HIGH NOISE GROUND SYSTEM TESTING:

Testing your Grounding System In a High Electrical Noise Environment

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In The Beginning:

Mr. Engineer has a physical plant that is starting to have electrical mishaps from lightning and power line surges and he has no idea if his grounding system is operating properly. If this is sounding a lot like your house, perhaps you should read further.

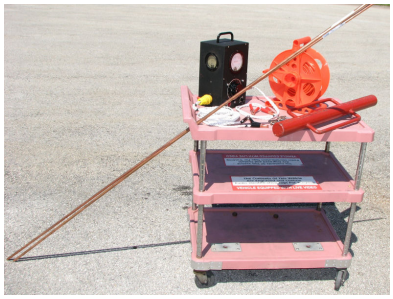

Figure 1.

In the typical physical plant in the Studio or Transmitter Site, some kind of grounding scheme has been installed. This ground scheme could be anything from a single 8 foot long rod, a gaggle of chemical type rods, or a specially designed .1 Ohm low inductance system that used to never let you down. No matter which type you have, along with the proper surge arresting for your site, when bad things start to happen for no really good reason, it is time to get out the grounding system test equipment or call your trusted Pro from Radio Works R.F. Consulting.

On first physical examination the system looks to be in good shape. Everything above ground is tight, clean and shiny. Three for three is pretty good but when the first test apparatus comes out, things go south.

The 3 point fall of resistance tester:

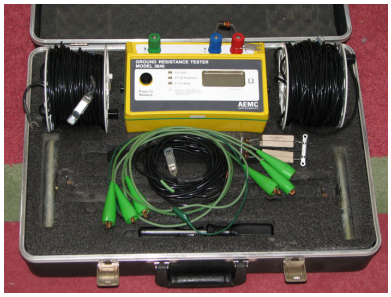

Figure 2.

This novel device utilizes 2 reference ground rods hooked to a bridge of resistors with a signal generator driving the bridge with an opposed third testing lead that gets hooked to the device or system to be tested. While usually running safe voltages, the emphasis is on ***usually*** and I do not recommend touching the third test lead or licking it while the "test" button is being pushed. Your trusty Pro hooks up this amazing gizmo from some reliable manufacturer and in the case of an older mechanical crank model, the needle starts flailing around in time to some unheard music or starts a rhythmic dance to some current that you can not identify. In the case of the newer electronic units, the Pin Ball machine equivalent of "Tilt" comes on and says "High Noise" while the digits strobe all over creation. This would be the first sign of a problem. Your Pro, being the high quality person he or she is looks at the piece of equipment, whacks it a couple of times and goes for it again with identical results. After a tightening of all connections and perhaps a change of batteries, the same defective result laughs at you and heads start to scratch.

The clamp on single point tester:

Figure 3.

This novel ammeter looking device is an all in one clamp on tool that induces an alternating current of some proprietary nature in to the wire, strap or rod it is clamped around. Through modern magic it determines the value of the resistive path of the loop of the items that you are clamped to. In this case, you are clamped around the down lead from your primary service disconnect to the first grounding point in the system. This is the only ground rod required by code. Ok, you can stop laughing now. The unit clicks and beeps wildly with similar flailing digitry and a little icon flashes madly and says again "high noise" Nervously you and your Pro start to laugh. Once again the symmetry of the clamp jaws is checked and the battery replaced with disappointingly similar results.

In today's modern vernacular, the phrase "What's Up With This" gets muttered and you are left with the testing mode from the dark ages of the 1930's and as it happens, the last resort. Your Pro says questioningly, have you had any serous lightning strikes here or has the electrical system in the plant or neighborhood changed? As you think about this and discover that sure enough, you got roasted some time ago, or the local electrical utility built a new substation across the street, the LED's begin to glow. Ok, now what? Your plant is caught in a black hole vortex of circulating currents and the neighbor is eating away at your electrical sanity but you don't know the extent of what is happening.

Here comes the answer key to your questions. First the AC clamp on ammeter. The pro now draws your system out in AutoCAD or some drafting program on a lunch bag and labels the points of interest. This is accompanied by an XL type spread sheet of these points. Ammeter readings are taken of all suspect points and interconnections. The Pro announces that in some places you are drawing as much a 3 amps of current in the ground system. As we all know, this current flow in the ground system is a huge No No, and we need to know if the ground system is still in tact before trying to get to the heart of the problem. A plan needs to be formed. The truth chart of the plan starts with the first question that asks if the current is a part of a defect in house or is it coming from the neighbor? Shutting down portions of your plant will answer this question which will spark another entire article but suffice to say, you and the Pro figure that regardless of the noise, your ground system stillneeds testing and with circulating currents like this, it might not be easy or fun. Much to your surprise it really is easy and can be fun.

High Current AC Ground System Testing:

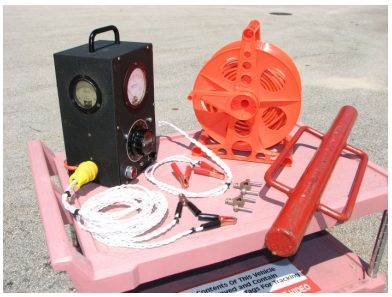

Figure 4.

Like the name suggests we could use the tester to do some itty bitty arc welding or bring earth worms to the surface for some great fishing, but this device is designed to check out your "High Noise" mis-behaving teenager. As the name implies, this device utilizes a 60 cycle AC wave at a low, safe voltage and a relatively high current when compared to other testing devices. In this case your Pro pulls out a tool that flies from 1955. This neat, black wrinkle painted box complete with olde glass face iron vane meters and a Frankenstein knob is here to save the day. While reminiscent of an olde tyme worm shocker, this is just what the doctor ordered. This is a 120 VAC plug in the wall device with a 15 Volt 8 Ampere output which is controlled by the Frankenstein knob on a small Variac which shifts the transformers input voltage. It should be mentioned that a simpler DC voltage and current source in the form of any variable "12" Volt supply could be used but the direct current is acted upon poorly by AC current flow and galvanic actions of the plant and area. There are also problems with using DC in large battery plants as there may already be improper DC circulating currents that the AC meter is impervious to. Most DC converters or supplies do not have an isolated negative lead which is dangerous or can give errant readings unless accounted for.

Figure 5.

The menacing red pilot light and fuse give comfort to the curious. The Pro positions the tester in a location that is conveniently located to the temporary Reference Ground. This Reference Ground consists of two, 8 foot copper clad rods driven full length about 7 feet apart. The tester now measures the apparent resistance between the rods. Let's say it is 10 Ohms. Mr. Ohm and Mr. Kirchhoff state that two 5 Ohm rods in series should make 10 Ohms. (sure they could be 6 and 4 Ohms or 7 and 3) These two rods are then paralleled for an equivalent resistance of 2.5 Ohms in relativity to the surrounding soils. This information is simply derived from the Voltage divided by the current as shown on the Iron Vane Meters. In this case we made 10 Volts and had 4 Amperes of current flow. The long test lead of the setup is now run to the system to be tested. We have a reference ground number that should be about 2.5 Ohms PLUS what ever the new testing point comes up with. Our new information shows us that at we made it to 15 volts and only drew 2 Amperes of current. While all the worms in the yard are coming up for a peek at what is going on, you quickly do the math in your head and realize that this part of the ground system has a resistivity of around 7.5 ohms, less the 2.5 Ohms of the reference system or 5 Ohms in the plant. Even the local Utility would agree with this method of testing.

When they hang a new transformer on a pole they take the gasoline generator on the pole truck and plug one lead in to the static ground line on the pole and the other on to the new ground rod that they just drove. When they blow a 20 Ampere fuse with this shenanigan, they feel comfortable that the new rod has a resistance of less than 6 Ohms and they go away happy. Subsequent tests of other parts of your systems anatomy reveal mathematic equivalents of 10 Ohms and higher. All signs that there may be problems brewing and this needs to be found.

The rest of the questions:

In a perfect world your system will actually only get up to 8 volts at 8 Amperes for an equivalent resistivity of 1 Ohm or you might even have numbers that are better than this.

In the realm of the problematic you really had a number rapidly approaching double digits and this signifies that you either have burned off connections, loose hardware or a ground system that is pretty well eaten away. At this point, more testing is certain. Ground system testing can be a very dangerous task. Assuming that you are running a large AC based plant and not a heavily active -48 volt battery plant core or worse, you have to be very careful what you touch, test and cautiously take apart. All safety precautions should be observed at all times.

In testing your plant you will need several devices. The AC clamp on ammeter, a DC clamp on ammeter, A multi-meter (Simpson 260 equivalent for ruggedness and low Ohmic value per volt) and of course the High Current Ground System Tester. As you go through your plant with the clamp on meters, you must note if any ground leads or conduits are passing Ac or DC current. If you find a system that is passing current, you will need to very carefully try to identify where this potential is coming from. Under no circumstances EVER disconnect a ground wire, or conduit that is hauling current. The voltages involved could be Lethal. Power down any device that seems to be generating or absorbing this current flow as corroborated by the ammeters and proceed very carefully. If you are not sure if a device has a good ground bond to the rest of the adjacent equipment, bring in the High Current Tester. You can clamp from chassis to chassis and flow all the current you want because the secondary of the tester is isolated. If you do not get a reading that is substantially below .5 calculated Ohms, check further to find out why, regardless of the current flow observed. The advantage of this particular tester is that it utilizes standard receptacle Nema 15 Ampere devices so ordinary extension cords can be test calibrated as an insertable resistance to the device and then testing of ground connections over several hundred feet can be easily and safely accomplished either to your new reference rods or from point to point in the plant. You can even go from building to building while measuring for voltage and current with the tester device. Knowledge is Power and Power is good as long as it is kept in its place.