How to Verify That a Pool is Safe from Electric Shock – In Accordance with the National Electrical Code®

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Caution: This document is written to be used by a qualified licensed electrician, who understands safe work practices. The instructions contained in this document specify that all power is to be turned off prior to removing any covers.

Before you start the process to verify that a swimming pool is safe, you must first understand electrical fundamentals, ground resistance, the concept of neutral-to-earth voltage, and the National Electrical Code equipotential bonding requirements for pools. This is accomplished by watching the following four videos.

- No. 1 Electrical Fundamentals - http://www.youtube.com/embed/mpgAVE4UwFw
- No. 2 Ground Resistance - http://www.youtube.com/embed/Yg6G5VUSsWA
- No. 3 Neutral-to-Earth Voltage - https://www.youtube.com/embed/pAs_FmdxXhQ
- No. 4 NEC Equipotential Bonding - https://www.youtube.com/embed/wyOILpoR39A

Finally, you need to download my digital book on Swimming pools.
http://www.mikeholt.com/download.php?file=PDF/Swimming_Pools_Spas_2017NEC.pdf

Part 1 – Ensuring that the electrical installation follows the National Electrical Code. Turn off power to all equipment, then remove the covers from all equipment (service disconnect, panels, time clocks, pool light transformers, pool light junction boxes, switch boxes, pool motors, heat pump motors, and so on) related to the pool system in any way.

Step 1. Electrical Service – Inspect service equipment to ensure it's in compliance with the *National Electrical Code*:

- Ensure that all circuit conductors are sized for the loads.
- Ensure that each circuit has proper overcurrent protection.
- Ensure that each conductor terminates on a single terminal, except the equipment grounding conductor.
- Torque all terminals to 90% of the manufacturer's recommendations in accordance with NFPA 70B.
- Ensure that the neutral conductor is bonded to service equipment with a main bonding jumper.
- Ensure that the covers for service equipment are installed and they fit properly.
- Ensure that the service is grounded in accordance with the NEC, typically a ground rod.
- Verify that the wiring methods were installed in accordance with the NEC, such as strapping and connectors.

Step 2. Pool Equipment Panel - Inspect the pool equipment panel to ensure it's in compliance with the *National Electrical Code*:

- Ensure that all circuit conductors are sized for the loads.
- Ensure that each circuit has proper overcurrent protection.
- Ensure that each conductor terminates on a single terminal, except the equipment grounding conductor.
- Torque all terminals to 90% of the manufacturer's recommendations.
- Ensure that an equipment grounding conductor, of the wire type, has been run with the feeder conductors to the pool equipment panel.
- Ensure that an equipment grounding conductor, of the wire type, has been run with all circuits to pool equipment.
- Ensure that the equipment grounding conductor for the feeder and branch circuits are sized in accordance with the NEC.
- Ensure that the neutral conductor does not contact the equipment grounding conductor except at the service equipment.
- Ensure that the cover for the pool equipment panel is installed and fits properly.
- Ensure that the voltage to the pool light doesn't exceed 15V.
- Verify that the wiring methods were installed in accordance with the NEC, such as strapping and connectors.

Step 3. Pool Equipment - Inspect pool equipment to ensure it's in compliance with the *National Electrical Code*:

- Ensure that all circuit conductors are sized for the loads.
- Ensure that each circuit has proper overcurrent protection.
- Ensure that each conductor terminates on a single terminal.
- Torque all terminals to 90% of the manufacturer's recommendations.
- Ensure that an equipment grounding conductor, of the wire type, has been run with all circuits to pool equipment.
- Ensure that the equipment grounding conductor is sized in accordance with the NEC.
- Ensure that the cover for pool equipment is installed and fits properly.
- Ensure that the voltage to the pool light(s) doesn't exceed 15V.
- Verify that the wiring methods were installed in accordance with the NEC, such as strapping and connectors.

Part 2 - Ensure that the metal parts of pool equipment are connected to an effective ground-fault current path (Equipment Grounding Conductor). Verify that all pool equipment, such as such metal parts of pool motor, heat pump, salt chlorinator, pool panel, pool junction box, and pool light are connected to an effective ground-fault current path in accordance with the NEC.

Watch No. 1 Electrical Fundamentals http://www.youtube.com/embed/mpgAVE4UwFw

Step 1. Turn off Power. Turn off power to the pool equipment panelboard and all pool equipment.

Step 2. Remove Bond Wires. Remove the 8 AWG bonding conductor from all pool equipment, such as pool motor, heat pump, the salt chlorinator, pool junction box and pool light. The reason to remove the bond wires is to ensure that we are only measuring the effective ground-fault current path (equipment grounding conductor) from the service to each piece of equipment.

Step 3. Measure Resistance. Measure the resistance between the service equipment and pool motor, heat pump, salt chlorinator, pool junction box, and pool light. You will need about 100' of 18 AWG conductor to accomplish this task.

Set an analog ohmmeter to the lowest resistance setting, then measure the resistance of the ohmmeter leads. If you use 18 AWG, the resistance of the leads should be about one ohm. Recalibrate the analog ohm meter (turn the dials) so that the resistance value shown of the leads will be zero ohms.

Now terminate one lead of an analog ohmmeter to the intersystem bonding terminal, the grounding electrode conductor, or the ground bar within service disconnect, then touch the other lead to the metal parts of pool motor, heat pump, salt chlorinator, pool panel, pool junction box, and pool light.

If the measured resistance is one ohm or less, then this means that the equipment is properly connected to an effective ground fault current path. If it exceeds one ohm, then you must investigate why the reading is greater than one ohm, and you must correct this issue immediately, or you must ensure that this equipment is not powered when you leave the premises.

Note: I suggest using an analog multimeter such as a MF500 Analog Multimeter; it costs about $30 on Amazon. Why an analog and not digital meter? My experience is that a digital multimeter will NOT give you the correct value as an analog multimeter does under every condition, the auto range setting of a digital multimeter can add confusion, and I like to "see" the needle move on the meter to the expected value.

Part 3 - Ensure that all metal parts are properly bonded. Verify that metal parts of pool motor, heat pump, salt chlorinator, pool panel, pool junction box, pool light, hand rails, ladders, and other metal parts within five feet of pool water are bonded together in accordance with the NEC.

Watch No. 4 NEC Equipotential Bonding https://www.youtube.com/embed/wyOILpoR39A

Step 1. Turn Off Power. Turn off power to the pool equipment panelboard and all pool equipment.

Step 2. Attach Bond Wires. Attach the 8 AWG bonding conductor to all pool equipment, such as pool motor, heat pump, the salt chlorinator, pool junction box, pool light, hand rails, ladders, and other metal parts within five feet of pool water.

Step 3. Measure Bonding Resistance. Measure the resistance between the service equipment and pool motor, heat pump, salt chlorinator, pool junction box, pool light, hand rails, ladders, and any parts within five feet of the pool water. You will need about 100' of 18 AWG conductor to accomplish this task.

Set the ohmmeter to the lowest resistance setting, then measure the resistance of the ohm meter leads. If you use 18 AWG, the resistance of the leads should be about one ohm. Recalibrate the analog ohmmeter (turn the dials) so that the resistance value shown of the leads will be zero ohms.

Now terminate one lead of an analog ohmmeter to the intersystem bonding terminal, the grounding electrode conductor, or the ground bar within service disconnect, then contact the other lead to the metal parts of pool motor, heat pump, salt chlorinator, pool junction box, pool light, hand rails, ladders, and any parts within five feet of the pool water.

If the resistance between service equipment and the measured metal part is one ohm or less, then this means that the equipment is properly bonded. If it exceeds one ohm, then you must investigate why the reading is greater than one ohm, and you must correct this issue immediately. Or you must ensure that the power to all pool equipment is turned off and the pool is not to be used.

Part 4 - Ensure that the concrete pool shell's reinforcing steel is bonded. Verify that the structural steel located inside the concrete pool shell's reinforcing steel is bonded in accordance with the NEC.

Watch No 3. Neutral-to-Earth Voltage https://www.youtube.com/embed/pAs_FmdxXhQ

Watch No. 4 NEC Equipotential Bonding https://www.youtube.com/embed/wyOILpoR39A

Step 1. Isolate Pool Water. Isolate the pool water from all bonded metal parts that contact the water such as hand rails, ladders, and pool lights. The pool water in a concrete pool's shell must not contact any bonded metal parts so that we can measure the neutral-to-earth voltage of the concrete pool shell's reinforcing steel without any false reading.

Step 2. Establish NEV. Measure the neutral-to-earth voltage between the service equipment and the concrete pool shell's reinforcing steel. You will need about 100' of 18 AWG conductor to accomplish this task.

Watch Swimming Pool Equipotential Bonding Testing
https://www.youtube.com/watch?v=Q8YLcXRo-Go&feature=youtu.be&t=132

The first step is to verify that the voltmeter is properly connected and operational. This is accomplished by terminating one lead of the voltmeter to the intersystem bonding terminal, the grounding electrode conductor, or the ground bar within service disconnect, then placing the other lead in the earth about twenty feet from the service. The voltage reading (NEV) should be between one and four volts, and it will fluctuate up and down slightly according to the loading on the utility primary neutral.

If the NEV is greater than four volts, the utility must be contacted, since this is a possible dangerous condition.

Step 3. Measure NEV of decking. Once we have verified that the meter is connected properly and operational, terminate one lead of a voltmeter to the intersystem bonding terminal, the grounding electrode conductor, or the ground bar within service disconnect, then contact the other lead to the water in the pool in at least four equally spaced locations. If the NEV is zero at ALL measured locations, then the concrete pool shell's reinforcing steel is properly bonded in accordance with the NEC.

Note: If the concrete pool shell's reinforcing steel is properly bonded, then the NEV between the water and all bonded parts will also be zero, please check this out as well.

If the NEV voltage is NOT zero at all four locations, then this means the concrete pool shell's reinforcing steel is not properly bonded. Until the concrete pool shell's reinforcing steel is bonded you must ensure that the power to all pool equipment is turned off and the pool is not to be used.

Part 5 - Ensure that the perimeter decking is bonded. Verify that the perimeter decking around a pool is bonded in accordance with the NEC.

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Watch No. 4 NEC Equipotential Bonding https://www.youtube.com/embed/wyOILpoR39A

Step 1. Establish NEV. Measure the neutral-to-earth voltage between the service equipment and the perimeter decking. You will need about 100' of 18 AWG conductor to accomplish this task.

Watch Swimming Pool Equipotential Bonding Testing
https://www.youtube.com/watch?v=Q8YLcXRo-Go&feature=youtu.be&t=132

The first step is to verify that the voltmeter is properly connected and operational. This is accomplished by terminating one lead of the voltmeter to the intersystem bonding terminal, the grounding electrode conductor, or the ground bar within service disconnect, then placing the other lead in the earth about twenty feet from the service. The voltage reading (NEV) should be between one and four volts, and it will fluctuate up and down slightly according to the loading on the utility primary neutral.

If the NEV is greater than four volts, the utility must be contacted, since this is a possible dangerous condition.

Step 2. Measure NEV of decking. Once we have verified that the meter is connected properly and operational, terminate one lead of a voltmeter to the intersystem bonding terminal, the grounding electrode conductor, or the ground bar within service disconnect, then contact the other lead to the perimeter decking at least six points (6, 12, 18, 24, 30, and 36 in. from the pool water) at least two locations around the pool.

Copper Bond. If the deck uses 8 AWG bonding copper conductor located between 18 and 24 in. from the pool water as the bonding grid, then the NEV immediately over the bonding conductor will be zero and the voltage reading of the other five points will slightly higher than zero. If the deck isn't bonded at all, then the voltage at all six points will be the NEV voltage.

Steel Bond. If the deck uses 6" x 6" structural steel wire mesh as the bonding grid, then the NEV reading at all six points should be near zero volts. If the deck isn't bonded at all, then the voltage at all six points will be the NEV voltage.

Until the decking is bonded you must ensure that the power to all pool equipment is turned off and the pool is not to be used.

Notice: This is a second draft 4/1/18. If you have any comments, please send them to Mike@MikeHolt.com, AFTER you have read this document and watched all videos at least twice.