iFLY straightened up, and flying right.

Fluke. *Keeping your world up and running.®*

Fluke Corporation
PO Box 9090, Everett, WA 98206 U.S.A.

Fluke Europe B.V.
PO Box 1186, 5602 BD
Eindhoven, The Netherlands

For more information call:
In the U.S.A. (800) 443-5853 or
Fax (425) 446-5116
In Europe/M-East/Africa +31 (0) 40 2675 200 or
Fax +31 (0) 40 2675 222
In Canada (800)-36-FLUKE or
Fax (905) 890-6866
From other countries +1 (425) 446-5500 or
Fax +1 (425) 446-5116
Web access: http://www.fluke.com

Printed in U.S.A. 5/2014 6002504A_EN