
# New Grounding System Ensures Radio Broadcast Stations Remain on the Air

The Marc Radio Group is headquartered in Gainesville, Florida. The group's seven stations, including its consolidated studio operations, have frequently suffered innumerable lightning strikes and power surges.

"When the storm season comes to Florida, lightning hits would take out our stations' equipment regularly," said Frank Garcia, the former chief information officer of the MARC Radio Group. "We would have outages almost every other week. We would have listeners tuning to other stations, and we'd have to work hard to get them back. It was a nightmare."

Fed up with the stations going dark all the time and doling out thousands of dollars to fix the damages, Garcia searched for a solution. In 2015 Garcia contacted Power & Systems Innovations of Tampa Inc. in Florida for help. John West Sr. is a well-known consultant in Central Florida with a reputation for rectifying electrical problems at broadcast, telecommunications and computer-based facilities.

Shortly after the call, West began his work at MARC Radio's central building **(Figure 1)**. From this location, the signals carry the programming for the group's AM and FM stations


**FIGURE 1.**

MARC Radio Group headquarters in Gainesville, Florida. From here, the programming is transmitted to its seven AM and FM station sites.

to four remote transmitter sites that carry the respective programming. West prioritized the problems and set up stages of work to address them. The work is now complete: the proper re-bonding of all equipment to newly installed ground paths.



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## Powering the Facility

One of the biggest mistakes made when circuiting a facility is mixing loads. At this particular building, West found a panel that contained feeds to the parking lot lights, which can bring lightning back into the panel; the main fire alarms; an air-conditioning compressor; and the elevator loads. According to West, such loads are very inductive and should not be on the same panel as the fire alarms.

"The alarms should have been isolated," West said. "Combining these loads was done to save money; but, in the long run, it will cost the end-user much more. That's poor economics."

To fix this, West moved the fire alarms and the parking lot lights to separate panels. The air-conditioning and elevators remain on a separate panel and a surge protection was installed on each. West recommends a surge protector be included on any panel that serves sensitive equipment. Originally, the surge protection was mounted two floors away from the main panel, rendering it nearly useless **(Figure 2)**.


**FIGURE 2.**

Separate panels now serve MARC Radio's control room, parking lot lights, elevator loads, and one for fire alarm and air-conditioning. West says that a surge protector should be on every panel that serves any equipment you care a lot about.

Panel SPD's are installed on the feed end of the panel, as close as possible to the neutral bar so the lead length is kept short (Figure 2). Properly installed, SPD form layers of protection. The lowest resistance and impedance path to utility neutral and ground is the service entrance. That is where the most robust (highest kA rating) unit would be installed.

"My preference is to mount the first SPD ahead of the means of disconnect (main breaker or disconnect), that is where you spend the money for a good one. The further you go into the building's electrical system (wire length) the lower the kA rating of the SPD, never dropping below 40-50 kA," said West.

"Each panel needs surge protection to be sized and connected properly. It must be proximate to the circuit being protected. The farther away it is, the less effective it is," West said. "The main power panel requires the most robust surge protector."

West explains that surge protectors shunt excessive voltages to neutral and/or ground, typically both. "You must use an appropriately sized conductor for that connection; otherwise, it's like flushing a toilet that has too small a drainpipe," he said. "The result is not pretty." Using an undersized conductor dooms a surge protector to failure. West uses nothing less than 4/0 stranded copper.

"Understand, surge protection, alone, does not protect against the danger of mixed loads," he added. "Surge protectors are not power-quality devices; they only protect against power surges. You can't solve a five-dollar problem with a nickel solution."

## Grounding the Power Sources

This facility has a standby generator with an automatic transfer switch. The ground is not made at the generator; rather, it is made at the transfer switch. If the generator were the main power source, then the connection would be made right at the generator. Otherwise, you create a difference in the ground potential that could destroy equipment.

At MARC headquarters, there are two other services coming into the building – one for telecommunications and one for cable. The telecommunication lines are protected by gas tube arrestors, as required by the FCC. Here, the mistake found was that both the gas tube arrestors and the cable line were bonded to the same ground bar.

"They should be home runs directly to the ground source," West said. "Otherwise, a surge coming in on the telco line would transfer to the cable shield affecting its associated equipment."

Using an undersized conductor for neutral and ground prevents the SPD from functioning properly. For grounding nothing smaller than a 4/0 should be used, but in a large facility with 250mcm feeding a panel, then the neutral and ground should be 250 mcm.

## The Ground Field

When West inspected the headquarters, he found the grounding to be inadequate; it had very high resistance – in excess of 200 ohms. To correct the issue, a new ground field installed outside was brought into the building on about 400 feet of 4/0 stranded copper and connected to the two main disconnects. West used an insulated ground cable where it went through the walls and above the ceilings in order to not cause any interaction between ground currents and the building steel.

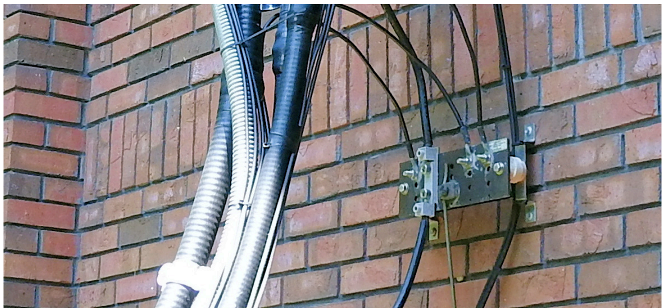

**FIGURE 3.**

West used an insulated ground cable through the facility's walls and ceilings in order to not cause any interaction between ground currents and the building steel. The original grounding cables outside were inadequate, so they were replaced with 4/0 stranded copper conductors and attached them to a new ground bar.

A new outside system benefited from the site's location and grounded the Andrew's Lighting Arrestors on the coaxial transmission line and the base of the transmission tower **(Figure 4)** to a nearby retention pond, thus, greatly lowering the ground resistance. However, the original grounding cables were inadequate, so they were replaced by 4/0 stranded copper conductors and attached to a new ground bar. **(Figure 3)**

The tower and the retention pond each have three ground rods connected by exothermic welds to 4/0 stranded copper. The rods at the tower are driven down 70 feet and are about 70 feet apart. The 50-foot rods in the retention pond are about 50-feet apart.

**FIGURE 4.**

An exothermic weld joins the 4/0 copper ground cable to the base of the transmission tower.

**FIGURE 5.**

Several racks of equipment populate the control room. Each chassis ground and the racks, themselves, must be bonded to a common ground path that's dedicated to the transformer and UPS unit powering the sensitive equipment loads.

**FIGURE 6.**

One of the several broadcast studios at the MARC Radio Group headquarters.

## The Main Equipment Room

Because of the tremendous amount of electronics, along with the confluence of multiple outside services and its location in the heart of lightning country, the biggest concerns West discovered were the problematic paths of destruction that could take down all of the equipment. West's challenge was to maintain power quality, power consistency and to prevent any of the outside wires from bringing in anything that could interrupt operations or damage equipment.

The main equipment room **(Figure 5)** is where all the telecommunications signals come in and where the programming is routed to the individual stations via microwave and T-1 lines. It is the heart and soul of the operation, a combination of Internet technology and control room. All the information from the many studios in this building **(Figure 6)**, as well as from myriad Internet sources, are processed here.

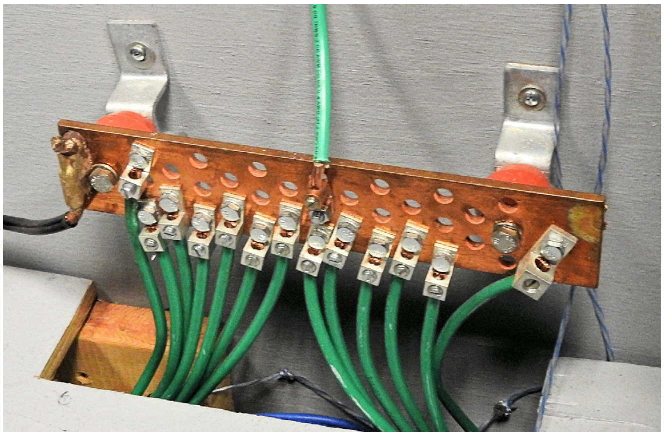

**FIGURE 7.**

This newly installed ground bar connects the metal racks and the chassis grounds of all the sensitive equipment they hold. West is replacing all the solid ground wires with 4/0 stranded copper wires or larger (as shown here), because he wants to take advantage of the skin effect from the surfaces of multiple conductors to accommodate the high-frequency content of lightning energy.

"If this room doesn't work, they're out of business," West said. "All the processing equipment must be at equal ground potential in order to function properly and reliably."

To ensure that, West installed a ground bar **(Figure 7)** that connects all the ground conductors from every chassis. From there, the ground bar is connected to a second ground bar dedicated to a ground path for all the sensitive equipment.

## Isolating the Power Sources

There are two sources of power in the control room. One is for lighting and other non-sensitive circuits. The second is for critical equipment. It's fed through a step-down transformer to a UPS system and then on to all the sensitive equipment. Should there be a power interruption, the UPS kicks in to keep the critical equipment operating and on the air **(Figure 8)**.

West said it's important that these two power sources be treated separately. Everything on each power source must be bonded to the source's ground. "When we inspected the facility, we found elements of both power sources bonded to a common ground path," he said.  "You can't have more than one ground reference **(Figure 9)**. Therefore, everything powered through the transformer and UPS must be bonded to the transformer's ground. Everything not powered through the transformer must be bonded to the regular utility ground path."

The facility has several coaxial cables coming in. Their shields were also bonded to a common ground. "You shouldn't do that," West said. "You should run a separate ground path for each coax shield, so you don't risk destroying your sensitive equipment with a lightning surge that wants to find the path of least resistance. When you combine ground paths, you create a low impedance situation that would transmit the energy to all the other connections."

Aside from the coax, the same principle pertains to modems, telephone lines and the like. They each need a home run path to ground to avoid what he terms "cross contamination."

**FIGURE 8.**

A second power source is for the critical equipment in the control room. It's fed through a step-down transformer to a UPS system and then on to all the sensitive equipment. Should there be a power interruption, the UPS kicks in to keep the critical equipment operating and on the air.

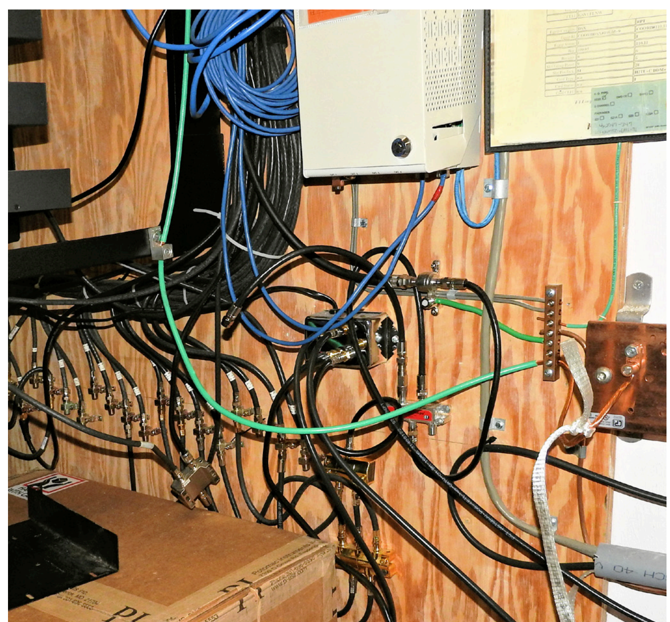

**FIGURE 9.**

West found this ground bar in the main equipment control room. Unfortunately, elements from two different power sources have been combined. West says, "You can't have more than one ground reference." Separate ground paths will be provided for coax, modems, telephone lines, non-sensitive power and the sensitive equipment power; all paths will be "down & out."

## When All is Said and Done

"When we're finished, we'll have exorcised the electrical demons that have been confounding this place," West said. "We'll have all new, correctly bonded ground paths using properly sized stranded copper conductors tied to a vastly improved ground field. And, we'll have appropriately segregated the electrical panels with correctly sized and placed surge protection."

MARC Radio's consulting broadcast engineer, Mark Schmucker, summed it up succinctly: "I believe that, for any broadcast or telecommunication facility, any investment you make in proper bonding and grounding is well worth the money spent."

Frank Garcia agreed, "The investment in bonding and grounding is more than paying for itself. Moreover, we're ensuring the safety of our valued employees."

**John N. West Sr.** is president of Power & Systems Innovations of Tampa, Inc. (PSI), Hernando Beach, Florida. Its focus is sustainable electrical systems that will perform for years to come: grounding, bonding, surge protection and lightning protection, including all aspects of power quality. PSI provides onsite consulting services. In addition, the company designs, installs and services a broad range of protection equipment and systems. For further information about PSI call 407-832-9018 or email JWest@PSITampa.com.

**Mark Schmucker,** Consulting Broadcast Engineer, MARC Radio Group, LLC, Gainesville, Florida. His responsibilities encompass maintenance of all the group's transmitter sites and broadcast facilities, including electrical, telephone, broadband, microwave, automation, computer and satellite downlink systems, along with IT services for office operations. Since 1972, Mark has provided similar services to other broadcast companies in North Florida markets. You can reach him at mschmucker@marcradio.com.

**Frank Garcia** was chief information officer of the MARC Radio Group, at the time of this writing, with offices in Winter Park, Florida. He oversaw the management and operations of the company's seven AM and FM stations in the greater Gainesville area. One of his prime concerns was growing and sustaining profitability. The sound functioning of its broadcast facilities has been a major aim, now being realized by renewed attention to fundamental engineering.

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