

As we approached Petersburg, Alaska, with only a few miles remaining northbound on the Wrangell Narrows, we contacted the harbormaster's office for the night's moorage. After providing the harbormaster with our vessel's length and shore power requirements, we were expecting a response with a slip assignment. Instead, the harbormaster asked "are you familiar with *something indistinguishable* ... shore power?" We asked for a repeat of the question which didn't help us at all. Assuming we could deal with any type of shore power, we answered in the affirmative; to which the harbormaster assigned us a slip in Petersburg's newly rebuilt North Harbor docks.



Rotary Selector Switch

We soon understood the harbormaster's earlier question when we were unable to connect to shore power. After plugging our shore power cable into the 30 amp outlet on the new gleaming white receptacle box, we switched on the breaker. Onboard, we followed our normal power-up routine with individual breakers turned off and the main breaker turned on. When we rotated the selector switch to SHORE POWER expecting to see 120 volts on the panel meter, we instead discovered no power at the panel. Something was wrong.

That was the beginning of a multi-season research and discovery of recent changes to shore power that are beginning to affect boaters cruising the Inside Passage and now in Puget Sound.

Shore Power Changes Are Coming

- Changes are coming to shore power at marinas and docks. Since 2011, efforts have been underway from both the building code side and from the boat building side to address safety issues due to a stray electrical current in and around docks and marinas. The National Electrical Code (NEC) Article 555 addresses electrical shock drownings caused by leakage of electrical current from A/C shore power facilities on docks and marinas. Concurrently, the American Boat & Yacht Council (ABYC) section E-11.11 has made changes to address A/C power leakage from boats into surrounding waters that endanger nearby people and boats.
- As marinas and docks upgrade their facilities, they will be adding Ground-Fault Interrupt (GFI) protection breakers to shore power receptacles. GFI breakers are designed to 'trip'

and turn-off power if it detects an imbalance in the power (amperage) going to the boat and returning via the shore power cable/wiring. In the past, marina shore power receptacle breakers have only had over-amperage breaker switches to protect the shore power wires and cables. These new GFI breakers will trip, turning off power, if the boat incorrectly leaks amperage, and will trip if too much amperage is consumed.

- Newly built boats and older boats upgraded to current ABYC standards will include an Equipment Leakage Circuit Interrupter (ELCI) breaker on the boat's side of the shore power connection. In the past, a boat's A/C shore power connection was protected by an over-amperage breaker protecting the boat's wiring. ABYC standards now call for an additional breaker which is designed to detect shore power amperage that leaks through onboard equipment and wiring into the surrounding water. ELCI protection is either a separate breaker on the boat's breaker panel or a combination ELCI and over-amperage breaker. ELCI continuously monitors amperage on the shore power connection and trips or shuts off the shore power if there is an imbalance of amperage coming from shore and returning to shore from the boat.

How GFI Breakers Might Affect You

- Your next visit to a marina with upgraded shore power may require some extra effort. If the shore power breaker has GFI protection and you have an inverter onboard, you may need to change your normal power-up sequence. GFI protected breakers have switches that include a third GFI RESET position in addition to the standard ON and OFF switch positions.
- First, try your usual connect and power-up sequence for shore power. If this works, great kick back and enjoy your now safer stay.
- If the GFI breaker trips as soon as you bring shore power to your panel, then you will want to try some alternate sequences of turning switches and flipping breakers on your panel.
 1. Before attempting alternative sequences, you will need to reset the GFI breaker on the dock power receptacle. Usually pressing the breaker switch away from the ON position through the mid-point OFF position, and beyond to a spring-loaded bottom, position will reset the breaker. Some GFI breakers have separate reset and test buttons.
 2. Before turning the dock GFI breaker to ON, turn off all A/C panel breakers on your boat, including A/C breakers on the separate inverter panel if equipped. Also, turn off all main A/C and Inverter breakers (double-pole breakers – the ones where two breaker switches are tied together).
 3. Now switch the dock GFI Breaker to ON.
 4. Then on the boat, start by switching the power source to Shore Power.
 5. Each boat's wiring will be different with one or more main double-pole breakers and A/C panel individual circuit breaker switches.
 6. Try different sequences of turning main-double pole breakers on and individual breakers on to discover what might be causing the GFI Breaker to trip. This may take some time as you will need to restart the process by resetting the shore GFI breaker with each attempt. (See below for one suggested sequence)

- For a temporary workaround, ask the marina for moorage space with non-GFI protected shore power.

What might be causing the GFI Breaker to Trip?

- Marine inverters appear to be the one source of inadvertent GFI breaker issues. Properly installed inverters may trip the GFI breaker if other onboard A/C breakers are switched on before the inverter completes its process of synchronizing with shore power source. Inverters for use on boats have a neutral-to-ground relay that correctly connects neutral to ground wires when the inverter is producing A/C but breaks that connection when shore power is detected and it is in pass-thru mode. When shore power is supplied to the inverter, the inverter goes through a synchronizing and switching process to pass-thru shore power instead of inverter supplied power. Some inverters phase-match during this syncing process to provide seamless switching between shore power and inverter produced A/C while others switch from one to the other. During this syncing phase, while the neutral-to-ground connection is being changed, GFI and ELICI breakers may sense an imbalance and trip the breaker.
- Marine inverters correctly tie or connect the boat's neutral (white) A/C wire with the ground (green) wire when the inverter is creating A/C from DC battery power. When the inverter senses A/C shore power from its A/C input wiring it begins a process of synchronizing and switching to pass-thru mode. Once the syncing and switching process are complete, the inverter breaks its neutral to a ground connection and correctly leaves the boat's ground to shore power ground and the boat's neutral to shore power neutral connections. If other main A/C breakers are ON during this syncing process, amperage on the neutral wire is conducted to the ground wire through the inverter's neutral to ground bonding and may trip the GFI breaker.

The following power-up sequence resolved the GFI Breaker trip on an Outback FX Inverter/Charger installed with two main double-pole breakers, one for the inverter A/C panel and one for non-inverter A/C panel.

- 1) After turning the GFI Breaker on and switching the boat's power source to Shore Power.
- 2) Then switch the main double-pole breaker that supplies power to the inverter ON and wait for the inverter to synchronize with shore power. Some Inverters have blinking, solid, or colored lights to indicate syncing. The syncing process normally takes 30 seconds to a minute.
- 3) Once the inverter syncs with shore power, then proceed to turn other main (double-pole) breakers ON, followed by individual A/C or Inverter panel breakers on.
 - Marine battery chargers are another potential cause of GFI breaker issues. Try turning off and/or lower the amperage setting to provide a temporary solution to a GFI breaker tripping.
 - Self-testing galvanic isolators may also be a cause of GFI breaker problems. Replace with a newer galvanic isolator.

- A possible source of an unwanted, problematic, neutral-to-ground connection is home-store (non-marine) type appliances where the neutral is tied to ground as called by UL standards for home use, but unwanted for boats.
 - Inverter installation may be a source of incorrect neutral-to-ground connection when the neutral conductors are not separated into two busses; inverted and non-inverted. ABYC recommendations call for separating all neutral and ground wires for inverter loads from non-inverted. A neutral/ground connection should only be present at a source of power.
 - Reportedly, certain “Y” shore power adapters cause GFI problems and trip new GFI breakers. The “Y” adapters are those that combine two 30 amp shore power receptacles into one 50 amp boat connection or two (2) 50 amp shore power receptacles into one 100 amp boat receptacle. Apparently, one brand of these adapters cause problems when used at the new GFI protected shore power locations.
- ELCI is an onboard device that might already be in place on newer boats and should be added to those built prior to the recent ABYC standards changes. As the owner of your boat, you probably already know if you have an ELCI. On boats already equipped, you will find the ELCI Breaker on the A/C breaker panel or near the boat’s shore power inlet. ELCI breakers are normally labeled as such and have a ‘TEST’ button. If you are bareboat chartering, your charter provider and boat owner should have documented any ELCI shore power procedures.
 - ELCI and GFI effect on your shore power connection issues is the same as GFI breakers. Your onboard ELCI will inadvertently trip if your inverter is not synched with shore power prior to turning other onboard A/C breakers on.
 - ELCI breakers have a test button. They recommend testing monthly.
 - If you experience problems with these new ground fault systems, you should have a qualified electrician check your wiring.[caption id="attachment_13306" align="alignleft"



GFI Breaker Eaton Power

Not All GFI Protected Installations Are The Same

- Some GFI protected breakers have a “Test” button for testing the GFI feature while others do not. Some breakers have a single “reset” position on the breaker toggle switch for resetting both the GFI trip and the over-amperage trip. Others have two separate reset positions on the toggle switch for resetting.
- NEC building code does not require GFI protected breakers at each power stanchion. Marinas may instead put a single GFI protection device at the main power feed to a section of the marina. If this is the case, there will be an over-amperage breaker with the normal over-amperage reset. However, there will be no reset for a GFI trip. Instead, any excessive amperage leakage will trip the single GFI device and turn off power for the entire section of the marina and marina staff will need to be notified to correct the problem.



GFI Breaker Roche Harbor

What about ELCI?

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Do I Need an Isolation Transformer?

- Isolation transformers all but eliminate the possibility of tripping dock GFI breakers. They also bring other benefits and are generally a good addition to the boat. Transformers are available in a variety of different voltages and amperages ranging in price from \$1,000 to \$4,000.
- If an isolation transformer is installed with 10 feet of the boat's shore power inlet, an ELCI breaker is not required to be ABYC compliant.
- An isolation transformer is not required in order to use new GFI power sources. If your boat is properly wired and powered up correctly, there is no requirement for an isolation transformer.

Why GFI and ELCI Breakers?



GFI Breaker in an Eaton Lighthouse Pedestal

- GFI Breakers are safety devices to prevent Electric Shock Drownings. While more dangerous in fresh water, drownings happen in both fresh and saltwater when people become better electrical conductors of leakage A/C current than the surrounding water. Faulty dock or boat wiring is a common cause of dangerous electrical power in waters around docks and marinas. The danger only becomes known when someone enters the water and is immobilized by the electrical shock. These tragedies grow when rescuers enter the same dangerous waters in an attempt to help and become victims as well.
- ELCI Breakers and GFI Breakers detect amperage difference (imbalance) between the hot (black) wire and the neutral (white) wire and trip if there is a significant difference (Leakage) between power going to the boat (hot wire) and that coming back (neutral wire) from the boat to shore power. ELCI and GFI Breakers detect and shut off power if power is detected leaking to a source such as the surrounding water.



Where to find upgraded GFI Breaker Shore Power?

- GFI Breakers first appeared at new or rebuilt marinas in Southeast Alaska. North Harbor in Petersburg, Juneau's Aurora Basin, Sitka's Breakwater, and some docks in Ketchikan are equipped with GFI Breakers.

- Here in Washington, Roche Harbor has new GFI Breakers on some of their permanent moorage docks and will be upgrading the transient guest dock in the coming seasons. [Rosario Resort & Spa](#) has all new docks which just opened in 2017 with GFI Breakers. Point Roberts Marina has replaced one of their docks with all new that includes GFI protected breakers. Point Roberts Marina will be replacing all of their docks with new docks over the course of several years.
- We are not aware of any GFI Breakers at British Columbia marina docks at this time.

How to prepare?

- Install an ELCI Breaker on your boat. Installing an ELCI breaker on your boat now will not only help ensure that you won't have unexpected problems while cruising but will also make for safer boating. If there are any electrical leakage issues on your boat, an ELCI will bring them to your attention and will do so at your schedule.
- ELCI breakers cost about \$500 or less and can be added to your existing panel or in a separate enclosure near your boat's shore power inlet.

Share your experiences with GFI and ELCI Breakers

- - Boaters' experiences with GFI and ELCI Breakers are just now emerging. We expect that there will be a variety of symptoms, issues, and solutions as we all gain more experience with these new safety devices. We encourage you to share your knowledge with us via WaggonerGuide.com so that we may share them with others.
 - Send Comments to: [Wagtalk \[at\] WaggonerGuide \[dot\] com](mailto:Wagtalk@WaggonerGuide.com)

~Leonard Landon, Co-Managing Editor Waggoner Cruising Guide

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