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A Technical White Paper
Equipment Leakage Circuit Interrupter (ELCI)

On July 31st, 2010, how will you comply with ABYC E-11.11.1?

Disclaimer

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ABYC Requirements

ABYC E-11.11.1 An Equipment Leakage Circuit Interrupter (ELCI) shall be installed with or in addition to the main shore power disconnect circuit breaker(s) or at the additional overcurrent protection as required by E-11.10.2.8.3, whichever is closer to the shore power connection.

ABYC E-11.11.1.1 This device shall meet the requirements of UL1053 Standard for Safety for Ground Fault Sensing an Relaying equipment and the requirements of UL 943 Ground Fault Circuit Interrupters with the exception of trip level and trip time. Trip level shall be a maximum of 30mA. The trip time shall be a maximum of 100ms.

Note: Trip levels of less than 30mA and trip times less than 100ms may result in nuisance trips in certain environments.

ABYC E-11.11.1.2 The ELCI shall be readily accessible

ABYC E-11.10.2.8.3 Additional Overcurrent Protection - If the location of the main shore power disconnect circuit breaker is in excess of 10 feet (three meters) from the shore power inlet or the electrical attachment point of a permanently installed shore power cord, additional fuses or circuit breakers shall be provided within 10 feet (three meters) of the inlet or attachment point to the electrical system of the boat. Measurement is made along the conductors.

Implementation of ABYC E-11.11.1 is required for all new shore power installations beginning July 31st, 2010. To obtain the latest information about the implementation of E-11.11.1, go to ABYC's web site @ www.abycinc.org, or contact John Adey, ABYC's Technical Director, at 410-990-4460.

Executive Summary

Utilizing a Coast Guard grant, ABYC conducted multiple tests to evaluate in-water shock scenarios and possible mitigation devices. Based on that data, ABYC has established a requirement for the aforementioned ELCI and has designated July 31st, 2010, as its implementation date.

In order to comply with the new standard, all 120VAC 60 Hz and 240VAC 60 Hz shore power installations are required to be equipped with an Equipment Leakage Circuit Interrupter (ELCI).

There are several manufacturers of these devices that have either launched or will soon launch production parts for 120VAC/ 30A, 120VAC/ 50A, 240VAC/ 50A, and 240VAC/100A applications that will comply with the requirements of ABYC E-11.11.1.

Implementation of this ELCI device will require OEM boat builders to initiate one of two courses of action:

include it as an integral part of the AC electrical system for each shore power line installed onboard;
or
provide an in-line solution for each shore power line.

There are pros and cons to each solution which will need to be weighed by the OEM.

ELCI Purpose

To reduce the risk of possible injury or electrocution to persons swimming in close proximity to vessels connected to shore power, as well as persons on board a vessel and persons on shore who are in contact with a vessel's bonding system in the event of an AC leakage fault current.

The ELCI is a residual current device (RCD) which detects equipment ground fault leakage current and disconnects the current carrying conductors at a maximum trip level of 30mA with a maximum trip time of 100ms.

In 120VAC 60Hz systems the ELCI/Breaker combination disconnects the Hot (ungrounded / black) and the Neutral (grounded / white) conductors, while in a 240VAC 60Hz system, the ELCI disconnects both the Hot #1 (ungrounded / black) and Hot #2 (ungrounded / red) current carrying conductors. An alternate 240VAC 60Hz

ELCI Rationale and History

Here in the U.S.A., the only requirement up to this point has been for a GFCI having a trip level of 5mA and 25ms to be located in galleys, heads, machinery spaces and weather decks (ABYC E-11.13.5)

The ELCI can actually trace its roots back to Europe. During 1994, the International Organization for Standardization (ISO) began developing standard ISO 13297 to regulate the installation of electrical systems in small craft. One of its directives, ISO 13297.8, focused on the potential danger to people from an electrical shock hazard from vessels connected to 220 VAC 50Hz shore power.

A Ground Fault Circuit Interrupter (GFCI)/ residual current device (RCD) having a maximum sensitivity of 30mA @ 100ms was required to be installed onboard in each main shore power supply line. As an alternative, an RCD having a maximum sensitivity of 10mA @ 100ms is required in certain spaces such as galleys, heads, machinery spaces and weather decks.

As one can plainly see, the trip levels of the ISO required GFCI/ RCD and that of an ABYC UL 1053 Listed GFCI are significantly different. The intention of the US based GFCI was to protect receptacles where portable appliances located in wet areas are plugged in. The intention of the ISO based GFCI/ RCD was to protect the whole vessel from a ground fault, or to protect receptacles where portable appliances located in wet areas are plugged in. However, both devices sense the

difference in the current flow in the Hot and Neutral lines. If this differential current exceeds the preset trip threshold, the device opens both conductors.

It is important to note that this differential current is a short circuit current or ground fault current caused by the failure of insulation in the boat's wiring, in onboard loads, or in onboard sources of power. Because the current level of this ground fault current may be in the milliamp range, no conventional main or branch circuit breaker onboard will trip. However, ground fault currents can prove to be a shock hazard; fortunately, the RCD fills this safety gap in European 220VAC 50Hz systems.

In the event of the absence of ground in the dockside power pedestal; a poor quality ground connection at the power pedestal caused by corrosion or improper installation; improper shore line connector maintenance; or an open ground conductor in any part of the AC shore power system, the RCD will still open both current carrying conductors in the event of a detected ground fault current.

In addition to the existing ISO requirement that a RCD be installed onboard for each main shore power supply line, each dockside power pedestal line must also be equipped with an RCD. At the present time, there is no provision in the NFPA-303-2006, the marina safety standard, to mandate the use of ELCI devices in US dockside power pedestals. There is a provision for an optional power pedestal mounted GFCI, but the GFCIs 5mA and 25ms trip point will undoubtedly cause nuisance trips (ABYC E-11.11.1.1 Note)

During the summer of 2007, funded by a grant from the United States Coast Guard, ABYC conducted tests on Lake Meade (a fresh water lake) in Colorado and fourteen other locations to determine a safe trip point for 120VAC 60Hz and 240VAC 60Hz ELCI devices. Utilizing ELCI test devices supplied by Sensata Technologies and North Shore Safety, Ltd., the same RCD 30mA and 100ms maximum trip levels were established for the 60Hz ELCI devices. Therefore, in the not too distant future, RCDs that have been tested to UL 1053 and UL 943 FTTJ2 can then be considered a qualified ELCI device that will comply with ABYC E-11.11.1.

The result of this exercise was the ABYC requirement for an ELCI device to be installed in each shore power line.

The International Marine Certification Institute has recently validated the ELCI as defined in ABYC E-11.11.1 as an acceptable replacement for the RCD device now utilized in Europe. However, international versions of the ELCI must be compliant with European 220V 50Hz power systems. In addition, ELCI RCBO devices must also comply with European 16A, 32A, or 63A shore power cord sets. Also, if an international version of the ELCI is located in a fume area, testing to the ISO 8846 Standard (Small craft- Electrical devices-Protection against ignition of surrounding flammable gases) will also be required. Although at the present time, there is no European standard for RCD construction within ISO 13297 (Small craft-Electrical

systems-Alternating current installations), the international ELCI should have the CE mark.

Current Solutions

Today, compliant ELCI devices are available in three basic configurations:

1. the **ELCI/RCBO** which combines overcurrent protection and leakage current protection in a single compact economical package;
2. the **ELCI/RCD** sensing module coupled with a separate compliant magnetic circuit breaker that provides overcurrent and leakage current protection;
3. the **ELCI/RCD** sensing module coupled with a compliant contactor that provides only leakage current protection.

Manufacturer's recommendations

Similar to a GFCI, the ELCI must be tested on a regular basis by depressing the Test and Reset Buttons mounted on the front of the device, and the LED indicators or toggle switch handle must be visible to determine the system status (Power On or Fault Condition). This is supported by the ABYC requirement for the device to be readily accessible (ABYC E-11.11.1.2).

In addition, the mounting location of each ELCI device establishes a specific set of environmental and electrical requirements that must be satisfied in order to be compliant.

1. Units mounted in engine rooms must be rated at a maximum operating temperature of 85℃ to allow a 35℃ rise above the 50℃ engine room ambient temperature to comply with ABYC E-11.5.1.
2. Units mounted in fume areas must be Ignition Protected and tested to UL 1500 or SAE J1171 to comply with ABYC E-11.10.1.5.1.
3. Units mounted in wet areas must be watertight to comply with E-11.4.30.
4. ELCI compliant circuit breakers must meet the requirements of UL 489 or UL 1077 and be trip-free; manually reset; and have an interrupting capacity of 3,000 Amps for 120VAC 30 Amp or 50 Amp systems; and 5,000 Amps for 240VAC 50 and 100 Amp systems per ABYC E-11.10.2.

Wiring requirements

At this time, most ELCI sensing modules utilize toroidal sensors. The inside diameter of this sensor will restrict the maximum diameter of the cable type used.

- 120VAC 30 Amp systems require the #10 AWG Hot (black) and the #10 AWG Neutral (white) power conductors pass through the toroid (ABYC E-11.17.1 and E-11.17.4). Please note that some ELCI manufacturers require that the conductors are twisted together when

they pass through the toroid to reduce electromagnetic interference (EMI).

- 120VAC 50 Amp systems require the #6 AWG Hot (black) and the #6 AWG Neutral (white) power conductors pass through the toroid (ABYC E-11.17.1 and E-11.17.4).

- 240VAC 50 Amp systems that do not include an isolation transformer require the #6 AWG Hot #1 (black), the #6 AWG Neutral (white), and the #6 AWG Hot #2 (red) power conductors pass through the toroid (ABYC E-11.17.2).

- 240VAC 50 Amp systems that include an isolation transformer require the #6 AWG Hot #1 (black) and the #6 AWG Hot #2 (red) power conductors pass through the toroid (ABYC E-11.17.5).

ELCI Solutions Available Now, and in Development September 1, 2010

Component Description	Availability	Range	Delay	Form Factor	Switched Neutral	Minimum Operating Temp.	Maximum Operating Temp.	Ignition Protected	Water-tight	Reverse Polarity Protector	UL RCBO Approvals	AIC RATING	Paneltronics' Part Number	Code
120V 2 Pole ELCI/RCBO	Now	30 Amps	Medium	3 Pole A	Yes	-35ºC	65ºC	No	No	No	UL 1077	5,000A 120V	004-666	b, c, e, f, g, h, i, j
120V 2 Pole ELCI/RCBO	Now	30 Amps	Long	3 Pole A	Yes	-35ºC	65ºC	No	No	No	UL 1077	5,000A 120V	004-610	b, c, e, f, g, h, i, j
120V 2 Pole ELCI/RCBO	Now	30 Amps	Medium	4 Pole C	Yes	-35ºC	65ºC	Yes	No	No	UL 1077	3,000A 120V	004-668	c, e, f, k
120V 2 Pole ELCI/RCBO	Now	30 Amps	Medium	4 Pole C	Yes	-35ºC	65ºC	Yes	No	Yes	UL 1077	3,000A 120V	004-669	c, e, f, k
120V 2 Pole ELCI/RCBO	Now	30 Amps	Long	4 Pole C	Yes	-35ºC	65ºC	Yes	No	No	UL 1077	3,000A 120V	004-667	c, e, f, l, k
120V 2 Pole ELCI/RCBO	Now	30 Amps	Long	4 Pole C	Yes	-35ºC	65ºC	Yes	No	Yes	UL 1077	3,000A 120V	004-650	c, e, f, k
120V 2 Pole ELCI/RCBO	Now	50 Amps	Medium	4 Pole C	Yes	-35ºC	65ºC	Yes	No	No	UL 1077	3,000A 120V	004-671	c, e, f, k
120V 2 Pole ELCI/RCBO	Now	50 Amps	Medium	4 Pole C	Yes	-35ºC	65ºC	Yes	No	Yes	UL 1077	3,000A 120V	004-672	c, e, f, k
120V 2 Pole ELCI/RCBO	Now	50 Amps	Long	4 Pole C	Yes	-35ºC	65ºC	Yes	No	No	UL 1077	3,000A 120V	004-670	c, e, f, k
120V 2 Pole ELCI/RCBO	Now	50 Amps	Long	4 Pole C	Yes	-35ºC	65ºC	Yes	No	Yes	UL 1077	3,000A 120V	004-651	c, e, f, k
120/240V 2 Pole ELCI/RCBO	Now	50 Amps	Medium	4 Pole C	No	-35ºC	65ºC	Yes	No	No	UL 1077	5,000A 240 V	004-673	c, e, f, k
120/240V 2 Pole ELCI/RCBO	Now	50 Amps	Long	4 Pole C	No	-35ºC	65ºC	Yes	No	No	UL 1077	5,000A 240 V	004-674	c, e, f, k
120/240V 2 Pole ELCI/RCBO	Dec-10	50 Amps	Long	4 Pole C	No	-35ºC	65ºC	Yes	No	Yes	UL 1077	TBD	004-652	c, e, f, k
120/240V 3 Pole ELCI/RCBO	Now	50 Amps	Medium	5 Pole C	Yes	-35ºC	65ºC	Yes	No	No	UL 1077	5,000A 240 V	004-675	c, e, f, l
120/240V 3 Pole ELCI/RCBO	Now	50 Amps	Medium	5 Pole C	Yes	-35ºC	65ºC	Yes	No	Yes	UL 1077	5,000A 240 V	004-676	c, e, f, l
120/240V 3 Pole ELCI/RCBO	Now	50 Amps	Long	5 Pole C	Yes	-35ºC	65ºC	Yes	No	No	UL 1077	5,000A 240 V	004-677	c, e, f, l
120/240V 3 Pole ELCI/RCBO	Now	50 Amps	Long	5 Pole C	Yes	-35ºC	65ºC	Yes	No	Yes	UL 1077	5,000A 240 V	004-653	c, e, f, l
120/240V 3 Pole ELCI/RCBO	Nov-10	100 Amps	Long	TBD	Yes	TBD	TBD	TBD	TBD	TBD	UL 1077	TBD	TBD	TBD
120V ELCI/RCD Sensing Module	Now	30/50 Amps	NA	Rect	NA	-35ºC	85ºC	Yes	Yes	No	NA	NA	206-467	e, f, h, j
240V ELCI/RCD Sensing Module	Now	50 Amps	NA	Rect	NA	-35ºC	85ºC	Yes	Yes	No	NA	NA	206-468	e, f, h, j
120V ELCI/RCD Sensing Module	Now	30/50 Amps Vert	NA	Round	NA	-35ºC	85ºC	Yes	Yes	No	NA	NA	206-451	e, f, h
120V ELCI/RCD Sensing Module	Now	30/50 Amps Hori	NA	Round	NA	-35ºC	85ºC	Yes	Yes	No	NA	NA	206-478	e, f, h
240V ELCI/RCD Sensing Module	Now	50 Amps Vert	NA	Round	NA	-35ºC	85ºC	Yes	Yes	No	NA	NA	206-452	e, f, h
240V ELCI/RCD Sensing Module	Now	50 Amps Hori	NA	Round	NA	-35ºC	85ºC	Yes	Yes	No	NA	NA	206-479	e, f, h
120V 2 Pole ELCI Circuit Breaker	Now	30 Amps	Long	2 Pole A	Yes	-35ºC	85ºC	Yes	Yes	No	UL 1077	125V 3,000A	206-470	a,, c, e, h
120V 2 Pole ELCI Circuit Breaker	Now	30 Amps	Long/In-rush	2 Pole A	Yes	-35ºC	85ºC	No	No	No	UL 489	120V 5,000A	206-483	a,, c, e, h, i
120V 2 Pole ELCI Circuit Breaker	Now	30 Amps	Long	2 Pole A	Yes	-35ºC	85ºC	No	No	No	UL 489	120V 5,000A	206-484	a,, c, e, h, i
120V 2 Pole ELCI + Rev Polarity	Now	30 A /65VAC	Medium	3 Pole A	Yes	-35ºC	85ºC	No	No	Yes	UL 489	250V 5,000 A	206-462	a, d, e, i
120V 2 Pole ELCI + Rev Polarity	Now	30 A /65VAC	Medium	3 Pole A	Yes	-35ºC	85ºC	No	Yes	Yes	UL 1077	125V 3,000A	206-471	a, d, e, i
120V 2 Pole ELCI + Rev Polarity	Now	30 A /65VAC	Medium	3 Pole A	Yes	-35ºC	85ºC	Yes	Yes	Yes	UL 1077	125V 3,000A	206-472	a, d, e, i
120V 2 Pole ELCI Circuit Breaker	Now	30 Amps	Long	2 Pole C	Yes	-35ºC	85ºC	No	No	No	UL 489	120/240V 5,000A	206-449	a, c, e, h, i
120V 2 Pole ELCI Circuit Breaker	Now	50 Amps	Long	2 Pole C	Yes	-35ºC	85ºC	No	No	No	UL 489	120/240V 5,000A	206-454	a, c, e, h, i
120V 2 Pole ELCI Circuit Breaker	Now	50 Amps	Long/In-rush	2 Pole C	Yes	-35ºC	85ºC	No	No	No	UL 489	120/240V 5,000A	206-480	a, c, e, h, i
120V 2 Pole ELCI Circuit Breaker	Now	50 Amps	Long	2 Pole C	Yes	-35ºC	85ºC	Yes	No	No	UL 1077	125V 5,000A	206-473	a, c, e, h, i
120V 2 Pole ELCI Circuit Breaker	Now	50 Amps	Long	2 Pole C	Yes	-35ºC	85ºC	No	Yes	No	UL 1077	240V 5,000A	206-474	a, c, e, h, i
120V 2 Pole ELCI Circuit Breaker	Now	50 Amps	Long	2 Pole C	Yes	-35ºC	85ºC	Yes	Yes	No	UL 1077	125V 5,000A	206-475	a, c, e, h
240V 2 Pole ELCI Circuit Breaker	Now	50 Amps	Long	2 Pole C	No	-35ºC	85ºC	No	No	No	UL 489	240V 5,000A	206-447	a, c, e, h, i
240V 2 Pole ELCI Circuit Breaker	Now	50 Amps	Long/In-rush	2 Pole C	No	-35ºC	85ºC	No	No	No	UL 489	240V 5,000A	206-481	a, c, e, h, i
240V 2 Pole ELCI Circuit Breaker	Now	50 Amps	Long	2 Pole C	No	-35ºC	85ºC	No	Yes	No	UL 1077	250V 3,000A	206-476	a, c, e, h, i
240V 3 Pole ELCI Circuit Breaker	Now	50 Amps	Long	3 Pole C	Yes	-35ºC	85ºC	No	Yes	No	UL 1077	250V 5,000A	206-477	a, c, e, h, i
240V 3 Pole ELCI Circuit Breaker	Now	50 Amps	Long/In-rush	3 Pole C	Yes	-35ºC	85ºC	No	No	No	UL 489	240V 5,000A	206-482	a, c, e, h, i
240V 3 Pole ELCI Circuit Breaker	TBD	100 Amps	Long	TBD	Yes	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Code Key:

a. All ELCI RCBO and RCD devices (comprised of an ELCI Sensing Module and an ELCI Compliant Circuit Breaker) have a single operating handle.

b. ELCI Form Factor A-Frame RCBO and RCD devices have a maximum over current rating of 30 amps.

c. To prevent nuisance over current tripping at the shore power inlet, ELCI RCBO and RCD devices with Long Delays are best suited to be mounted at the shore power inlet.

d. ELCI RCBO and RCD devices with Medium Delays are best suited to be mounted on or at the main distribution panel.

e. ELCI RCBO and RCD devices are tested to meet the requirements of ABYC E-11.11.1.1; however, today's restrictions on the marking of ELCI devices set by Underwriters Laboratories will cause UL compliance marking to vary by configuration and manufacturer.

ELCI RCD Sensing Modules that utilize an external toroidal transformer today may not be marked UL Listed or ЯU Recognized because UL considers that these devices require field assembly, and UL 943 does not today have a designation for an ELCI device. Additional markings may include a statement indicating compliance with ABYC E-11.11.1.1, a statement that the product meets the requirements of UL 1053, UL 943, UL 943 Category FTTJ2, and the name of an independent testing laboratory,

ELCI RCD Compliant Circuit Breakers that today meet the requirements of UL 489 are marked UL Listed, or if they meet the requirements of UL 1077 Recognized they are marked ЯU (ABYC E-11.10.2.1).

ELCI RCBO devices that utilize external toroidal transformers today may not be marked UL Listed or ЯU Recognized because UL considers that these devices require field assembly, and UL 943 does not today have a designation for an ELCI device. However, a specific ELCI RCBO manufacturer utilizing a UL 943 compliant sensing device and UL 489 constructed circuit breaker has received permission to mark their ELCI RCBO device ЯU Recognized.

f. Because the ELCI is not a combination outlet and GFCI device, no end of life indicator is required by the UL Standards.

g. Does not provide an indicator to distinguish between leakage current and over current trips

h. Does not provide Reverse Polarity Protection or indication (ABYC E-11.6.3.3.1)

i. To comply with either the ABYC E-11.10.1.5.1 Ignition Protection Standard, or ABYC E-11.4.30 requirements for installation in wet areas, a NEMA enclosure is available.

j. Insufficient current transformer inside diameter to accommodate twisted multiple #6 AWG marine conductors.

k. Optional watertight boot available P/N 004-681

l. Optional watertight boot available P/N 004-683.

Further Information

Since 1979 Paneltronics, Inc. has been the industry-leading manufacturer of high quality electrical power distribution panels. We now offer OEM's our expertise in the design of Custom ELCI Panels utilizing readily available standard components that meet the new requirements presented in ABYC E-11.11.1. Call us today for an evaluation of your requirements.