

**CAPCA**

**June Meeting 2015**

**Ground Fault**

**Protection**



John McDevitt

Based in the Mid-Atlantic  
Chesapeake Bay, Delaware River and Bay  
and the New Jersey Coast.

Marine Electricity

Marine Fire Protection

CAPCA Member for many years

# Marine Industry Activities

Marine Surveyor – SAMS - AMS

Society of Accredited Marine Surveyors



# Marine Industry Activities

NFPA 302 Watercraft – Chairman

NFPA 303 Marinas and Boatyards  
Member – Since 2002



**National Fire Protection Association**

The authority on fire, electrical, and building safety



# Marine Industry Activities

ABYC Master Technician

Eight ABYC Marine Certifications

ABYC Instructor – Marine Electricity



Based In Kent Narrows

New Boat Sales and Brokerage

Maryland, Virginia, the Carolinas and  
Florida



# Marine Industry Activities

Licensed Captain – 100 Tons since 1993  
100+ trips up and down the East Coast.

Erie Canal, Great Lakes, Inland Rivers  
Great Loop/Circle Route.

Inspected and Uninspected Vessels to 110'  
Boat Owner for over 30 years

Perform a wide range of activities for manufacturers, dealers  
and consumers in the boating industry.



# Marine Electricity Basics:

First - There are three types of electrical systems found on boats:

**AC** – **A**lternating **C**urrent

**DC** – **D**irect **C**urrent

**GC** – **G**reen (**C**urrent) Wires

**G**rounding and bonding.

# AC - Alternating Current

Examples of equipment that produce  
AC Power

**In the marina:** Marina Transformer  
(an expanded electrical field)

**Onboard the boat:** Generators  
and Inverters  
(a somewhat restricted electrical field)

# **GC – Green Wire Current** (or **G**arbage Current)

Sources: Lightning, static electricity, stray AC fault current, stray DC fault current, faults from other nearby boats, etc.

Can't be easily detected.

Should not be hot or energized...

Should not be controlled by switches or breakers...



# Basic **GC Electric** Components

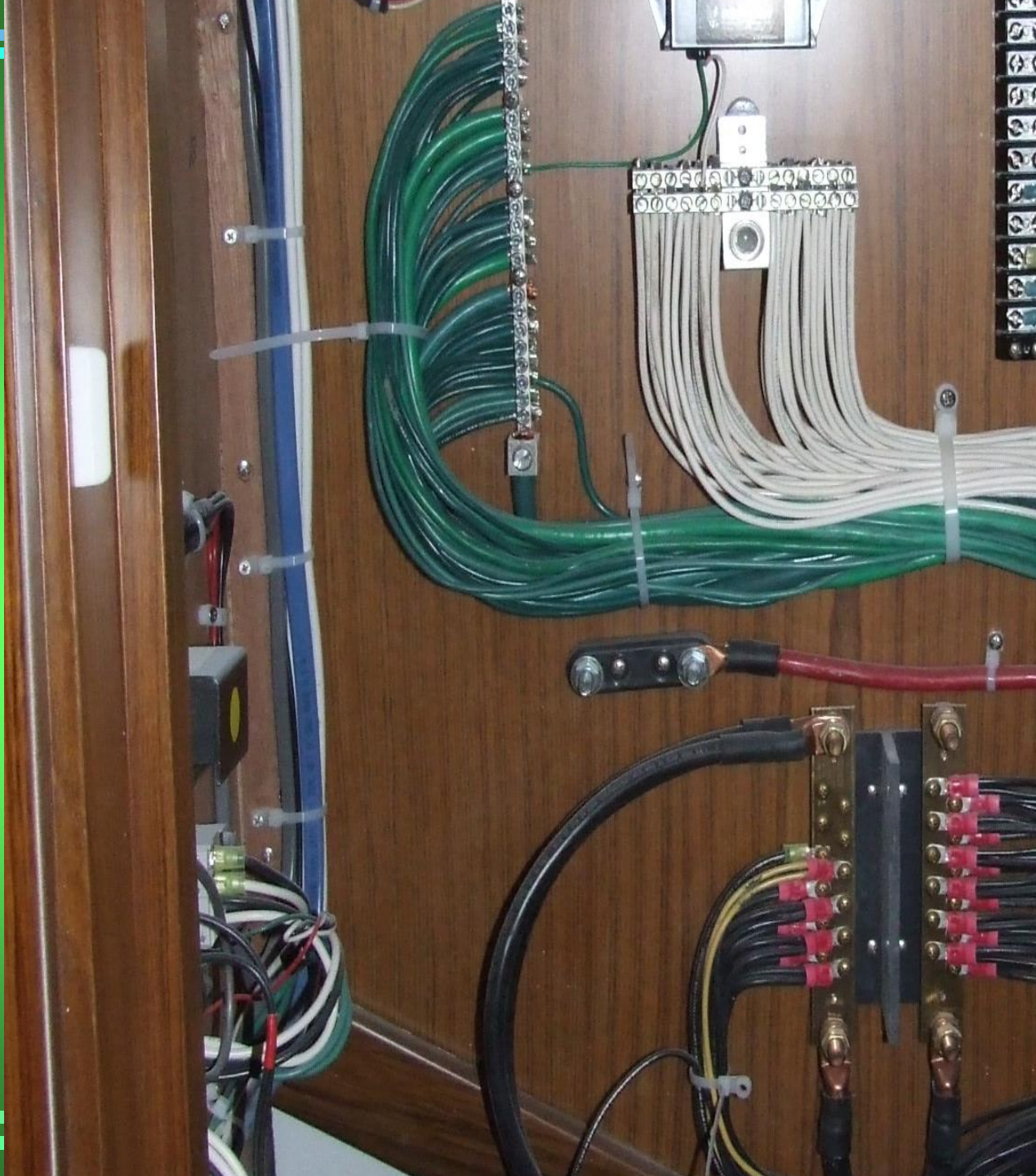
AC Grounding **g** (Green) Conductors

DC Grounding **g** (Green) Conductors  
when installed.

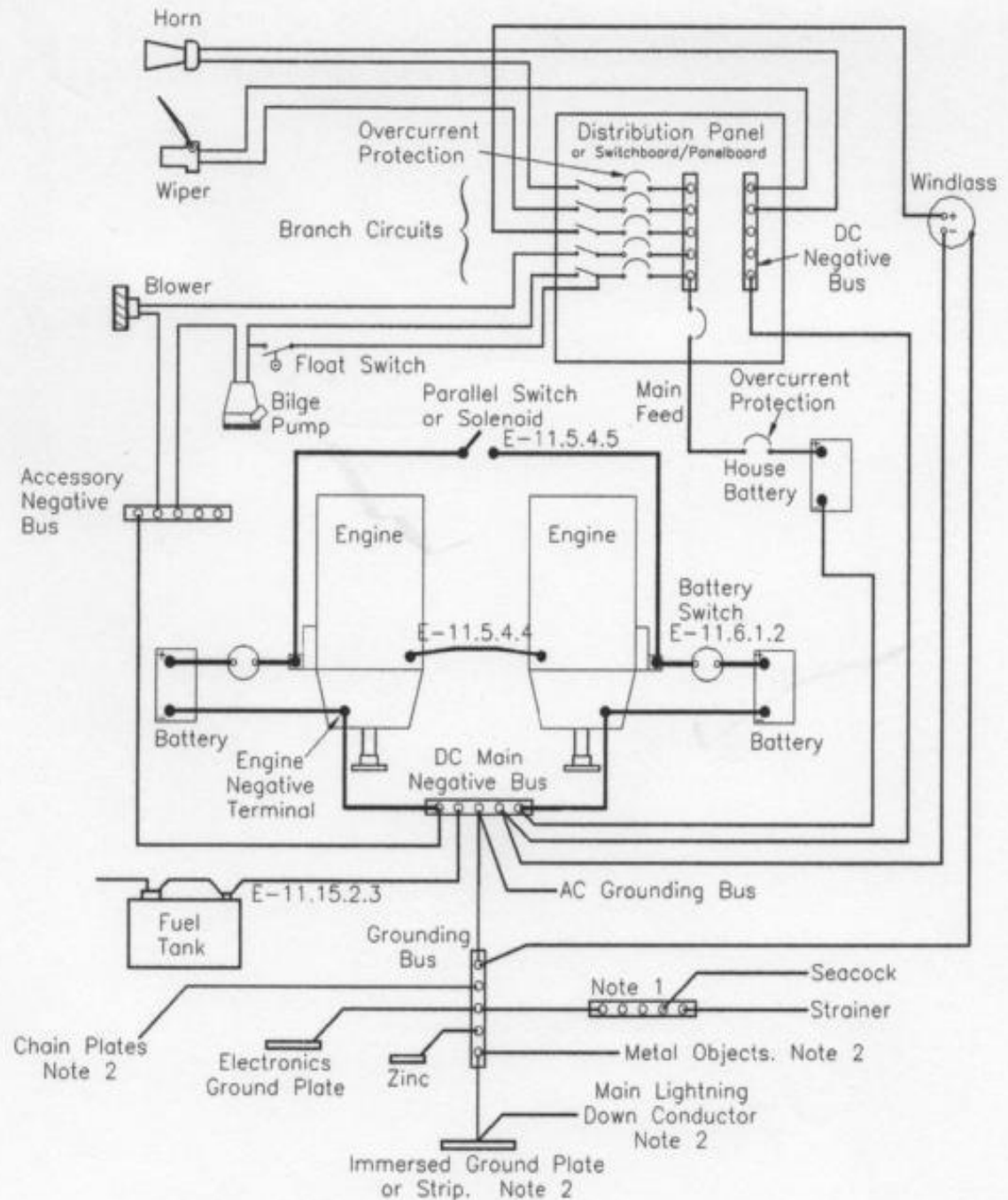
The Bonding System – connecting all  
metals that contact sea water.

...all are usually tied together in the boat.

GC  
Electric:  
green wires  
(or green  
with a  
yellow  
stripe.)



Important  
Point:  
Common  
Grounding  
AC, DC and  
GC are all  
tied  
together





# Return Path to Ground

Electricity always will seek the least resistant return to ground at the source of power.





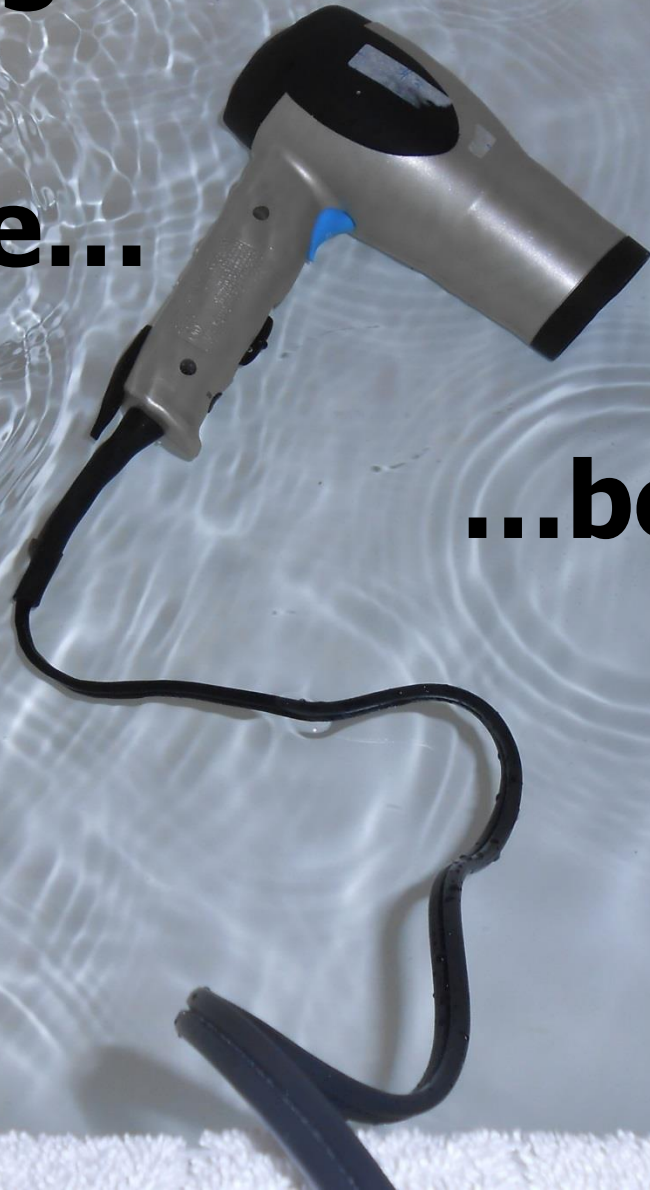


## The Return Path to Ground aboard a boat


If the AC or DC system is faulty,  
electricity will seek and usually find  
another path to ground.

...a boat and it's environment  
provides many opportunities for  
this to happen.

**So what is  
the  
difference...**



**...between  
this...**

A photograph showing the stern of a white boat docked at a wooden pier. A yellow fuel hose is connected to the boat and runs down to a black rope coiled on the pier. The water is dark and reflects the boat and the pier. The text "...and this?" is overlaid in the upper right corner.

**...and  
this?**



**KEEP AWAY FROM WATER**  
**DANGER**



AS WITH MOST ELECTRICAL APPLIANCES, ELECTRICAL PARTS OF DRYER ARE ELECTRICALLY LIVE EVEN WHEN SWITCH IS OFF. IN ORDER TO REDUCE RISK OF DEATH BY ELECTRIC SHOCK:

1. ALWAYS "UNPLUG" AFTER USE.
2. DO NOT PLACE IN STORE WHERE DRYER CAN FALL OR PULLED INTO TUB, TOILET, OR SINK.
3. DO NOT USE NEAR OR PLACE IN WATER.
4. IF DRYER FALLS INTO WATER, UNPLUG IMMEDIATELY.
5. REACH INTO WATER.

**This has  
Ground Fault  
Protection!!!**



A photograph showing the stern of a white boat on a dark, calm body of water. A yellow fuel hose is connected to the boat and runs down to a grey dock. A black rope is coiled on the dock. A white outboard motor is visible on the left. The text "...and this does not!!!" is overlaid in large, bold, black font on the right side of the image.

**...and this  
does not!!!**



**...and  
what  
is the  
difference  
between  
this...**





**...and  
this?**

**...this  
outlet is  
Ground  
Fault  
Circuit  
Protected  
(GFCI).**







**...and  
this  
is not!**

# Ground Fault Protection

In these examples there are redundant ground fault devices on the hair dryer and the outlet.

While in the marine environment neither the boat or the pedestal is ground fault protected.

## Definition: Circuit Breaker

Protective AC or DC electrical device that turns itself off (trips) to interrupt flow of electricity, if the current exceeds a preset limit.

Protects equipment from fire.



# Definition:

## Ground Fault Circuit Protection

Protective AC device that disconnects a circuit whenever it detects that the electrical current is not balanced between the energized or hot (black) conductor and the neutral or grounded (white) conductor.

Protects people from shock.

# Ground Fault Protection

Measured in milli-amps:  
5mA, 30mA and 100mA

Also measured in milli-seconds:  
100ms is the typical trip time

Can be an outlet or breaker

# NEC GFCI Requirements

**1968** - Swimming pool underwater lighting

**1971** - Outdoor receptacles and near swimming pools

**1975** - Bathroom receptacles and construction sites

**1978** - Garage receptacles

**1981** - Spas or hot tubs

**1984** - Bathrooms of hotel or motel guest rooms

**1987** - Basements, receptacles near kitchen sinks, and boathouses

## **NEC GFCI Requirements Cont'd**

**1990** - Unfinished basements and crawl spaces

**1993** - Wet bar sinks


**1996** - All kitchen countertop receptacles,  
unfinished accessory buildings, rooftops

**2005** - Near laundry and utility room sinks,  
outdoors in public spaces

**2008** - All sinks (other than dwelling units), electric  
water drinking fountains

# GFCI – Boats and Requirements

- GFCI - Ground Fault Circuit Interrupter
- GFCI protection is required in heads, galleys, engine rooms and on deck.
- GFCI's frequently feed other receptacles.
- GFCI's are not ignition protected.
- GFCI's should be tested regularly.

A white boat with "SOUNDSEA" written on its side is shown from a side-rear perspective, sailing on the water. The scene is set at sunset, with a warm orange glow on the horizon. In the distance, a suspension bridge is visible against the sky. The boat has a blue stripe and a yellow light fixture.

# The Rules and Regulations for Boats



# Alternating Current Creature Comforts



100% Heavy Duty Corrugated  
FRAGILE GLASS  
SHOWER DOOR  
TAPPAN  
CONVECTION GRILL  
MICROWAVE OVEN  
Model No. TC189S

Mech Wash  
TAPPAN  
CONVECTION GRILL  
MICROWAVE OVEN  
Model No. TC189S

DO NOT HANDLE FROM SIDE  
MADE IN THE USA  
700BR  
5250420  
2792816  
M676140  
SUB-ZERO  
DO NOT HANDLE FROM SIDE  
CAUTION: DO NOT HANDLE FROM SIDE  
DO NOT DROP

MALBI  
SHARP  
900. 1.5 cu. ft.  
Carousel  
R-930CS

74040  
FRONT  
GARDALL SAFE CORP  
TEL NO. : (800) 722 7233  
Website : www.gardall.com

CAUTION:  
DO NOT HANDLE FROM SIDE  
UP  
DO NOT DROP  
700BR  
5230420  
2728667  
M447170  
SUB-ZERO

# AC – Alternating Current

AC current has not been around as long as DC current in boats.

First – on board battery chargers.

Then air conditioning, heat, hot water heaters, etc.

Now – TV, Bose system, computer, stove, microwave, block heaters, hair dryer, freezers, washer/dryers, etc.



**KEEP AWAY FROM WATER**  
**DANGER**



AS WITH MOST ELECTRICAL APPLIANCES, ELECTRICAL PARTS OF DRYER ARE ELECTRICALLY LIVE EVEN WHEN SWITCH IS OFF. IN ORDER TO REDUCE RISK OF DEATH BY ELECTRIC SHOCK:

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3. DO NOT USE NEAR OR PLACE IN WATER.
4. IF DRYER FALLS INTO WATER, UNPLUG IMMEDIATELY.
5. REACH INTO WATER.



**Remember  
This?**



# Meet this!



# The ABYC Standards

**STANDARDS  
AND  
TECHNICAL  
INFORMATION  
REPORTS  
FOR  
SMALL  
CRAFT**

**July 2012-2013**

(Includes Supplement 52)

**BOATS - ENGINES - MARINE PRODUCTS**

**ABYC**

*Setting Standards for Safer Boating®*

613 Third Street, Suite 10, Annapolis, MD 21403

Tel 410-990-4460 Fax 410-990-4466

[www.abycinc.org](http://www.abycinc.org)



## ABYC E-11

11.11.1 An Equipment Leakage Circuit Interrupter (ELCI) or Type A Residual Current Device (RCD) 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.

NFPA  
302  
Pleasure and  
Commercial  
Motor Craft  
(up to 300  
Gross tons)  
2015

NFPA® 302  
Fire Protection  
Standard for  
Pleasure and  
Commercial  
Motor Craft  
2015 Edition



# NFPA 302 Watercraft (2015)

**10.20.8.5** Ground-fault protection equipment shall be installed in the main shore power conductors with or in addition to the main shore power disconnect circuit breaker(s) aboard the vessel.

**10.20.8.5.1** The device trip level shall be a maximum of 30mA and the trip time shall be a maximum of 100mS. The device shall be readily accessible.

# CFRs Code of Federal Regulations for Pleasure Boats

# code of federal regulations

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## Navigation and Navigable Waters

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### 33

PARTS 1 TO 124

Revised as of July 1, 1999

CONTAINING  
A CODIFICATION OF DOCUMENTS  
OF GENERAL APPLICABILITY  
AND FUTURE EFFECT

AS OF JULY 1, 1999

*With Ancillaries*

Published by  
the Office of the Federal Register  
National Archives and Records  
Administration

as a Special Edition of  
the Federal Register



# CFR Requirements

There are no CFR ground fault requirements for uninspected pleasure vessels and likely there never will be.

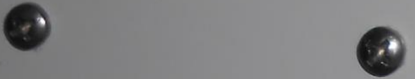
There may be CFR ground fault requirements for uninspected commercial towing and fishing vessels.



240V 50A  
SHORE POWER



240V 50A  
SHORE POWER



50A ELCI  
SHORE POWER

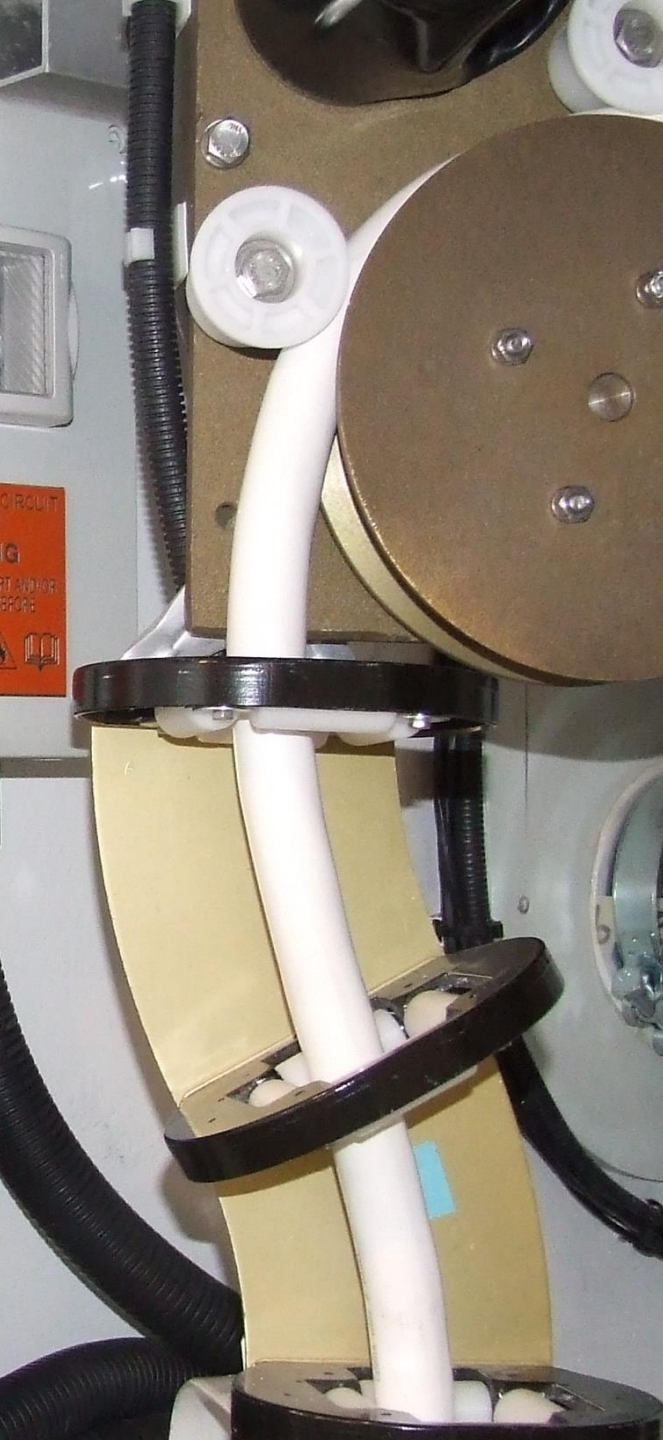


50A ELCI  
SHORE POWER



SHORE SUPPORT CIRCUIT  
BREAKER  
**WARNING**  
UNPLUG SHORE SUPPORT AND/OR  
STOP GENERATOR BEFORE  
OPENING  
⚠ ⚡ ⚠ 🔧  
MGB 50A

SHORE SUPPORT CIRCUIT  
BREAKER  
**WARNING**  
UNPLUG SHORE SUPPORT AND/OR  
STOP GENERATOR BEFORE  
OPENING  
⚠ ⚡ ⚠ 🔧  
MGB 50A

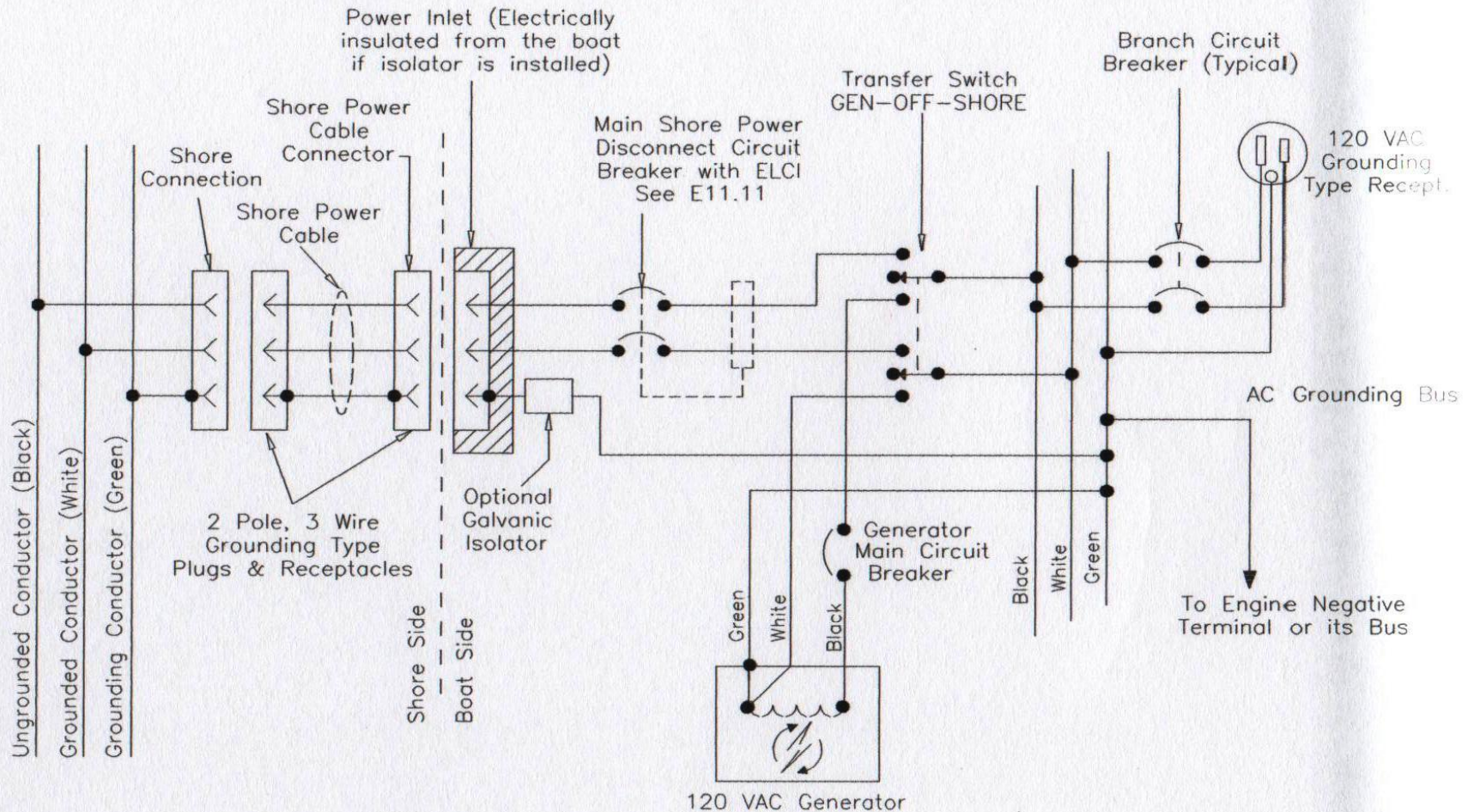




**DIAGRAM 2 – (See E-11.17.1)**

**Single Phase 120-Volt Systems with Shore-Grounded (White) Neutral Conductor and Grounding (Green) Conductor.**

**Note: This diagram does not illustrate a complete system. Refer to appropriate text.**



# Ground Fault Protection for Boats Summary

The new ABYC and NFPA ground fault requirements should be implemented in all new boat builds.

If in fact the builders are installing these devices, it will still be a number of years before the greater percentage of boats in the marina are ground fault protected.



# The Rules and Regulations for Marinas



# The electrical regulations for marinas...

The NEC National Electrical Code is Law!

Contractors don't follow the NEC rules for marinas and boatyards.

AHJ frequently signs off on the contractors non-compliant work.

Marinas don't know or follow the NFPA 303 rules for marinas and boatyards.



# NFPA 303 Marinas and Boatyards

2015  
Edition  
Coming  
Shortly

NFPA® 303  
Fire Protection  
Standard for  
Marinas and  
Boatyards  
2011 Edition



NFPA®, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02169-7471, USA  
An International Codes and Standards Organization

**NEC**

**The  
National  
Electrical  
Code**

**NFPA 70**

NFPA 70®

**2014**

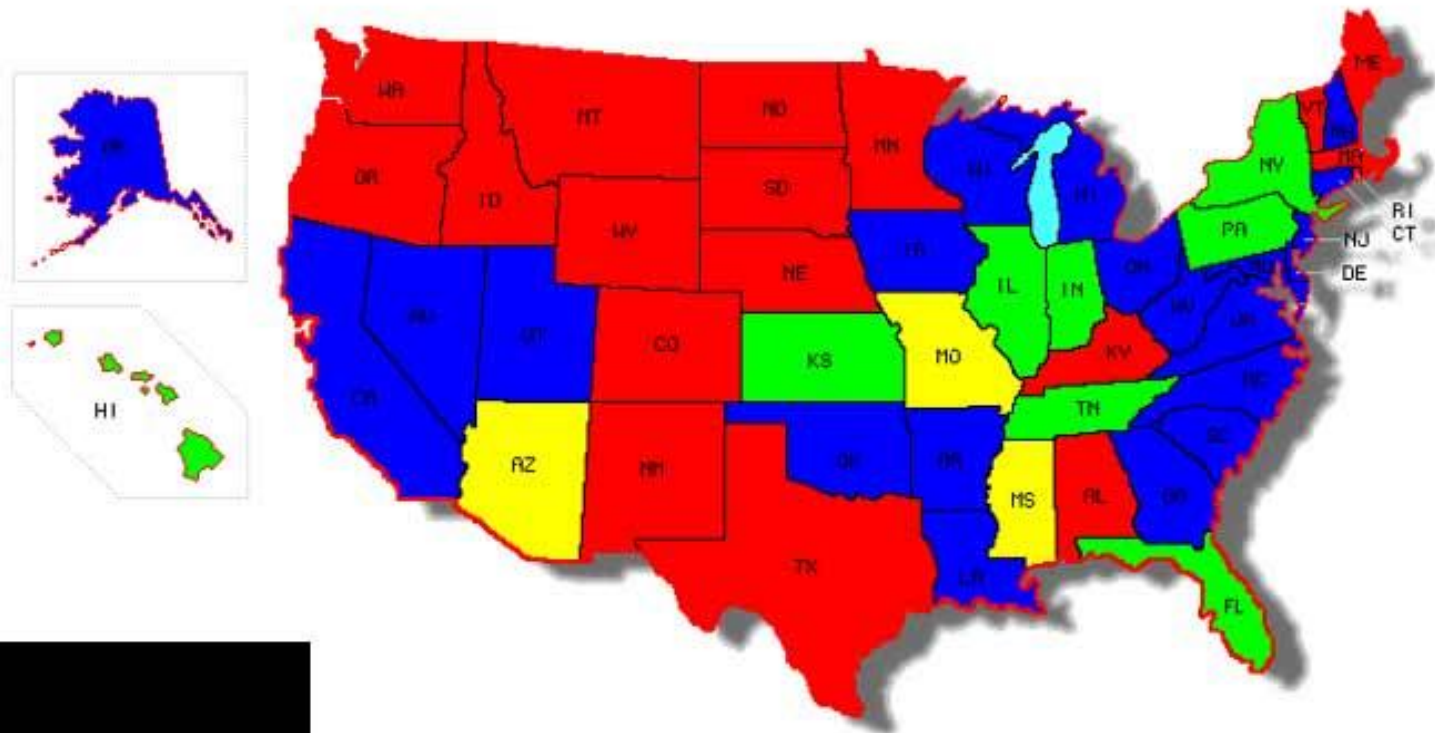


National Electrical Code®  
International Electrical Code® Series

# NEC Adoption States

NEC® in Effect

11/1/2014



2014 NEC®

2011 NEC®

2008 NEC®

No Statewide NEC® Adoption



NEC  
National  
Electrical  
Code

Includes  
Article 555  
Marinas and  
Boatyards

NFPA 70®

**2014**



National Electrical Code®  
International Electrical Code® Series

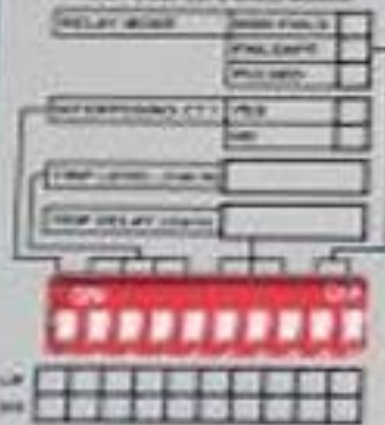
**Remember  
This?**







**DISPATCH SETTINGS**  
FOR COMPLETE BUILD MODEL



EXTERNAL CT SENSOR  
RATINGS PER IEEE 519  
I<sub>N</sub> (A) = 300  
I<sub>SC</sub> (A) = 0.83 x I<sub>N</sub>  
F (Hz) = 45 - 480

**Eaton | Cutler-Hammer**

**DIGITAL GROUND FAULT RELAY**  
**D64RPB100**

T1  
CT  
T3R2  
TEST RESET  
R1



SEE MANUAL FOR  
SET-UP INSTRUCTIONS

**RESET**

DOUBLE CLICK FOR TEST

RUN TRIP

**Meet this!**

# 2011 NEC - Marina Requirements for Ground Fault Circuit Protection

**NEC 555.3 Ground-Fault Protection.** The main over-current protective device that feeds the marina shall have ground fault protection not exceeding 100mA. Ground-fault protection of each individual branch or feeder circuit shall be permitted as a suitable alternative.

# NFPA 303 Marinas and Boatyards

303.5.5.3 Ground fault protection shall be installed in accordance with *NFPA 70*, Article 555.3.

(Approved for the next edition which will be out later this year.)

# The Current 555.3 Requirement

The current NEC 555.3 requirement does not provide a complete solution.

It creates a problem for marina owners and their customers and invites circumvention of the protective devices.



# Ground Fault Protection Elsewhere

Ground fault protection has been a requirement for boats in Europe for many years in the form of an RCD.

Ground fault protection has also been a requirement for marina power pedestals for years as well.



PORTOONL7

S 310

 Danger



WYLEX  
RCD  
63A 30mA  
WRS63/2

Schneider Electric  
C60HC  
C6  
240/415V~  
10000  
3  
25643

Schneider Electric  
C60HC  
C25  
415V~  
10000  
3  
25661

Schneider Electric  
C60HC  
C25  
415V~  
10000  
3  
25661

Stray  
Current  
In the  
Marina  
Vs.  
Out on  
The  
water





# Stray Current in the Marina

Stray AC current in the marina is a larger concern because the circuit starts in the marina's electrical equipment.

Stray current always attempts to return to its own source of power.

The fault circuit will potentially include a great amount of the marina's water.

# Generators and ESD











# Stray AC and Fresh Water

The amount of salinity in the body is very close to the amount of salinity in salt water. Electricity does not see the difference.

Fresh water does not carry electricity as well. When a body enters fresh water the electricity is attracted to it.



**Fatalities**

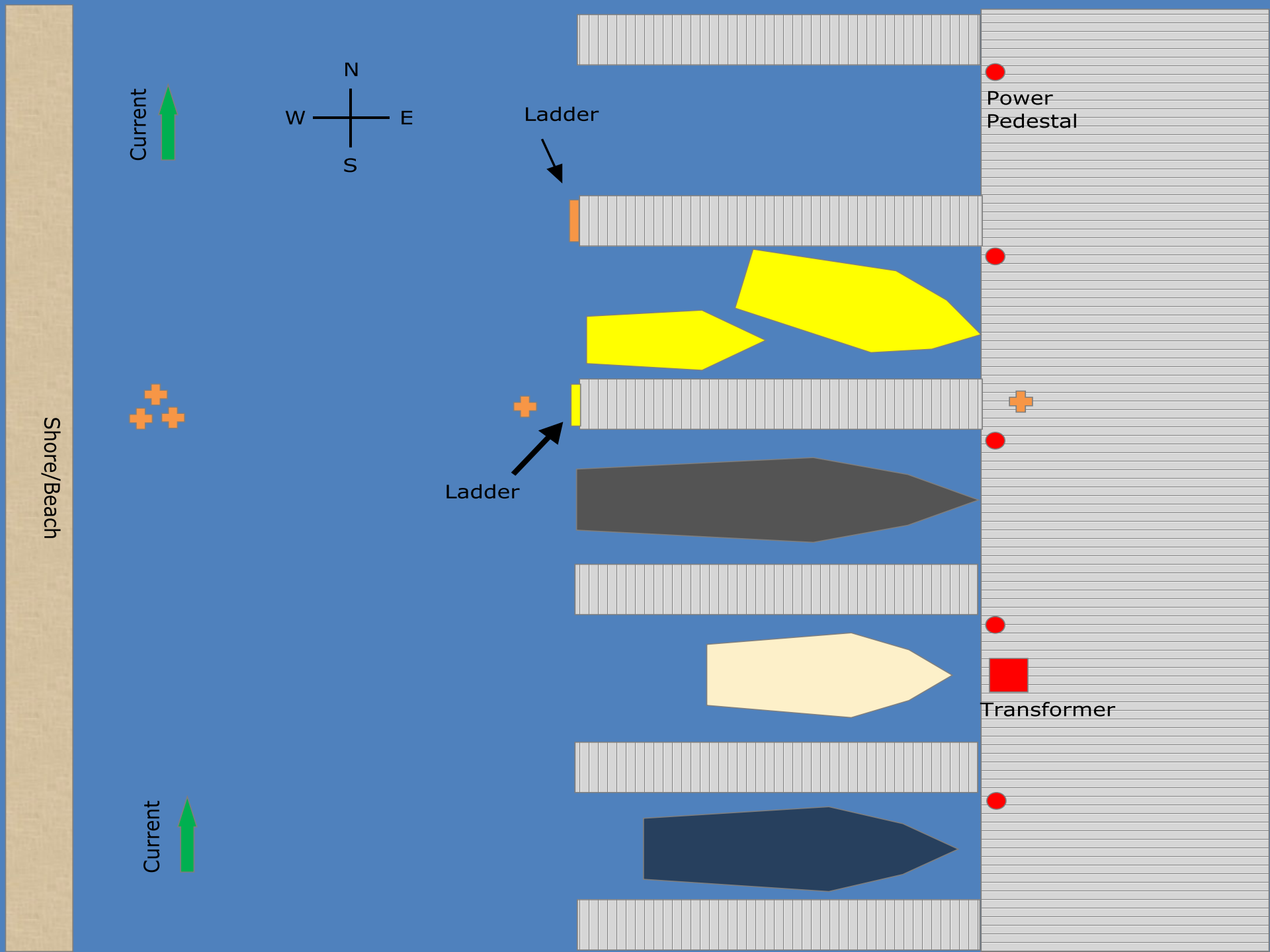
# Stray AC and Shock Drowning

A small amount of stray AC current in the water immobilizes the victim and the victim drowns.

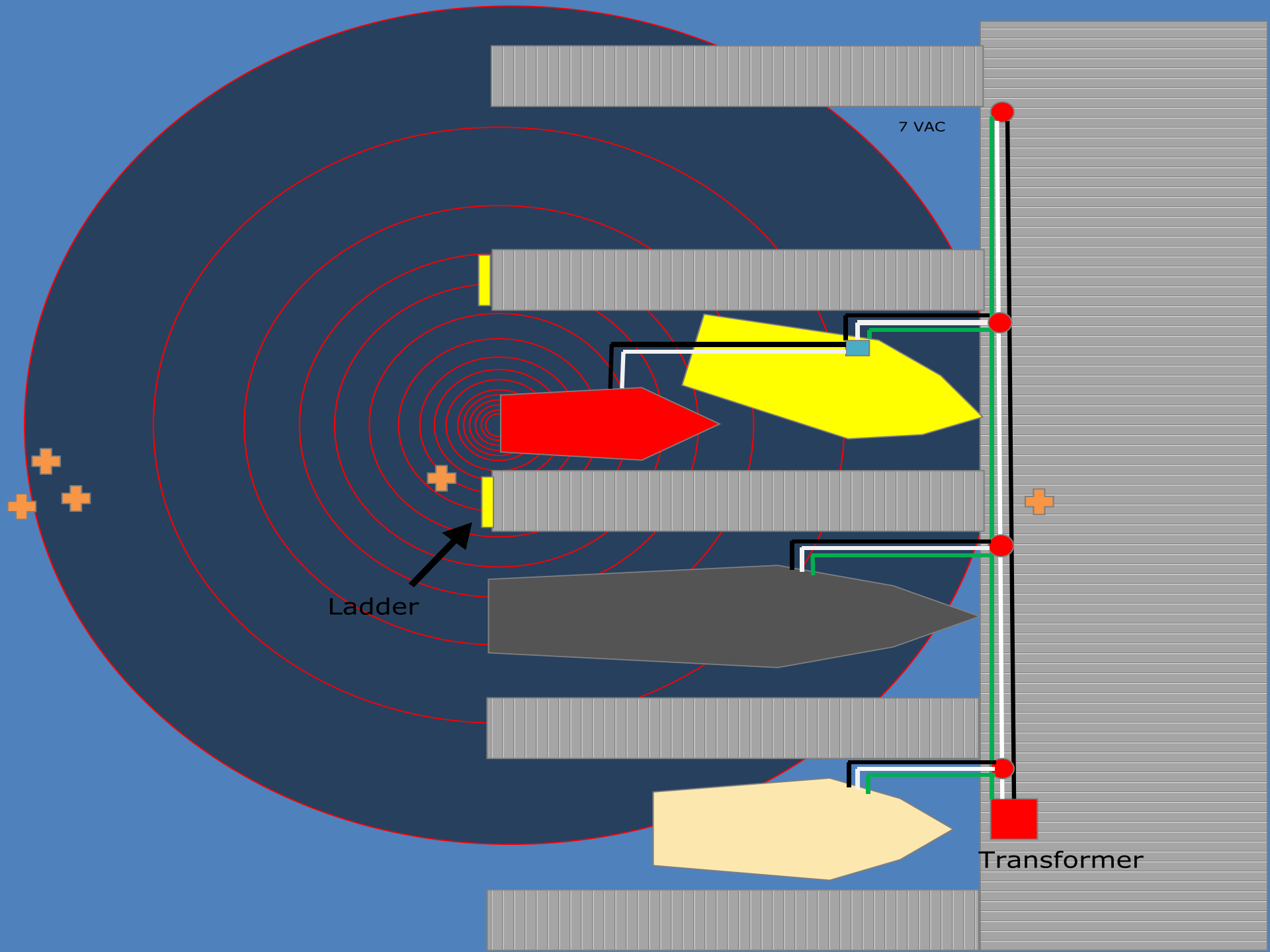
Typically the result of **two faults**:

An AC fault aboard the boat and...

A defective (GC) **g**reen grounding wire aboard the boat and/or the dock.







7 VAC

Ladder

Transformer

# West Virginia Michael Cunningham Act



COMMITTEE SUBSTITUTE

FOR

## **H. B. 3020**

---

(BY DELEGATE(S) MILEY, IAQUINTA, LONGSTRETH, GUTHRIE,  
WHITE, BOGGS, CAPUTO, SKAFF, P. SMITH, MOYE AND FERRO)

---

(Originating in the House Committee on Finance.)

[March 28, 2008]

A BILL to amend the Code of West Virginia, 1931, as amended, by adding thereto six new sections to article seven, chapter twenty, designated §20-7-24, §20-7-25, §20-7-26, §20-7-27, §20-7-28, and §20-7-29, all relating to boat, boat dock and marina safety; providing definitions; requiring compliance with certain standards; requiring work by certified electricians; establishing a date for compliance; and providing penalties.

# Arkansas Act 571 Jesse's Law

Stricken language would be deleted from and underlined language would be added to the law as it existed prior to this session of the General Assembly.  
Act 571 of the Regular Session

As Engrossed: S2/24/11

## A Bill

SENATE BILL 317

1 State of Arkansas  
2 88th General Assembly  
3 Regular Session, 2011

4  
5 By: Senator Whitaker

### For An Act To Be Entitled

6  
7  
8 AN ACT TO ENSURE THE SAFETY OF BOAT DOCKS AND MARINAS  
9 BY ESTABLISHING MINIMUM ELECTRICAL STANDARDS AND  
10 SIGNAGE REQUIREMENTS; AND FOR OTHER PURPOSES.

### Subtitle

11  
12  
13  
14 JESSE'S LAW: TO ENSURE THE SAFETY OF BOAT  
15 DOCKS AND MARINAS BY ESTABLISHING MINIMUM  
16 ELECTRICAL STANDARDS AND SIGNAGE  
17 REQUIREMENTS.

18  
19  
20 BE IT ENACTED BY THE GENERAL ASSEMBLY OF THE STATE OF ARKANSAS:

21  
22 SECTION 1. NOT TO BE CODIFIED.

23 The General Assembly finds:

24 (1) Arkansas is known for its beautiful and abundant lakes and  
25 rivers, which provide a draw for tourism and a boost for our economy;

26 (2) Our lakes and rivers should be a safe place for children and  
27 families to enjoy;

28 (3) There have been cases recently where children have died  
29 because the water where they were swimming was electrified by the ungrounded  
30 and improper connection of electricity to boat docks and marinas;

31 (4) Electricity and water create a deadly combination that can  
32 paralyze a swimmer which can result in the swimmer drowning, and children who  
33 are swimming are particularly vulnerable to electrocution and shock in the  
34 water; and

35 (5) Bringing boat docks and marinas up to the National Fire  
36 Protection Association Standards for Marinas and Boatyards and the National



# **Kentucky**

House Bill 356

Samantha Chipley  
Act

is currently under  
consideration.





**Tennessee**  
House Bill 1892  
The  
Noah Winstead  
Nate Lynam  
Electric Shock  
Drowning  
Prevention Act.



# New state laws refer to existing long time NFPA standards...

Arkansas Law: “Bringing boat docks and marinas up to **National Fire Protection Association 303 Standard for Marinas and Boatyards** and the **National Electric Code** is necessary for the protection and safety of all of those who enjoy our lakes and rivers for recreation and to protect our tourism and boating industry.”

## **New Laws / Old NFPA Standards**

Tennessee Law: “...for the purpose of ensuring compliance with the standards for maintenance of electrical wiring and equipment contained in the **National Fire Protection Association (NFPA) 303, section 5.20...**”

# **NFPA Research Foundation Grant**

**Assessment of Hazardous Voltage  
Current in Marinas and Boatyards.**

**Awarded to the ABYC.**

**Power pedestal Ground Fault Protection.**

**Other notification and trip devices.**

**No swimming signage in the marina.**



# Dangerous Stray Current Marina Managers and Boat Owners

Improved and pro-active approach to **monitoring electrical current conditions** by marina management and personnel.

Boat owners should also be mindful of the danger that deficient electrical equipment may cause.

# Program Summary

Captains should **elevate their observation of the AC electrical integrity** on the boats they are responsible for.

Pay close attention to the condition of electrical equipment in a marina.

Discourage swimming in the marina.

# Thank you

I appreciate the opportunity to spend  
some time with you.

Please feel free to contact me anytime  
if I can ever be of help to you.

John McDevitt - 610-220-5619

[jmcdevittcaptain@aol.com](mailto:jmcdevittcaptain@aol.com)