Megger

4 Things You Need to Know About Insulation Resistance Testing Above 1kV

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Insulation resistance testing is nothing new. In fact, it's been around for over 100 years. But insulation testing at higher voltages? Well, that was unheard of for years; manufacturers typically stopped at 5kV. Until, Megger developed a 10kV model to meet the new testing recommendations outlined by the IEEE. Since then, insulation testing at 5, 10, and even 15kV has become common practice for certain testing situations.

But what situations? Well, that's the first thing you need to know about insulation resistance testing above 1kV.

When should I use a 10kV or 15kV insulation tester?

Well, in early 2000, the IEEE Standards Board revised IEEE STD 43-1974 – the "IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery", and created a new Std 43-2000, emphasizing the need for upgrading current practices to accommodate changes and improvements in insulation materials and the value of higher voltage testing that reveals otherwise hidden flaws. In this new standard, they recommended using test voltages up to 10 kV for windings rated greater than 12 kV.

If you're an engineer working with high voltage equipment, then a 15 kV insulation tester might be a great option for you – providing earlier degradation detection and better fault detection. In the United States, NETA standards specify 15 kV test voltages for equipment with a maximum voltage rating of 35 kV and above or motors with 34,500 V or above nameplate voltage.

What's the point of diagnostic insulation testing?

Over time, electrical insulation naturally degrades. We'll get into that in more detail in the next section, but insulation is designed to withstand that everyday wear and tear for a certain number of years (or even decades). It's the abnormal stresses that can speed up this natural aging process and shorten your equipment's life that you really need to worry about. And for this reason, we recommend performing regular diagnostic insulation testing. With periodic testing, you can identify increased aging, pinpoint the cause, and create a plan of action to correct the problem before it results in equipment failure or downtime.

At the most basic level, diagnostic insulation testing involves performing a simple "spot test" – applying voltage to the insulation and measuring the resistance. While a spot test alone can give you valuable feedback – like pass/fail, standards conformance, or narrowing possibilities - this information is more helpful when compared to previous results. Thus, the need for regular testing. When insulation readings are recorded over time, you'll be able to identify downward trends and create a remedial action plan, when called for.

While most electricians and electrical maintenance techs are more than comfortable performing insulation tests at 500 or 1000V, it's higher voltages above 1 kV that are often unfamiliar and confusing. Thus, the need for an in-depth guide to insulation testing above 1 kV – outlining the benefits of testing at higher voltages and providing guidelines for testing and understanding results.

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However, it's these higher voltages that can give you a more complete picture of your electrical insulation's health. Take the step voltage test, for example. Good insulation is resistive, so increasing the test voltage should have no effect on the resistance. But, if there's a defect in your insulation, you'd see a deviation, as you increase the voltage. At lower test voltages, below 1 kV, it is possible that you'd never see these defects. Increasing the voltage allows you to reach a point where ionization can take places within small cracks or cavities, increasing the current and resulting in a decrease in resistance that you can actually see!

Why does insulation degrade?

There are 5 reasons why insulation typically degrades, including: electrical stress, mechanical stress, chemical attack, thermal stress, and environmental contamination. These factors tend to interact with each other, causing a downwards spiral in insulation quality. Electrical stress, often caused by overvoltages and undervoltages, is not the typical stress that insulation is designed to withstand. When faced with these abnormal voltages, insulation can crack or delaminate. Mechanical damage can take the form of physical damage, like when a cable is hit while digging a trench, or vibrational damage that may occur from frequent starts and stops or running a machine out of balance. Contamination – from chemical vapors, dirt, or oil – can all reduce the effectiveness of insulation too. When running a machine in extremely hot or cold environments, insulation can expand or contract, which could cause cracks and failures. But, even the stress of starting and stopping a machine can induce thermal stress, unless the machine is designed specifically for intermittent use.

Finally, various environmental conditions, including humidity, moisture from processes, and even attacks from squirrels, gophers, or mice, can all contribute to the degradation of your machine's insulation – causing pinholes or cracks to develop in the insulation.

Is testing at these higher voltages safe?

While our equipment is designed to keep you safe, it is essential that safe working practices are followed when in an electric test environment. However, we know that insulation testing at high voltage poses a number of unique hazards, which we have addressed in the manufacturing and design of these testers.

Probe tips and crocodile clips pose the potential danger of temporarily bridging and momentarily shorting out, causing an extremely high current to flow through the metal, melt the insulation, and potentially burn the operator. These are external dangers though, originating from the utility or the test item, but not the tester itself. High voltage insulation testers are redundantly protected from these dangers. Clips are fully insulated to protect the operator and prevent disasters, while maintaining practicality and allowing reliable connections between bus bars, wires, terminals, etc.

When testing with long cables, the risk of plugs accidentally becoming disconnected is a big concern. High voltage testers are equipped with lock plugs at the end of the instrument to reduce the likelihood for this lethal mistake. It's easy to use the lock function and it helps ensure the integrity of load discharge after a test.

If you're connecting to an upstream supply

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increased protection is required from overvoltages, since transients naturally occur. With high voltage insulation testers, clips are rated for use on CATIV 600 V or 1000V environments. These clips, molded from high dielectric strength insulating polymers, ensure safety is maintained, even under adverse conditions.

It's also a common fear that your instrument's out putting 5, 10 or even 15 kV, when in reality, it's not the voltage that's dangerous, it's current. And these testers output less than mere harmless shock currents, generally limited to a few milliamps, which is a relatively low hazard. The real danger isn't the output, but rather the surrounding environment. If you're connected to a capacitive load, it can produce a lot of energy when charged to a high voltage from the tester, which can be potentially lethal if touched. In many high voltage environments, it's not uncommon to have to climb ladders to reach connections on equipment. At this height, a seemingly harmless electrical impulse could trigger a natural reaction in the operator, which could cause a fall and serious injury. Fortunately, fully insulated clips help minimize this risk.

As mentioned, some of the safety precautions fall on the operator's shoulders (lock out/tag out). The circuit under test must be switched off, de-energized, isolated, and checked for safety before you make any insulation test connections. This is a non-negotiable, every time. You'll need to ensure that the circuit is not reenergized while the instrument is connected and remind yourself to never touch the connections during a test too.

When you're finished testing, remember to completely discharge capacitive circuits before you disconnect the leads, as capacitive charges can be extremely dangerous. With the built-in safety features of an advanced tester, along with safe working practices, high voltage insulation testing can provide early detection and advanced warning of insulation damage or failure – preventing unexpected machine failure, downtime, and high costs.

We know insulation testing above 1 kV can be unfamiliar, scary, or just plain complicated for many electrical testing professionals; that's why we created our Guide to Insulation Testing Above 1 kV. In this guide, you'll find comprehensive tutorials for setting up tests, running various test procedures, safety information, understanding test results, and more.