



LOSS CONTROL BULLETIN

Another loss prevention service from Bollinger, Inc.

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SWIMMING POOL ELECTRICAL HAZARDS #112

Introduction

Electrical equipment installed in and near swimming pools can create shock hazards to people entering the swimming pool area. Electrical devices with ground faults or shorts (hereafter referred to as defective) can create these hazards in any environment. However, this hazard is increased in the pool area because the water in the pool, on the surrounding surfaces and equipment, and moisture on the skin provides a path of low electrical resistance for currents to travel from the defective device through a person's body to ground. Defective underwater lighting fixtures are an especially dangerous hazard to swimmers.

A person may receive a shock when touching an energized metal part and simultaneously contacting a metal object that is at a different electrical potential. For example, a swimmer might touch an electrically grounded metal diving board frame or ladder with one hand while the other hand or foot contacts the energized metal ring of a defective pool light. A swimmer might also receive a shock simply by touching a defective radio, since the water can provide a path to ground.

An energized, defective underwater light fixture can also generate a charge in the water surrounding it. This charge will be above that of grounded objects. If a swimmer in charged water touches a grounded object, the swimmer can be shocked. Even if the swimmer is not touching a grounded object, the current can flow from the defective fixture through the swimmer and water to ground.

Effects of Contact with Electric Current

The flow of current through the body can cause loss of muscular function and damage to vital organs. The extent of loss of function or damage will be determined by the effective level of current entering the body (the greater the resistance provided by the skin, the lower the effective current), the path taken by the current through the body, and the health and stature of the individual. Some general guidelines on the effect of exposure to electric current are outlined below:

- Currents of less than one milliamperere may be felt by a healthy person as a slight tingle and normally causes no injury. However, a sick person, particularly one with a coronary condition, may be injured by a current 1/100 of this value.
- "Let-go" current is the maximum current at which an individual, grasping a conductor such as the "hot" chassis of an appliance or tool, can release it by using the muscles directly affected by the current. "Let-go" current is about 16 milliamperes for men and about 10 milliamperes for women. This level of current does not normally cause tissue damage.
- Lethal currents for healthy persons may be as low as 18 milliamperes. When current of this level, or higher, flows through the chest cavity, the chest muscles may contract and could cause breathing to stop. If the current is maintained, unconsciousness and death may result.

Ventricular fibrillation is another potentially lethal result of this level of current. In this case, the heart ceases its rhythmical pumping action and undergoes irregular non-coordinated contractions. As a result of this condition, blood circulation stops.

Sources Of Electrical Hazards

Electrical defects in the equipment or improper wiring of the circuits providing power to the equipment can cause electrical shocks. The following types of auxiliary and accessory electrical equipment used in or located near pools are potential sources of electrical shock hazards.

- Filter pump motors
- Timer clocks
- Receptacles and light outlets
- Underwater light fixtures (dry or wet niche)
- Lights on metal poles
- Garden lights
- Pool ladders with built-in lights
- Bathhouse lights
- Water heaters (motors and pumps)
- Portable lights
- Skimmer filter motors
- Pool cleaning equipment
- Electrically-operated pool covers
- Radiant heat equipment
- Junction boxes for electrical connections
- Electrical circuit boards
- Hydrotherapy equipment
- Electric barbecues
- Charcoal starters
- Televisions, radios, and PA systems
- Refrigerators
- Snack bar equipment
- Electrical switches
- Electrical hair dryers

Installation Requirements and Electrical Safety

The requirements for the construction and installation of electrical wiring and equipment in or adjacent to pools are provided in the National Electrical Code (NEC), published by the National Fire Protection Association. State or local codes may also have requirements for electrical equipment and accessories associated with pools. The general principles of electrical safety for swimming pools are:

- Grounding
- Bonding
- Safe distances
- Ground fault circuit interrupters (GFCIs)
- Warnings, Labels, and Procedures

Grounding

Grounding provides a low resistance path from equipment to ground for undesirable fault currents. Article 680 of the NEC requires that the following equipment be grounded:

- Electrical equipment located within five feet of the pool walls.
- Electrical equipment associated with circulating the pool water.
- Junction boxes.
- Transformer enclosures.
- Circuit boards associated with the pool's electrical supply.
- Ground fault circuit interrupters.
- Wet and dry niche lighting fixtures. Dry-niche fixtures are those installed in the wall of a pool in a niche that is sealed against the entry of water. Wet-niche fixtures are those installed in a metal shell mounted in a pool where the fixtures will be completely surrounded by water.

Bonding

Bonding all metal chassis and pool components connects the components by means of a low resistance path to ground, which brings "everything within touch" to ground potential. This eliminates the shock hazard due to stray currents. The NEC requires that the following parts be bonded together:

- All metal parts of the pool structure, including the reinforcing metal of the pool shell and the deck.
- All metal fittings within or attached to the pool structure.
- Metal parts of electric equipment associated with the pool water circulating system, including pump motors.
- Metal parts of equipment associated with pool covers, including electric motors.
- Metal-sheathed cables and raceways, metal piping, and all fixed metal parts that are not separated from the pool by a permanent barrier. If these items are within 5 feet horizontally of the walls of the pool, or within 12 feet above the maximum water level of the pool, any observation stands, towers or platforms, or any diving structures they must be bonded.

The NEC also requires that a common bonding grid be established that includes the steel reinforcing elements used in a concrete pool. Except under certain conditions, electric pool heaters should also be bonded (see Figure 1).

Safe Distances

The NEC stresses the importance of keeping electrical receptacles, lighting fixtures and similar equipment away from the pool and areas that are likely to become wet. The Code requires that receptacles on the property be located at least 10 feet from the pool walls. In general, lighting fixtures and lighting outlets should not be installed over the pool or over the area extending 5 feet horizontally from the pool walls, unless 12 feet above the maximum water level. The clearances between overhead conductors and the surface of the pool are established in NEC 680-6.

Ground Fault Circuit Interrupters

In a properly functioning electrical device, all the current that flows in (through the "hot" conductor) should flow out through the intended path (the "neutral" conductor). When a fault, or electrical "leak," develops, the current flowing out the neutral conductor is less than the current flowing in to the device. The difference is "leakage current" that can flow to ground through some unintended path, such as a person. Ideally, leakage current should always be zero, but current leakage of a small fraction of a milliamperes is permitted by most electrical standards.

A GFCI measures the difference between the input and output current through a circuit. When the difference is approximately 5 milliamperes, the GFCI opens the circuit, limiting the duration of the shock to the person. The NEC requires the use of GFCIs in many locations near a pool. Specific GFCI requirements in NEC 680-6 for swimming pools include:

- 125-volt receptacles located within 20 feet of the pool walls.
- Lighting fixtures and lighting outlets installed in the area extending between 5 feet and 10 feet from the pool walls.
- Underwater lighting fixtures operating at more than 15 volts.
- Motor and controller electrical circuits used in electrically operated pool covers.

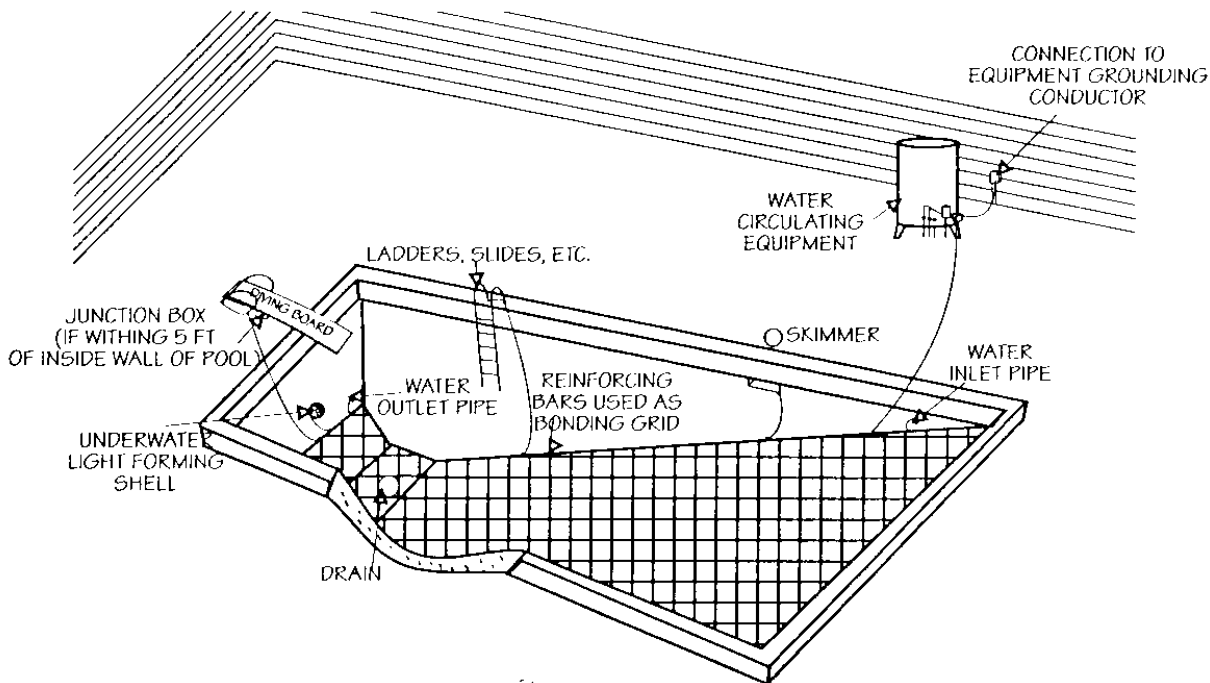
It should be noted that the NEC requires that all 125-volt, single-phase, 15- and 20-ampere receptacles installed outdoors where there is direct grade level access to the receptacles have GFCI protection (NEC 210-8).

Warnings, Labels and Procedures

The following information and requirements should be posted and/or enforced:

- Electrical equipment such as radios, sound systems and personal grooming equipment, should not be used close to the pool.
- Extension cords should not be used around the pool or wet areas.
- Written instructions should be provided for the use of electrical pool maintenance equipment, such as vacuums and pool sweeps.
- Written instructions should be provided for the use of electrically operated pool covers.
- Written operating and maintenance instructions should be provided for the water circulation system.
- The electrical power system should be shut off prior to servicing any electrical equipment.
- All electrical service equipment should be periodically checked for possible defects.
- A qualified electrical technician should perform a comprehensive electrical safety inspection of pool components at least once a year.
- All employees working around the pool should be specifically trained on electrical hazards associated with a pool and empowered to eliminate any hazards observed (user connected devices, etc.) and to inform users of hazards they may be encountering or creating

Figure 1. Bonding of Non-Current Carrying Metal Parts.



IMPORTANT NOTICE - The information and suggestions presented by Bollinger Inc. in this Loss Control Bulletin are for your consideration in your loss prevention efforts. They are not intended to be complete or definitive in identifying all hazards associated with your club, preventing workplace accidents, or complying with any safety related, or other, laws or regulations. You are encouraged to alter them to fit the specific hazards of your club and to have your legal counsel review all of your plans and club's policies.