Electrical Shock Around Docks and Piers

Assessment of Electrical Shock Condition

Thank you for bringing the subject issue to our attention. Safety is one of our core principles, and we always investigate electrical shocking complaints to verify that there is no system anomaly or equipment malfunction. We have completed our investigation and not found such. The following describes the matter, as well as solution options.

Voltage Creating Electrical Shock Scenario

One scenario that can create a shocking voltage involves insulation degradation of an energized conductor (fault), generating what is called a contact voltage. This is always hazardous and must be dealt with immediately.
The second scenario involves development of voltage between utility system neutral/ground and remote earth (i.e. NEV). The United States electric utility distribution system utilizes a neutral/ground design to quickly clear faults to enhance safety and reliability. This design can develop NEV between the utility's neutral/ground and remote earth based on system loading and harmonic characteristics. It is usually of much lower magnitude than contact voltage scenarios. Since immersion of body parts in water lowers the body's resistance, a low NEV can create a shocking sensation or bodily harm that would not ordinarily be the case. This is explained in next section.

Factors Creating Concern

Current flow through the human body and its magnitude determine the human body's response. Current magnitude = voltage between two contact points divided by body resistance. Body resistance is considerably lower in a wet environment, allowing a low voltage to be hazardous. For example, for an NEV of 6 volts divided by a body resistance of 500 ohms, the current is 12 mill-amps, which can create muscular contractions, and lead to a drowning.

National Electrical Code (NEC)

The National Electric Code is a rather large document that instructs electricians to safely wire homes, factories, boat docks and piers. In accordance with the National Electrical Code, all metallic parts of a dock or pier, including boat lift, hand rails, walk planks, and ladders shall be bonded to the electrical grounding system. The required bonding of the metallic parts of a dock or pier is done to protect persons operating equipment on the facility from electrical faults by creating a low impedance path for fault currents to flow in order for fault protection to clear it. This requires metallic parts of the dock or pier in turn be bonded to the utility's multi-grounded neutral, which can create a potential difference between the metallic parts of the dock or pier and water.

Article 555 of the 2017 NEC defines the proper installation of electrical service on a dock or pier. The following excerpt from the 2017 NEC addresses this potential shocking hazard by requiring signage to be installed warning of the potential hazard.

NFPA 70 NEC Article: 555.24 Signage: Permanent safety signs shall be installed to give notice of electrical shock hazard risks to persons using or swimming near a dock or marina and shall comply with all of the following:

(1) The signage shall comply with 110.21(B)(1) and be of sufficient durability to withstand the environment.
(2) The signs shall be clearly visible from all approaches to a marina or boatyard facility.
(3) The sign shall state "WARNING – POTENTIAL SHOCK HAZARD – ELECTRICAL CURRENTS MAY BE PRESENT IN THE WATER"

The NEC Handbook commentary text includes the following:
"Prohibiting recreational swimming in the immediate vicinity of boats and docks using ac electrical power will protect the public against the dangers associated with using electrical power in marinas and boatyards."

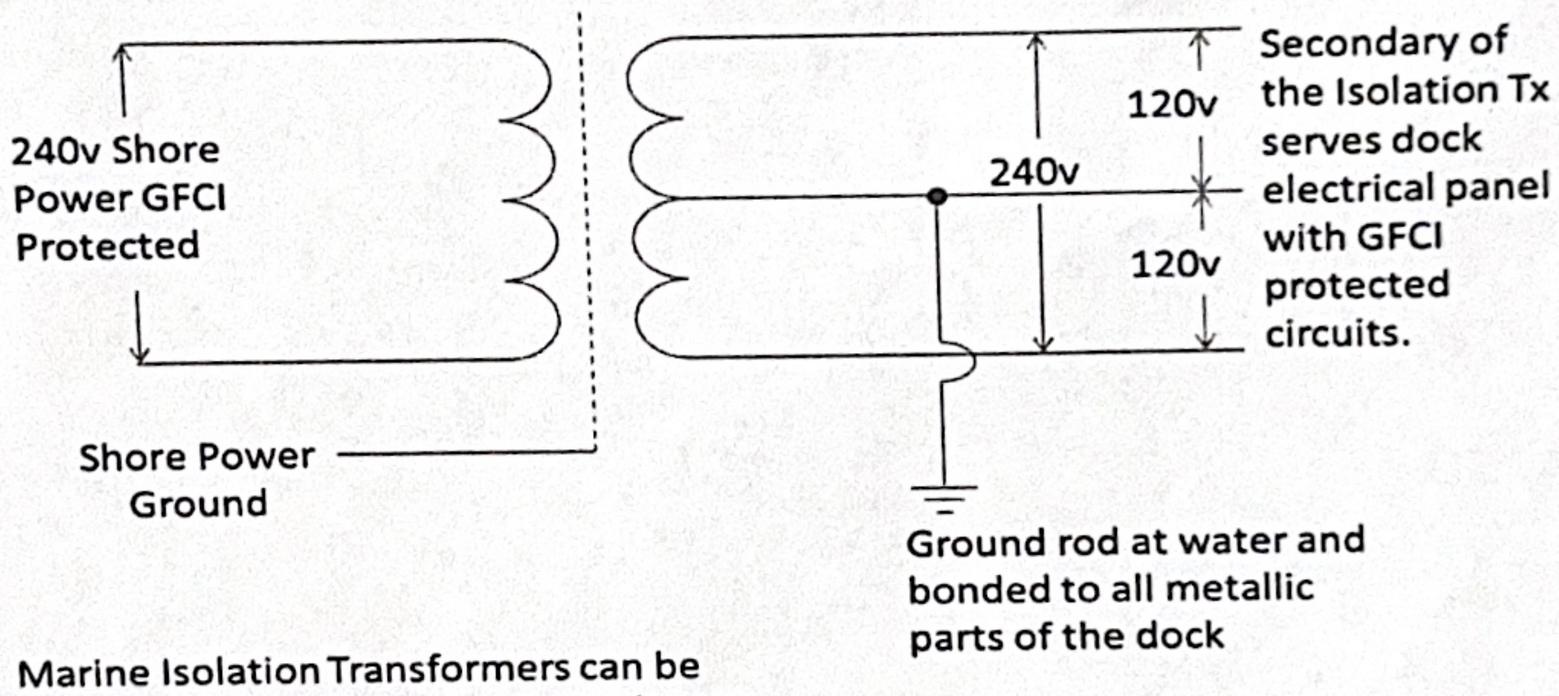
Solution Options

The safest way to mitigate the potential shocking hazard around docks and piers is to not have electrical service on them. If electrical service is required for such equipment as a boat lift, lights etc., then the following are recommendations for creating a safe environment for those in the water around the structure.

Option 1: Use a cord and plug connection to totally disconnect the dock or pier's electrical system when electrical service is not needed. This will totally separate the dock or pier's metallic parts from the electrical grounding system. All electrical code requirements shall be followed when installing the cord and plug connection.

Option 2: Install a double insulated UL listed marine isolation transformer, which totally isolates the dock or pier from the utility neutral/ground system. Charles Industries manufactures such a device. The secondary side should include a GFCI, as directed by NEC. Grounding and other installation requirements should be done per NEC.

Marine Isolation Transformer
Example



Marine Isolation Transformers can be purchased in 120V-120V or 240V-240/120V as shown above and must be sized for dock loads.

Words of Caution

The local utility cannot make a dock or pier's electrical system totally safe by doing anything on the utility side of the meter. Use of option 1 or 2 will remove the electrical utility system as the source of an electrical shock due to NEV. This assumes no other grounded utilities, such as phone line or cable are on the dock or pier. The ground on their cable sheath can bypass the isolation provided by the marine isolation transformer or cord and plug scenario, negating its protection. Additionally, a fault on customer's equipment can still present an electrical shock hazard, if not promptly removed by GFCI. The GFCI should either have a self-checking design to warn of malfunction or be periodically checked per manufacture's recommendations. Installing and maintaining a safe electrical supply to a dock or pier is the responsibility of the customer.