Protecting your irrigation system from lightning

by Dana Blakeslee

Any number of golf-course superintendents can attest that disaster strikes in the blink of an eye-or, more specifically, in a flash of lightning. An age-old enemy of nearly every aspect of golf, lightning sends shivers down the spine of every superintendent. Nowhere is this more apparent than with irrigation systems.

Irrigation systems help maintain the quality of turf-and therefore the quality of play-on golf courses across the country. Highly advanced irrigation systems are at the heart of the most attractive courses. While these systems incorporate new technology and enable centralized overall irrigation control, the ever-present threat of lightning damage becomes not only an economic issue, but also a competitive one.

Acting as an antenna or network, on which surges of electricity travel with little resistance, an irrigation system's wiring-not unlike office or home-equipment wiring-is susceptible to lightning-based surges. The costly repairs and loss of productivity associated with surge damage to an office's computer network also applies to golf courses when lightning strikes. In addition to repairs to the management system, satellite controllers or the pump station, surge damage affects turf quality by interrupting finely tuned watering schedules. Though it is unusual for lightning to knock out an entire system, even small repairs are a setback for courses competing to attract a finite number of players. For this reason, several lightning countermeasures are available to protect your irrigation systems and your course's competitive edge.

Voltage-limiting devices Voltage-limiting devices, commonly known as "surge suppressors" or "lightning arrestors," are the most widely used lightning-protection mechanisms. Integrated into the equipment wiring, these devices channel dangerous surges away from exposed electronic components to an earth ground where they harmlessly dissipate.

Present in the majority of sensitive electronic equipment to protect against all types of surges, these devices appear as an "open" circuit-until a surge enters the wire. This open circuit changes to a conducting path and diverts the surge to an external ground when it (the surge) exceeds a predetermined voltage level. Proper grounding is the most important aspect of voltage limitation. You must test the ground on a regular basis to see if it is functioning properly and offering proper protection.

Two types of limiting devices-metal-oxide varistors (MOVs) and spark-gap arrestors-comprise many conventional lightning-protection systems. Combined, these devices address the speed at which lightning surges reach their peak current on the wire as well as the magnitude of large lightning strikes.

Research shows that lightning surges reach their peak current within the first few milliseconds of a strike. Therefore, lightning's most destructive period often occurs before limiting devices can react. MOVs, however, react quickly to clamp the initial energy spike when it exceeds a safe level and shunt the excessive energy away from vulnerable circuit components.

When particularly intense lightning (30 million volts or more) strikes, the surge of current onto your system wiring is too much for a MOV to handle. In this situation, spark-gap arrestors, though slower to react to lightning surges, respond to the massive energy surge. Large current surges break down an inert gas in the spark-gap arrestor's tube, channeling excess current flow toward the ground-rather than the electronic components.

Shortcomings Varistors and spark-gap arrestors, used in tandem with a good grounding system, provide remarkable protection from fast-moving energy spikes and massive energy surges once they enter the system wiring. However, these countermeasures have several shortcomings. The case against their conventional protection includes the following complaints:

* They don't offer any protection until a voltage surge is literally in the wiring connected to your equipment. * They have a finite life span. They will work for a specific number and level of surges, then their effectiveness diminishes or they cease to function. * They provide lightning (in certain situations) an electrical path to enter and damage equipment.

According to Dan Young, president of Rabun Labs Inc. (Plant City, Fla.), conventional protection devices can pass a dangerous voltage surge, known as "low-side" surge, from the grounding wire into electronic components. This surge comes from lightning striking the earth near the area used to ground an electrical system. The energy from the lightning dissipates into the earth and becomes electrically connected to equipment, depending on how well the ground is connected. At this point, the surge runs back toward the protection device and passes into the equipment.

Isolation Ironically, the system that protects against the widest range of lightning-related problems is perhaps the most obvious one-isolation. Unplugging a piece of equipment is a sure way to avoid lightning damage.

While disconnecting a piece of equipment from outside seems simple enough, almost anyone will agree that unplugging every piece of equipment each time there is a threat of lightning is unrealistic. Moreover, even if it were realistic, irrigation systems are far too complex to simply unplug. Today's modern systems feature active-disconnect technology that takes the place of manual disconnection.

Active protection Compared to the "passive" protection of conventional surge-limiting devices that react once lightning is actually on the system wire, "active" protection responds to the threat of lightning. Active technology literally isolates the irrigation system from outside power before the lightning surge enters the wiring system. Divided into three separate units, protect the main areas of an irrigation system (management-control system, satellite controllers and pump-station equipment), these units disconnect each area during the threat of lightning. Each unit reacts to a lightning threat by automatically disconnecting and isolating the AC power, field wiring or weather-station and telephone lines. Additionally, when a storm subsides and the threat diminishes, the system automatically restores all power connections to the equipment and proper function resumes.

Generally located in a building (such as your office building), the system-control box communicates via a remote detection unit (RDU) that senses lightning's radio energy and connection relays. It then physically disconnects the equipment when it detects a lightning threat. Sensing radio energy (distinct from man-made frequencies) as far away as 2 miles, the RDU's remote distance of 500 feet allows for convenient location in areas free of interference from power lines or debris. To protect your equipment, you place disconnect relays in series with the power lines leading to your management-control system, satellite controllers and pump station.

Tri-disconnection begins by alerting the control system and disconnecting each unit if the radio energy received by the remote unit matches the lightning profile. In other words, switching circuits at each relay connection immediately disconnect the equipment from AC power. Complete isolation for satellite controllers, however, includes the two-wire path still connected to the satellites. The satellite-controller unit isolates the field wiring when it senses that the AC input to the satellite disconnects at the source or when a storm causes the loss of commercial power. This option disengages the inputs of each satellite and outputs from all outside power sources until the storm moves safely away.

You accomplish pump-station protection in much the same way as you do the irrigation-management-control system and field-satellite controllers-by electrically isolating the pump motor and controllers. However, when the system detects lightning, it signals the pump controller to shutdown the pumps, and it leaves the satellites on for approximately 30 seconds to relieve pressure before they are disconnected.

Shunting, grounding and reconnecting A common concern with any isolation technology is the possibility of lightning "jumping" the switching contacts that perform the various disconnect functions. To protect against the possibility of surges jumping onto the wiring, active-protection technology also utilizes shunting action and grounding to ensure that a surge of energy on the wiring diverts away from the equipment. By shunting and grounding these inputs away from the system's equipment, surges cannot jump the disconnection.

To understand "shunting," imagine an AC power plug that has all three prongs-hot, neutral, ground-connected together. When a dangerous surge moves onto a shunted wire, with all three legs at the same ground potential, it follows the ground because electrical energy always follows the path of least resistance. Again, the ultimate success of this technology relies on proper grounding function. You must check grounds on a regular basis to ensure proper function. The disconnect-cycle timer on the system remains in the disconnect mode for a minimum of 6 minutes after the last detected lightning strike. By staying disconnected for this amount of time, the system not only isolates equipment from AC power surges but also prevents short circuiting in motors and powering-up of equipment when the possibility of a lightning strike still exists. When the threat of damage passes, the system automatically reconnects the relay points, reintroduces AC power and normal operations resume.

The bottom line Various factors play a role in decisions concerning lightning countermeasures. However, the rationale for your decisions remains the same-preservation of your irrigation system. Budget, location, experience and personal preference cause every decision-maker to rely on the type of lightning protection with which he or she feels most comfortable.

Despite advances in lightning protection, there is no complete defense against lightning damage. A direct hit from a bolt of lightning makes every protection system look the same-inadequate. The use of new and existing technology to reduce lightning damage is a measured investment by anyone's standard. However, few superintendents with a (lightning-induced) useless central-management computer or a melted circuit box take this standard lightly.

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