# Explanation of Stray Voltage and Mitigation Possibilities

Getting Shocked on your Pool Deck?

It is possible the shock is coming from stray voltage. This article contains a brief and simple explanation of stray voltage and equipotential bonding planes around swimming pools & spas, and their decks, in "ordinary" terms. This article also covers the changes to the National Electrical Code and how it affects the pool owner's safety. At the end of the article are remedial options that have been suggested by those in the industry, to mitigate the effects of stray voltage if your deck was built without protection from stray voltage.

Stray Voltage exists in the ground throughout the USA. Stray voltage emanates from multiple power sources, i.e. cut/nicked underground transmission lines, pad mount transformer leakage and faulty overhead to underground drops to name a few. Stray voltage travels along a path of least resistance and gravitates more quickly to wet/moist conductive areas.

If a pond is on the property and stray voltage is present, it will enter the pond rather than the dry ground, just like a swimming pool. Fiberglass or Vinyl Liner Pools are constructed with pre-insulated non-metallic shells through which stray voltage cannot pass, and harmlessly continues on a path of least resistance to ground. Whereby a concrete, (poured concrete, shotcrete, gunite, etc.) pool shell is conductive, the stray voltage will enter the pool just as it would a pond. However, because almost all concrete type shells are reinforced with rebar, the rebar cage creates an "Equipotential Bonding Plane" and helps to equalize, dissipate or minimize the voltage across the plane. Any individuals in the pool or on the deck become part of the equipotential plane helping to diminish the effects of the stray voltage. In most cases it will not even be felt by the persons.

The deck around the pool exists to allow swimmers to enter and exit the pool without encountering dirt & mud. It is specifically designed to be a safe wet pedestrian surface. Wet concrete is more conductive than dry concrete, and therefore will attract concentrated stray voltage. In years past this was never an issue because builders placed rebar in the deck to prevent cracking. This rebar extended the equipotential bonding plane from the pool shell to the deck area and provided protection from stray voltage as well.

Sometime prior to 2005, builders began using fiber reinforced concrete which is stronger than regular concrete and does not need rebar reinforcing. This saves about $500/deck and works well, EXCEPT that by removing the rebar, the metallic grid creating the equipotential bonding plane is also removed, and the deck left unprotected from stray voltage. The potential for serious injury and death has been proven by national testing laboratories, when a grid is not installed in the deck. (see NEETRAC Test, EPRI Test, ENEREX Report)

Because of this new installation practice of eliminating rebar in decks, in 2005, the National Fire Protection Association (NFPA) changed the National Electrical Code (NEC) and required a copper grid to be installed in the deck, if no rebar is used. The installed cost is about the same, but the copper grid is much faster than laying rebar and chairing it up to comply with the IBC, so it is fully encapsulated by the concrete. The copper grid also works to protect Paver decks and does not corrode in the sand. Both rebar and copper grids provide conclusive protection helping mitigate stray voltage.

The Pool Lobby objected. They wanted the cost savings and felt any grid was unnecessary, and therefore successfully had this requirement removed from the NEC. This was an unprecedented move by the NFPA to reduce the level of safety without ANY testing or justification whatsoever! Code Making Panel 17 (CMP17), the 10 member panel responsible for that section of the Code, voted to eliminate the equipotential copper grid and allowed an "Alternate Means" of a single copper wire, installed 18 inches from the pool. This 2008 NEC change was proven ineffective, by testing from organizations like NEETRAC and EPRI. CMP17 and the Electrical Standard's Council refused to reinstate the proven level of safety, stating that each Inspection Jurisdiction had the authority unilaterally to require the grid. CMP17 states that the NEC is only a minimum level of safety/protection and the NFPA accepts no liability as it is the "Authority Having Jurisdiction" (local municipality or state) that is responsible or liable concerning Public Safety. However, most Building/Electrical Inspection Departments simply adhere to the NEC. Fortunately, many jurisdictions nationwide have refused to lower the level of safety, and continue to enforce the 2005 version of the NEC.

One interesting issue is that CMP17 still requires a grid of rebar or copper around the shell of the pool. This creates a logical error that the Technical Correlating Committee of the NEC refuses to address. The question is raised that if a single wire can protect an entire pool deck, why isn't it sufficient for the shell? Some people conclude that the CMP17 knows the single wire will not provide adequate protection, but the desire to allow builders to save money, overrides safety as it relates to pool decks and the perimeter surfaces.

Another interesting issue is that Article 547 of the NEC requires a grid of rebar or copper in the deck/floor of Agricultural buildings such as dairy barns. This means livestock are afforded a higher level of safety than humans.

If "Special Interests" influence the Code Making Panel to pass something considered unsafe by another member of the NFPA, and that Member feels the panel is being coerced by money and or industry pressure, that NFPA Member can make a motion and let the entire "NFPA Member Body" vote on reinstatement. This is the final "Check and Balance" against Special Interests on the Code Making Panel. This actually happened in 2010 during the final development stages of the 2011 version of the NEC. The NEC is revised every 3 years. The members in the "Electrical Section" of the NFPA overwhelmingly voted to support a motion to reinstate the 2005 requirement of a rebar or copper grid extending equipotential protection to the pool deck. The Edison Electric Institute unanimously voted to reinstate the grid. Top experts from the Utility Industry wrote letters strongly urging the requirement for the grid in the deck. At the Annual Meeting the entire NFPA body voted almost unanimously to reinstate the requirement of the rebar or copper grid in the pool deck. The final motion voted on at the Annual Meeting was to accept the "Codes as Amended" and adjourn. Amendment motion was passed and the requirement for the grid in pool decks was reinstated. It turns out this is not true!

Because of what some declare as flawed parliamentary procedures, the same Code Making Panel gets to veto the will of the entire NFPA membership body. CMP17 did in fact vote to overturn the motion passed by the membership. In the opinion of many, this results in NO "Checks and Balances" against "Special Interests" on the Code Making Panels.

Efforts with Legislators and other industry experts, are underway currently to reinstate the requirement for a rebar or copper grid in the pool deck.

**Methods to Mitigate Effects of Stray Voltage on the Pool Deck that have been Suggested by those in the Industry:**

CMI makes no statement or guarantee of results in the following reported suggestions. It is only reported from those in the industry, and are topics of conversation to have with the proper licensed professionals.

The best suggestion is to contact a reputable Licensed Pool Builder, a Licensed Electrician familiar with wiring, grounding, and bonding of swimming pools, the local Electrical Utility, and the local Electrical Inspector that is familiar with swimming pools and spas. There usually is at least one Inspector in every department that somewhat specializes in pools and spas. Having everyone involved meet at the site is the best way to begin a resolution.

One option they may recommend is to replace the deck installing a grid of either rebar chaired up to encapsulate in the concrete, or copper wire under the new concrete deck. For a paver deck, sand can be placed and a copper grid laid on top so that it sits flush with the top of the sand, then pavers can be laid. Either instance, a bond wire or wires need to be connected to the metallic grid, then run back to the pump motor and bonded to it.

Another option they may recommend is to drive a sufficient number of ground rods directly underneath the deck as horizontally as possible, bonding them all together, and running the bond wire back to the pump motor. Also more rings of copper wire can be installed around the outside of the deck, all bonded together to create as much of a "grid" configuration as possible. The Electrician, the Utility Company, and the Electrical Inspector can elaborate more on this option, as it relates to the individual circumstance.

It has been reported that these two methods have been successfully used in the past to mitigate the effects of stray voltage. Obviously, they are much more expensive than installing it during the construction phase. Ensure proper testing is conducted by licensed professionals to conclude the environment has been deemed safe.