Technical Note 064

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System Grounding and Lightning Recommendations

The following guide reviews Tucor's recommendations for grounding, including the reasoning behind grounding an irrigation system. Please note, to extend a Tucor controller's warranty to a full Five years, an Authorized Tucor Service Provider (TSP) must verify that Tucor specified grounding has been installed.

1. Specification

1.1. All Tucor controller systems must be grounded. This includes the controller itself and the 2-wire path (if used). Failure to properly ground the system can result in controller and decoder damage due to lightning, and possible harm to people nearby. Lightning damage is not covered under warranty.

1.2. **Tucor's Grounding Specification can be summarized as follows:**

1.2.1. Surge protection SP-100 shall be **installed at every line termination point**. Additional installation of Tucor SP-100's are needed per **500 feet of wire cable**, located at the nearest line decoder. The SP-100 ground wires shall be connected to a **single 8 ft ground rod**. If the valve is metallic or the solenoid valve has a metallic center pin, one SP-100 ground wire shall be connected to this. For every TWC-NV/TWI controller, a LD-400 and LD-600 contains a built-in surge arrestor, and that must be grounded.

1.2.2. The field ground resistance shall measure **50Ω or less**.

1.2.3. The ground resistance at the controller shall be **5Ω or less**.

2. Reasoning & Methodology

2.1. When lightning strikes, it quickly discharges a tremendous amount of electrical current into the earth, as when you touch a doorknob in the winter. The current – which is often compared to the flow of water – tries to dissipate itself through the earth. As the current flows through the earth, it creates a difference in voltage (electrical pressure) from one spot to the next. That voltage can be very large even across short distances. Sometimes the current will flow easier in different substances, like a wire, a pipe, or the water within the pipe. When that happens there will be a voltage difference between the pipe and the surrounding earth, or whatever may be connected to the pipe… like your sprinkler. When the voltage is too high the current will jump across the gap.This is especially true of wire in the ground. The electrical surge in the earth is transmitted easily through the 2-wire. When the surge reaches the decoder, the resulting voltage between the decoder and the solenoid is very high so it may jump across the decoder's electronics to ground itself through the solenoid. This will damage the decoder and often the solenoid.

2.2. An effective way to minimize this arcing is to "ground"[1] the 2-wire path at regular intervals**.** Due to the way lightning moves through the earth, it has been found that the installing surge protection every 500 feet or less on the 2-wire path will most always prevent spikes high enough to cause decoder damage. As the lightning's voltage wave moves down the 2-wire, it reaches the surge protector – Tucor's SP-100 – which will shunt the electrical current to ground before it's high enough to damage the decoder. The SP-100 has no effect on the 2-wire during normal operation.

2.3. Obviously, in order for the current to travel from the 2-wire, through the SP-100, then to ground means that there has to be a connection to ground. More importantly, the resistance of that connection must be low enough to allow the very high current to very quickly dissipate into the earth; otherwise, the voltage will remain high and continue to travel on down the 2-wire, damaging other decoders.

2.4. Electrical resistance is measured in units called "Ohms" (Ω). The lower the resistance, the easier current will flow. Tucor specifies that the resistance to ground of the 2-wire at the location of an SP-100 shall be **50Ω or less**. The ground resistance at the controller shall be **5Ω or less**. If either is higher, lightning protection will be ineffective. There are various tools to measure ground resistance. The only type of ground resistance devices suitable for 2-wire use are "fall of potential" testers. These use two or more small rods driven into the earth at specific distances from the grounding device being tested. (One common type you may see is a "clamp-on" ground tester. However, due to the way these work, they cannot be used on the 2-wire. As of this writing, a reasonably priced ground tester is the Extech 382252.

2.5. The specified grounding device is an 8' copper-clad grounding rod. The length is important, since it ensures an adequate surface area for the current to flow through. For ease of access and protection from damage, these may be installed in the valve box right next to the SP-100. However, in some types of soil (sandy) or unusual situations (rocks) a single ground rod may not be sufficient to adequately dissipate the lightning's electricity, so other grounding schemes may be necessary to reach the 50Ω. Alternative methods include adding ground enhancement material to the soil, adding additional ground rods, or using a ground plate. Various drawings are available from Tucor concerning grounding techniques.

2.6. Regardless of what ground is used, the resistance must be 50Ω or less in the field and 5Ω or less at the controller. Also, since the connections from the SP-100 to the ground rod may deteriorate over time, it is necessary to check the resistance at regular intervals (every two years or so).

2.7. Be aware that the resistance of the 2-wire itself to ground should be very high! The 2-wire is not connected directly grounded. Only the yellow wires from the SP-100 are grounded, so there should be no electrical continuity from the blue wires of the SP-100 to the yellow wires.

2.8. Some Tucor decoders have a built-in SP-100. These are the LD-400 and LD-600, used on TWC-NV controllers. The decoder's SP does not have to be used just because it's there, but the added protection is certainly worth the minimal cost of a ground rod.

[1] The 2-wire is not directly grounded. It is connected to ground through a "spark gap".

2.9. When lighting hits it may arc across the solenoids as described above. Sometimes damage to it is not obvious. The solenoid is made up of a small coil of wire. When the electricity arcs across the solenoid it might short out just a few of these turns of wire. The coil will still conduct electricity (that is sent from the decoder) and it will still pull in the valve, but the current will be very high. For example, most solenoids draw about 25 ma (milliamps) from the decoder. A shorted solenoid may pull 100 ma or more. You may think the valve is still working, but when you try to run a number of valves simultaneously the system will fail ("short circuit"). Further, high solenoid current will shorten the life of a decoder. The condition of valves may be verified as follows:

2.9.1. TWC / NV: put the controller into Line Survey and run Test of Line Decoders. Observe the increase in current (from idle current) as the valves turn on. It should be consistent among valve types. See Tech Note 41.

2.9.2. RKD / RKS: Put the controller into Line Survey and run the Test Program. If the valve types are the same the current should increase by the same amount. Alternatively, run the Station Test.

2.9.3. Procom: Run the Decoder Test and note the holding current. (Setup > Installation Data > Test > Manual Test > Line Dec.) The solenoid's current would be the holding minus the idle.

2.10. As a rule, if you replace a decoder due to lightning damage, it is best to replace the solenoid also.