Airfield Insulation Resistance (Megger) Testing

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What is it?

Insulation Resistance Testing, or Megger Testing, is a test of the electrical insulation in a circuit. It uses a Megohm meter which is connected between the insulated conductor and the ground. The meter charges the conductor with a high voltage and monitors any leakage to ground resulting in a "Meg Reading" value for the wiring. The reading can be 2000 + megs which is very good, or less than 1 meg which is considered very poor.

Why Do Megger Testing?

Electrical insulation can become damaged by overheating, ice, insects, rodents, or poor installation practices, and it can degrade due to environmental conditions such as water or chemicals. It also degrades from the electrical voltage itself, which over time breaks down the insulation. The higher the voltage, the more damaging it is to the insulation.

Airfield lighting circuits are exposed to all of the above conditions that degrade the systems integrity. The FAA AC Circular 150 -5340-26C says that it is normal to expect a 10% - 20% decrease in Meg reading values per year.

How Does This Affect the Electrical System?

Because airfield lighting electrical systems are ungrounded, the fact that the insulation is weakening may not have any effect on the function of the circuit at all. If the copper wire has good continuity and low resistance, the electricity will continue to use it as a path and the lights will continue to function. Even a crack in the insulation exposing the copper conductor may have little or no effect on the system's function, even though the meg reading drops nearly to zero. Everything might work just fine – until it doesn't.

A single bad spot in an airfield constant current lighting circuit does not affect the circuit. Because it is an ungrounded system the electricity has nowhere to go so it remains in the wire. However, if there is more than one fault in the system, the electricity may begin to flow outside of the wire on the ground wire, conduit, or water in the area until it can jump back into the wire and resume its journey through the circuit, re-entering at the second fault. It does this because there is less resistance in the external path than there is in the circuit with lighting in it. It chooses the path of least resistance. This bypass of the lights may cause sections of the circuit to go out or become dim. The places where the electricity exits and re-enters the system often arc and degrade rapidly, which may lead to burned off wires and connectors. Suddenly "no big deal" becomes a problem – especially if it happens in the middle of the night during a snowstorm (most likely scenario!). The stray voltages can also wreak havoc with other parts of the electrical system by creating electrolysis between different metals. Grounding systems may become corroded and badly damaged. The more leaks you have, the more degradation and failures you will likely see.

Why Should You have a Meggering Program?

Early detection of wire failures by meggering is an important preventative maintenance procedure that can be a warning for future failures and the need to make maintenance repairs, or the consideration of replacing the circuit completely. A single meg test may not tell you much about your circuit's condition, just as a single blood pressure test may not tell a physician enough about a patient's health to prescribe treatment. There are many environmental conditions that can affect a single test, and it is long term trends that give the information the doctor needs. Megger testing is much the same.

Megger testing should be conducted weekly in order to be useful. A single meg test may give you a high reading, but it might give you a false sense of security (see AC 150-5340-26C 5.1.3.1). Meg readings change with the environmental conditions. Consider a wire with a cracked insulation inside of a dry PVC conduit. The meg reading might be excellent because the air around the wire and the non-conductive PVC pipe will not allow a connection to ground. Now, flood the conduit with rainwater and the meg reading drops to practically nothing. The same wire in a conduit full of ice will act similarly. Ice is an excellent insulator, but as soon as the ice melts it becomes an excellent conductor. Meg readings that are consistently recorded over a long period of time often have very drastic highs and lows for this reason.

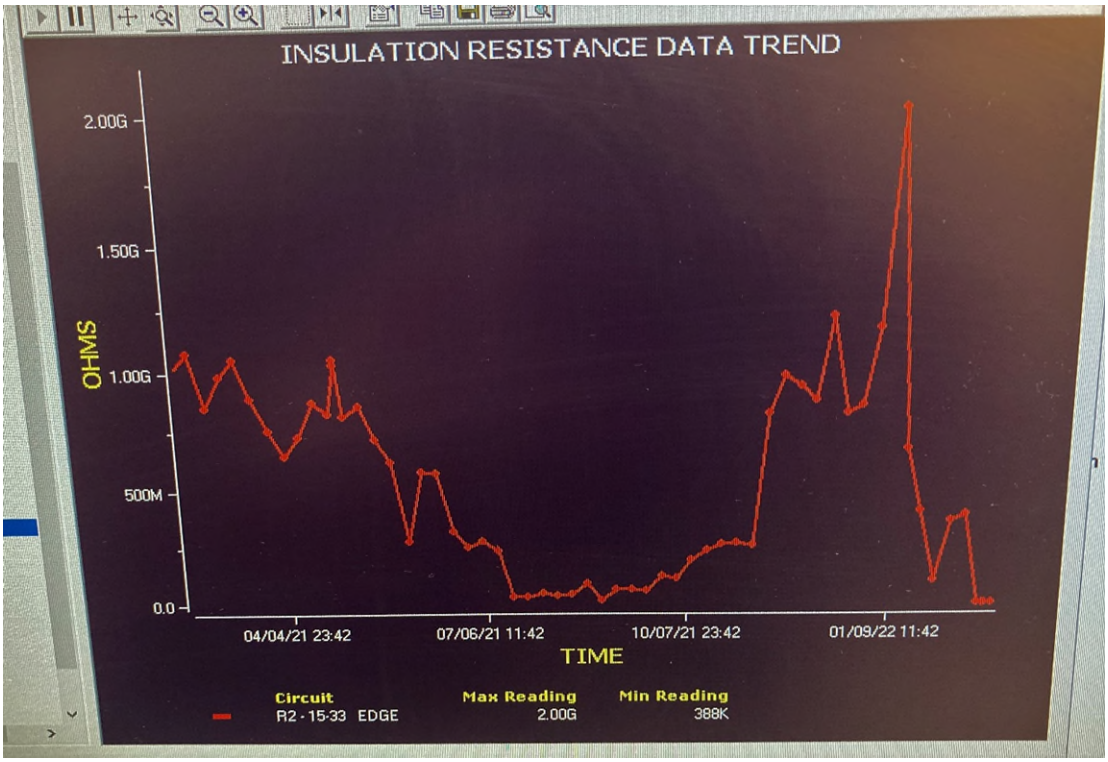

Figure 1. Example of Meg Readings

Consistent meg records can help you see trends that might indicate the type of problem you have and help you to know when to get out there and fix it. It is much easier to find a .02 meg fault than it is to find a 200 meg fault, so look for it in conditions when it tends to be bad.

When is a Meg Reading "Bad"?

AC 150 5340-26C 5.1.3.1 has excellent details describing Insulation Resistance Testing and what the results of the test might mean. It states: *"There is no ideal value for insulation resistance readings on series circuits due to factors such as circuit length, age, etc. The best rule here is to base this decision on past experience with your own facility."* It also states that*: "Generally speaking, any circuit that measures less than 1 megohm is certainly destined for rapid failure."*

There are many variables that affect the decision to make repairs based on the circuit's meg readings which may differ from one circuit to another at the same facility. Larger circuits that run at higher voltages are more likely to "blow-out" at weak insulation spots, and circuits that are in areas that are notoriously wet may be prone to more serious failures than dry areas. Drastic changes in a circuit's meg reading are often a good sign that something is going wrong. If the meg readings improve after the circuit is running on high step for a long time it may be an indication that moisture is being driven out of the wire or a transformer by the heat. Some faults will get worse after running the lights which may indicate the weak spot is deteriorating or getting hot and melting the ice around it. Of course, priority should be given to circuits of high importance such as runway circuits.

Figure 2. Meggering an airfield lighting circuit to find a fault in the field

Single bad spots such as a cracked wire, bad transformer, or a bad splice are often fairly easy to find and repair. It gets tougher to nearly impossible when there are multiple tiny faults adding up to a bad overall meg reading. Poorly sealed splices are an example of this. Every splice may leak just a tiny bit due to moisture penetration, resulting in a very low overall meg reading which has little effect on the function of the circuit. However, this extremely low meg reading might mask a more serious failure which then would cause little change in the overall reading but may lead to system failure. In this case it may be time to consider replacing the circuit, and this time pay closer attention to your splicing methods.

Consistent and regular meggering of the airfield lighting circuits is easy to do with the proper training, and only takes a few minutes per circuit each week. Unfortunately, many airports do not perform these tests and recordings consistently.

Figure 3. Insulation Resistance Test (Megger) of an airfield lighting circuit at the S1-Cut-Out

The best method for consistent meg recordings is an automated Insulation Resistance Monitoring System or IRMS, which can be set to megger and record the circuit at whatever interval you want. Larger airports with Airfield Lighting Control and Monitoring System computers (ALCMS) often have IRMS built into their computer systems. Even if your airport does not have an ALCMS computer you can purchase regulators with individual IRMS capability, and many regulators can be upgraded with IRMS equipment. Automated meggering systems will give you very consistent data and make it much easier to understand and properly maintain your airfield electrical system.

Figures 4 & 5. Two examples of automated Insulation Resistance Monitoring Systems (IRMS)