PART FIVE.ONE
of a predictive maintenance series

Insulation resisting testing on lighting circuit wiring

Application Note

Measuring tools: Fluke 1520 MegOhmMeter*

Operator: Minneapolis-St. Paul International Airport electrical foreman

Test conducted: Lighting cable insulation resistance

Preventive maintenance

The Minneapolis-St. Paul (MSP) International Airport, with more than half a million takeoffs and landings per year, is the seventh busiest airport in the world. And it's getting busier. Consequently, MSP is opening yet another runway — its fourth — in 2005. That's a 33 % increase in capacity.

At the same time, MSP has managed to keep operating expenses low, compared to other U.S. airports! The cost savings extend all the way down to the runway, where electrical foreman Bob Litke is using the Fluke 1520 MegOhmMeter for preventive lighting maintenance.

The 1520 is a professional electronic test tool that combines insulation resistance testing, ac/dc voltage measurement, and Lo-Ohms function in a single tool. It provides insulation testing up to 4,000 MΩ, with three output voltages: 250, 500, and 1000 V. The 1520 switches automatically to voltage sensing when connected to a live circuit with voltage over 30 V and provide ac/dc measurements up to 600 V.

*Note: The Fluke 1520 has been replaced by the Fluke 1507/1508 Insulation Testers.

Tequipment.NET
USA
205 Westwood Ave
Long Branch, NJ 07740
1-877-742-TEST (8378)
Fax: (732) 222-7088
salesteam@Tequipment.NET

For more information on Fluke Predictive Maintenance Products and Services go to **www.fluke.com/pdm**

Scope of work

Keeping the runway lights and related systems lit and functioning is a large part of the electrical maintenance effort at MSP. The full scope includes runway edge lights (on each side of each runway, placed about 200 ft/61 meters apart), threshold lights at each end of the runway (red or green depending on flight direction), centerline lights (flush lights on 50 ft/15 meters centers that go from white to red as end of the runway is reached), touchdown lights, taxiway signs that direct ground traffic, and the Precision Approach Path Indicators (PAPI) that sit along side and near the end of each runway.

Failure of any runway lights during airport operations is not an option. Under Bob Litke, the MSP electrical department regularly performs insulation resistance testing on the wiring for each lighting system to detect insulation degradation and prevent failure.

Considering that many of these lights run in series circuits, even localized damage can have significant effects. Degradation is accelerated by freeze/thaw cycles, especially at bad connections caused by defective splices and animal damage. Presently, 90 % of all lighting wiring is in conduit and 10 % is direct.

Cost efficiencies

Each runway light is a 6.6 V unit sitting on its own transformer. The lighting string is fed through a constant wattage regulator that makes 6 A available at each light. When all wiring is properly maintained, 500 V will power the system load. However, as wires degrade and leakage to ground increases, the system self-corrects. In doing so, it increases supply voltage as high as 3,500 V just to keep 6 A at each light. Preventing that electrical waste and associated electrical cost puts wiring insulation integrity at premium importance.

Checking leakage to ground along wiring paths

Checking leakage to ground along wiring paths is the only sure way to identify potential lighting failure. Bob Litke's department uses the Fluke 1520 MegOhmMeter to perform preventive maintenance, troubleshoot failures, and locate trouble spots. "Our process in locating a problem varies with how many lights are out," says Litke. "Often,
we must use the process of elimination to locate it."

Methodology

Check the cable (from point to point for preventive testing, or on each side of the failure when troubleshooting)e at 1,000 V for two minutes minimum.

1. Prepare each cable in the circuit for testing.
   a. Lockout/tagout the supply breaker. Use an electrical tester like the Fluke T5 to confirm circuit is not powered.
   b. Disconnect at the load (that is, each individual load served by that breaker).
2. Perform the test (at the load end).
   a. Set the 1520 to 1 kV.
   b. Connect one lead to ground, and the other to the cable under test.
   c. Press and hold the TEST button, then press LOCK.
   d. Release TEST and LOCK at the same time.
   e. If the initial resistance reading is high then note the time and continue the test for at least two minutes.*
   f. If resistance holds or goes up, consider that cable good.
   g. Record the readings.

*"High" is relative to the specifications of the cable, the history of the installation and operating requirements. For example, the Federal Aviation Administration (FAA) requires these cables test at a minimum of 50 MΩ. Newly installed cables should show a resistance of 2 GΩ or higher.

3. Continue the process for each load served by that breaker.
4. If the technician discovers a problem, the next step is troubleshooting.

Troubleshooting involves checking the cable on each side of the failure—the point where a light is out. Then, isolate the failure by the process of elimination—rather than verify a run is good (as in preventive).

1. Prepare each cable in the circuit for testing.
   a. Lockout/tagout the supply breaker. Use an electrical tester like the Fluke T5 to confirm circuit is not powered.
   b. Disconnect at the load (that is, each individual load served by that breaker).
2. Perform the test (at the load end).
   a. Set the 1520 to 1 kV.
   b. Connect one lead to ground, and the other to the cable under test.
   c. Press and hold the TEST button, then press LOCK.
   d. Release TEST and LOCK at the same time.
   e. Continue the test for at least two minutes.
   f. Watch for not just low resistance but dropping resistance readings—that means failure is imminent.
   g. If resistance holds or goes up, eliminate that area of the run and move to another.
   h. Record the readings as you go.
3. Continue the process until the degraded wires are located.
4. Remove damaged wires from wireways, pull new wires, and splice the new wires in place. In other cases, dig up buried cable and replace or repair it.
5. Repeat the predictive testing on the new cabling, prior to energization. This ensures you don't energize a damaged cable.

Preventive maintenance benefits

By conducting insulation resistance testing on a weekly preventive maintenance schedule, the electrical department can see the pattern of insulation deterioration. This allows them to predict impending insulation failure and replace the wiring before failure occurs.

Sample preventive maintenance schedule

1. Develop a regular schedule for testing insulation resistance. Incorporate the schedule into the overall preventive maintenance system.
2. After each test, add the test results to the database for trending, and then observe the trends.
3. If the latest test results indicate a drop-off in insulation resistance, then the electrical department knows to initiate further action.
4. The first step is to schedule the wiring for replacement. The electrical department does this in concert with the operations people to reduce operational interruptions at the most critical times.
5. In some cases, that particular wiring will get increased monitoring. Whether it does or not depends on the slope of the trend.
6. All wiring undergoes insulation resistance testing at installation, to establish baseline data. It's then included in the regular preventive mainenance system for scheduled testing.

[1]Source: 1/03 Report by the Minnesota Office of the Legislative Auditor.

At 960 MΩ, this cable tests satisfactorily.

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