

A scenic view of a wooden dock extending into a calm lake. At the end of the dock is a covered pavilion with a brown tiled roof. The dock has metal railings and stairs leading down to the water. A small white boat is moored nearby. The background is filled with lush green trees.

**Electric Shock  
Drowning**

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**Risks and  
Opportunities**

# Edward "Ed" Lethert





# **Electric Shock Drowning Awareness Initiative**



# Edward "Ed" Lethert

## Electric Shock Drowning Safety Specialist



Member of the  
Electric Shock Drowning  
Prevention Association



# Very Honorable mention...



PDC Dale Perry

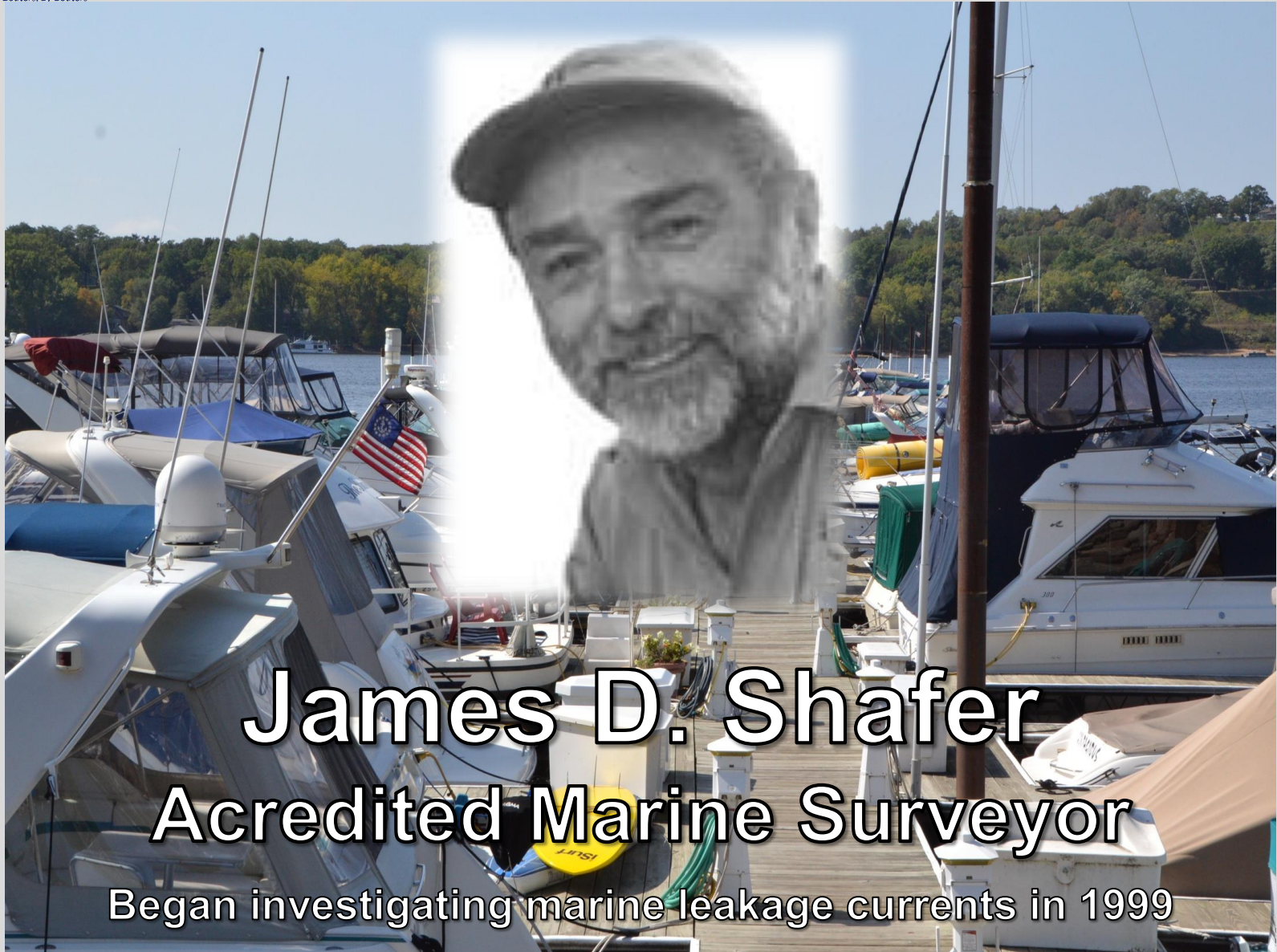


PDC Alan Wentworth

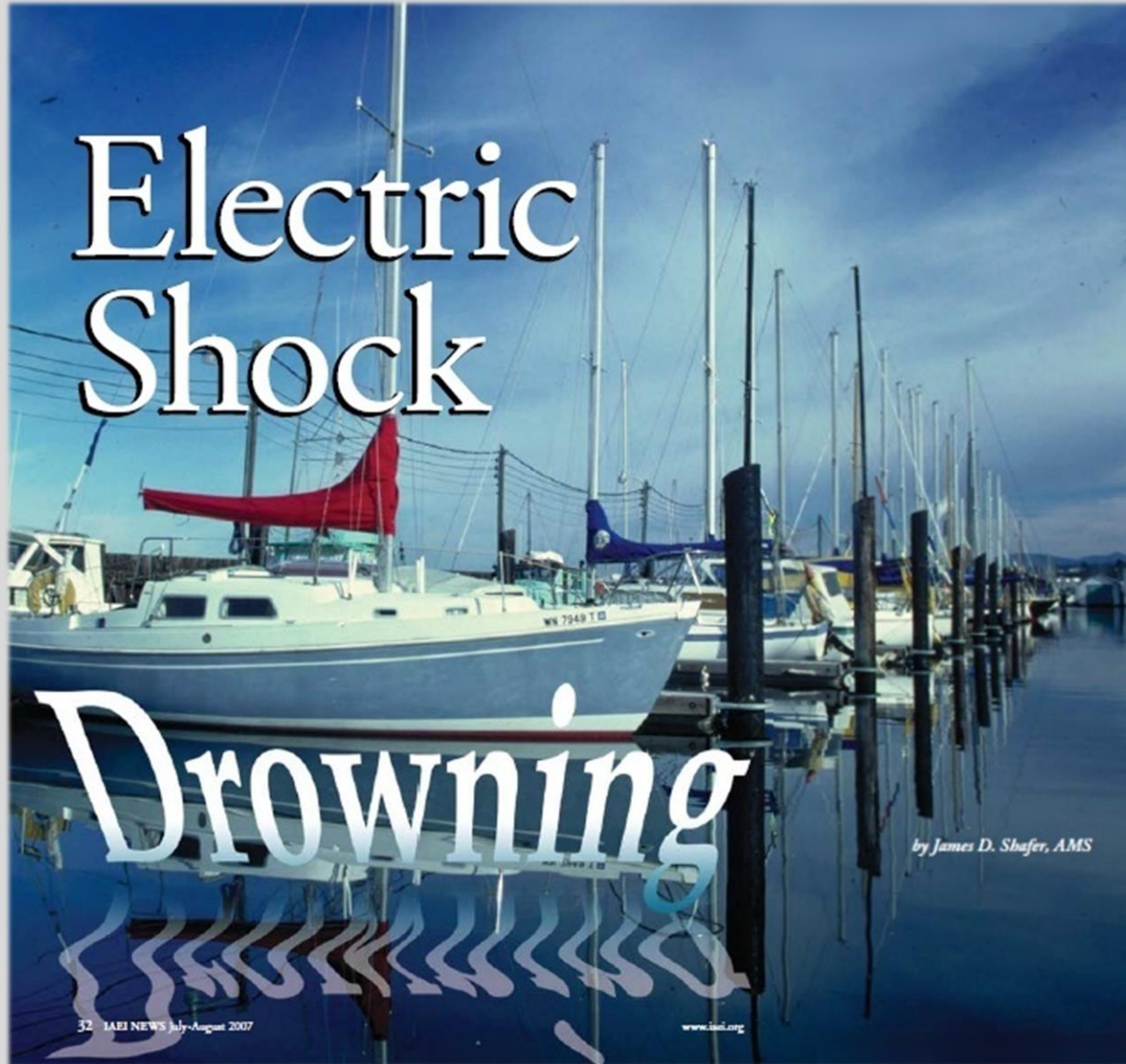


PDC Thad Smyczek









IAEI NEWS July-August 2007



*Produced under a grant from the Sport Fish Restoration and  
Boating Trust Fund, administered by the U.S. Coast Guard.*

USCG FY2006 Grant  
*In-Water Shock Hazard Mitigation  
Strategies*  
Final Report October 1, 2008



**ABYC**  
Setting Standards for Safer Boating



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# What is ESD?



ESD is a unique form of drowning caused by the presence of AC electrical currents in freshwater lakes, rivers, swimming pools, ponds, canals, etc.

The current can flow through the body of a living being immersed in the electrically charged water

The current, where sufficiently intense, can paralyze the body's skeletal muscles, inhibiting the ability to swim or move one's limbs (i.e. electrically induced cramp)

The outcome in many such cases is the drowning death of an otherwise healthy individual

Research has determined that an AC current of just **10 mA** passing through the human body is sufficient to cause muscular paralysis and is considered by the ESDPA and others as the threshold for a possible ESD incident

That's two percent of the current flowing through a 60 watt light bulb





Depending on magnitude and path, thru-body alternating current can:

1. Paralyze skeletal muscles
2. Cause respiratory paralysis (shut down the lungs)
3. Initiate ventricular fibrillation
4. Cause full cardiac arrest (electrocution)

# Electric Shock Drowning

Table II. Quantitative effects of electric current on man.

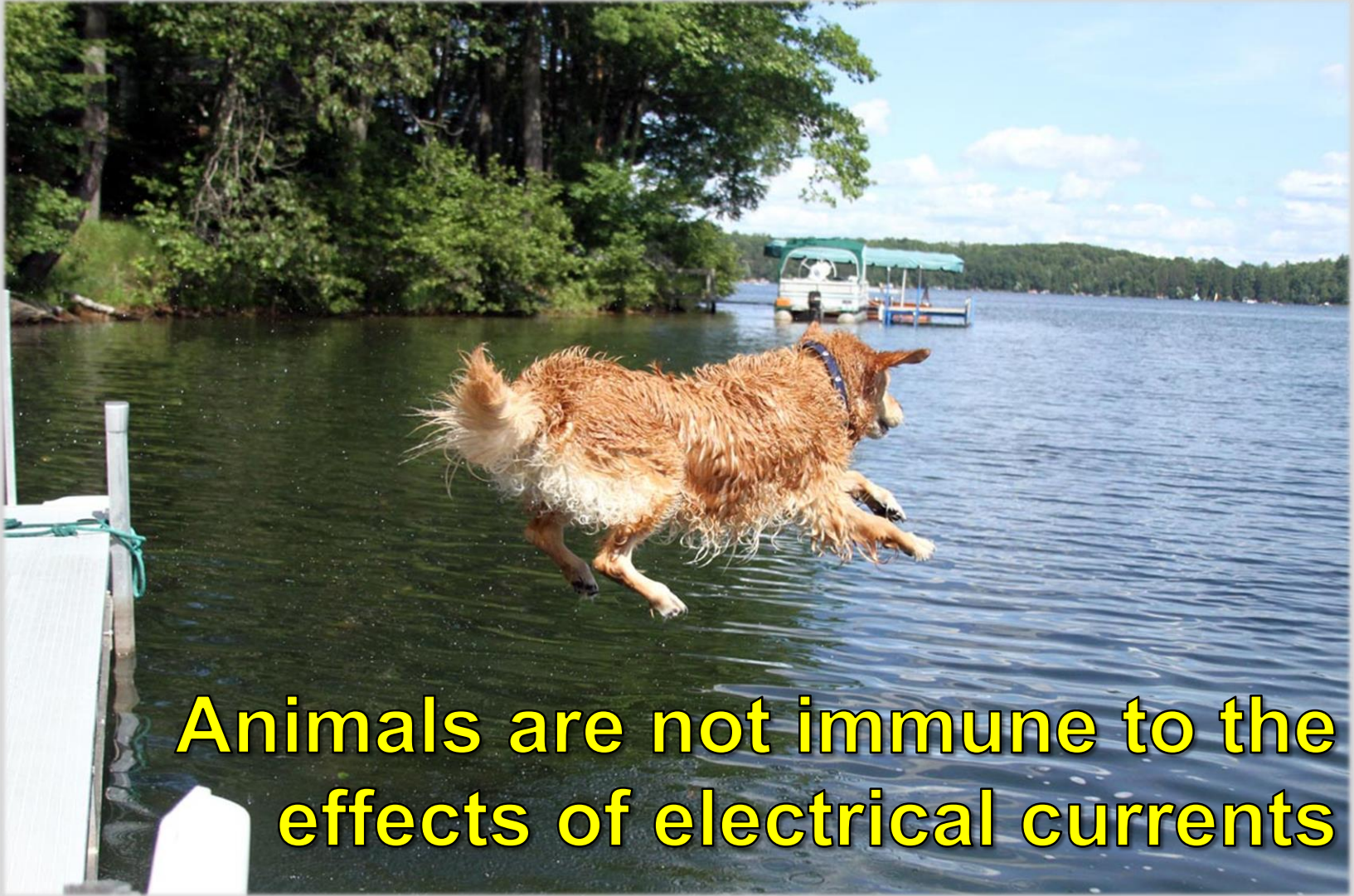
Effect	Milliamperes					
	<u>Direct Current</u>		<u>Alternating Current</u>			
	<u>Men</u>	<u>Women</u>	<u>10,000</u>		<u>60-Cycle Cycles</u>	
			<u>Men</u>	<u>Women</u>	<u>Men</u>	<u>Women</u>
Slight sensation on hand	1	0.6	0.4	0.3	7	5
Perception threshold, median	5.2	3.5	1.1	0.7	12	8
Shock— not painful and muscular control not lost	9	6	1.8	1.2	17	11
Painful shock— muscular control lost by 1/2 %	62	41	9	6	55	37
Painful shock— let-go threshold, median	76	51	16	10.5	75	50
Painful and severe shock— breathing difficult, muscular control lost by 99 1/2%	90	60	23	15	94	63
Possible ventricular fibrillation						
Three-second shocks	500	500	100	100		

## ESD is a Fresh Water Phenomenon

	In-Water Leakage <u>Current</u>	Through- Body <u>Current</u>
Salt Water	6 Amps	1.1 mA
<b>Fresh Water</b>	<b>0.3 Amp</b>	<b>23.8 mA</b>

Note: 1/20<sup>th</sup> of the saltwater leakage current results in more than 20 times the body current





**Animals are not immune to the effects of electrical currents**

ESD has claimed numerous family pets  
*and*

Family members, relatives, and others  
have become victims when entering the  
water to attempt a rescue



## A Terrible ESD Tragedy in 2012

**Blackfoot, Idaho**



Jackie Poulson, who was trying to save her dog, jumped into a canal and died along with the dog. Two others who tried to help also died. A fourth person almost died.

### A victim in electrically charged water ...

- May become partially or totally disabled
- May or may not call for help
- May or may not remain conscious
- May or may not remain on the surface
- May make their situation worse while seeking a 'safe haven' by moving toward the source of the current, rather than away from it

Electric Shock Drowning is not the same as death by electrocution, which usually results from direct contact with energized metal objects or surfaces

*In-water electrocutions are included in the ESDPA's statistics because they are caused by the same electrical conditions that cause an ESD fatality*



# What Causes the Shock Hazard?

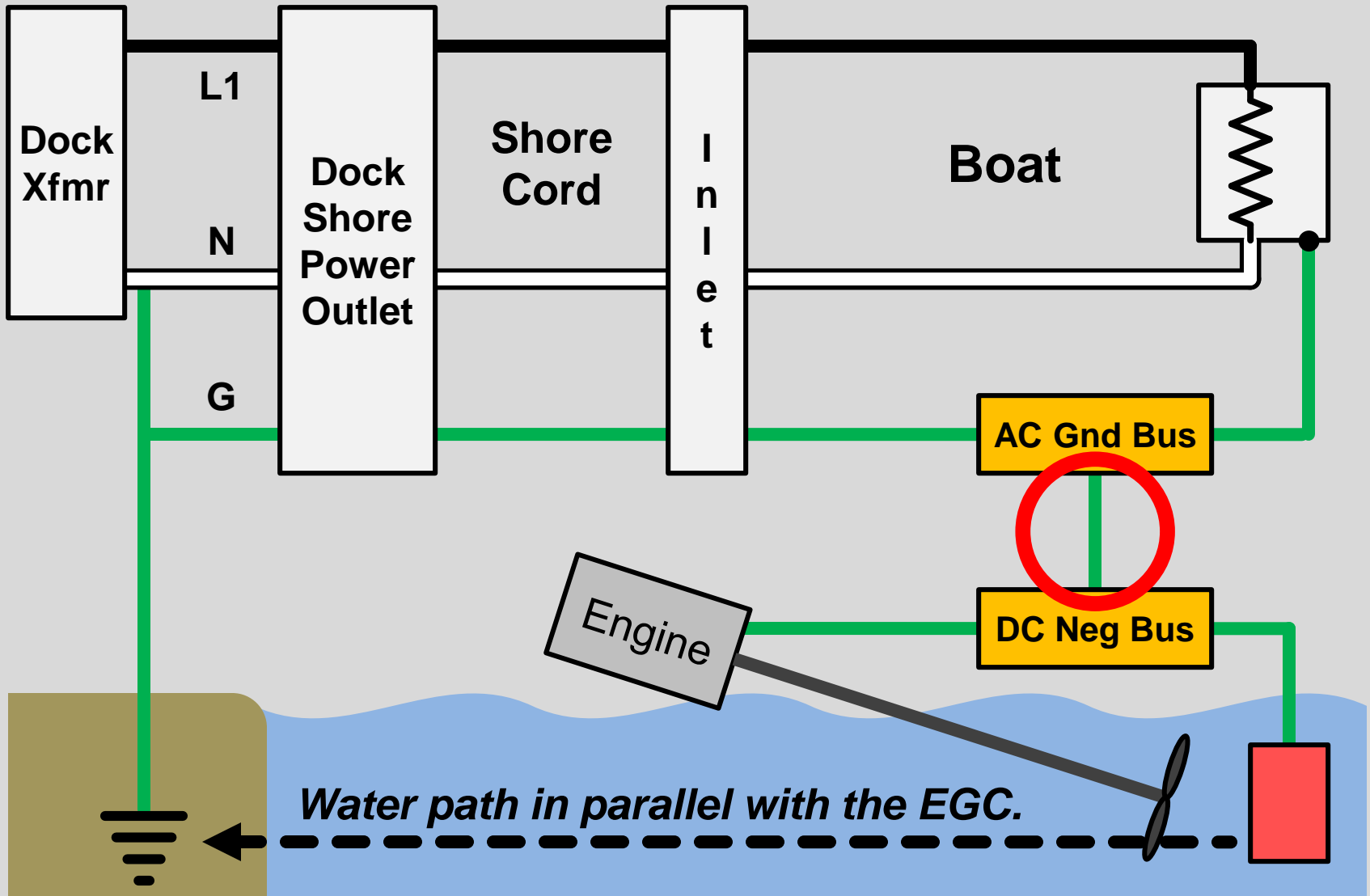


Two conditions must exist to produce dangerous levels of electrical current in the water...

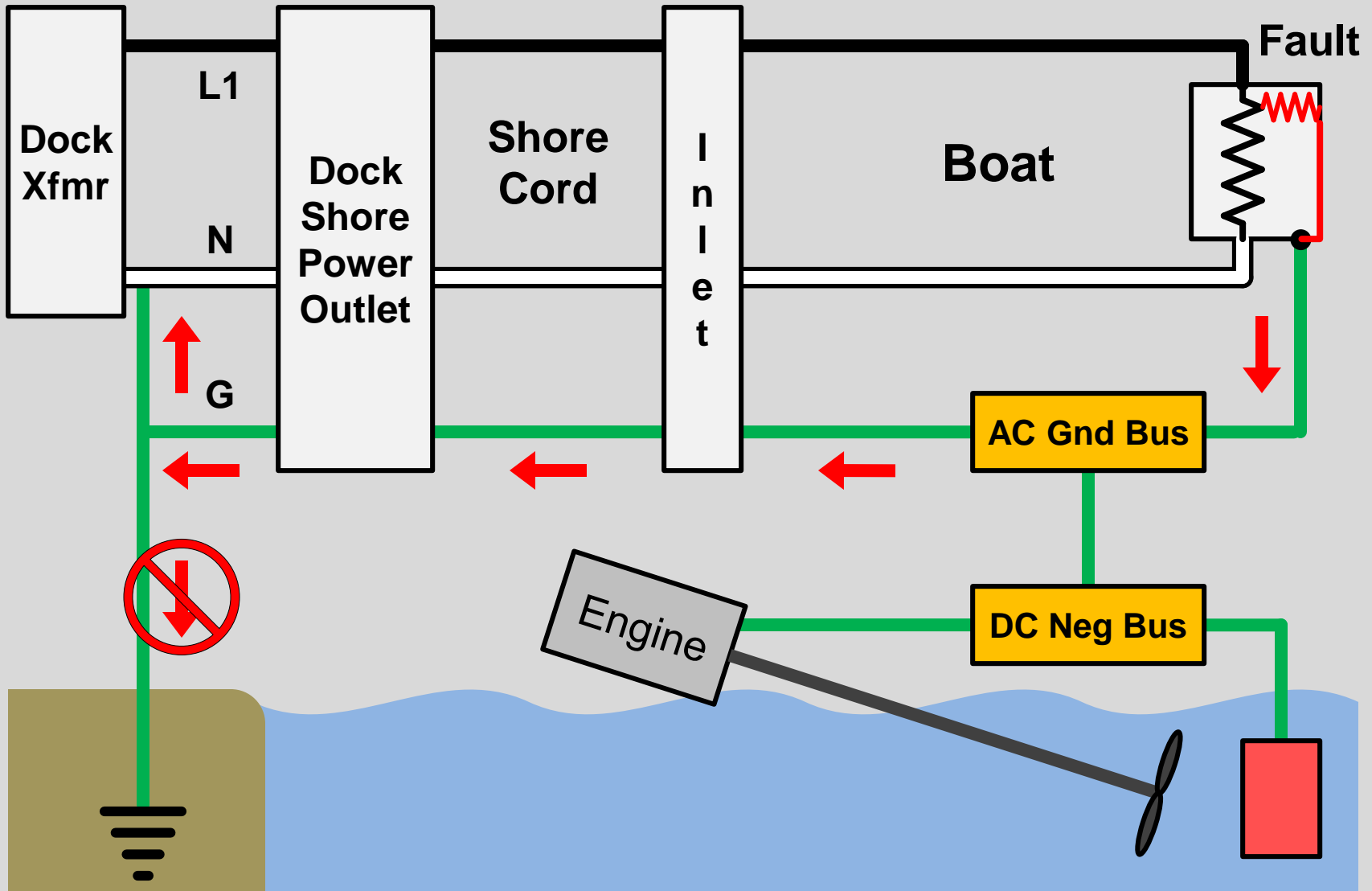
**1st** — there must be some form of electrical fault (hot to ground) at some point in the AC system or AC powered equipment (on the boat or on the dock)

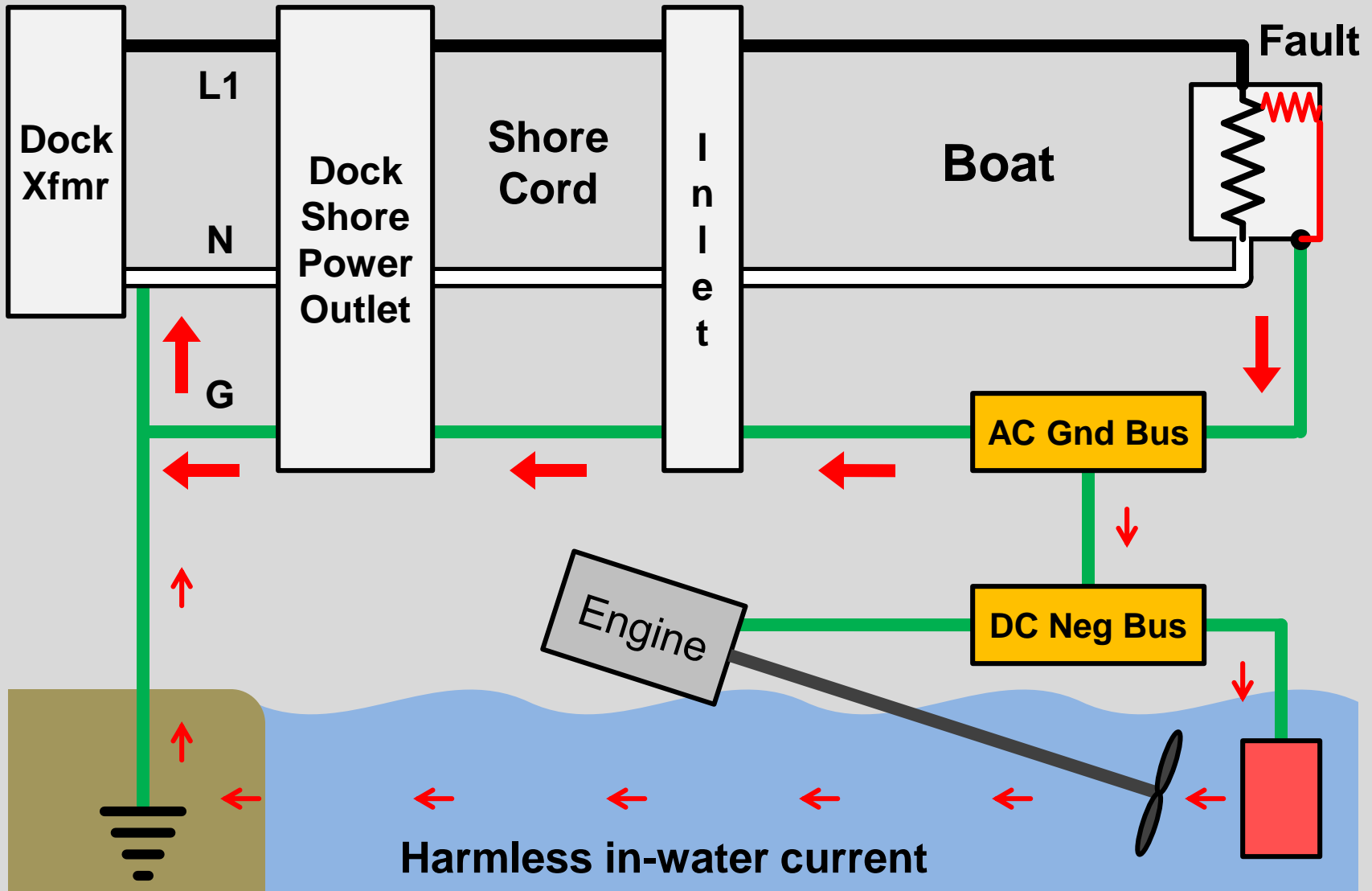
**2nd** — There must be a failure or loss of the equipment grounding conductor (on the boat or on the dock)

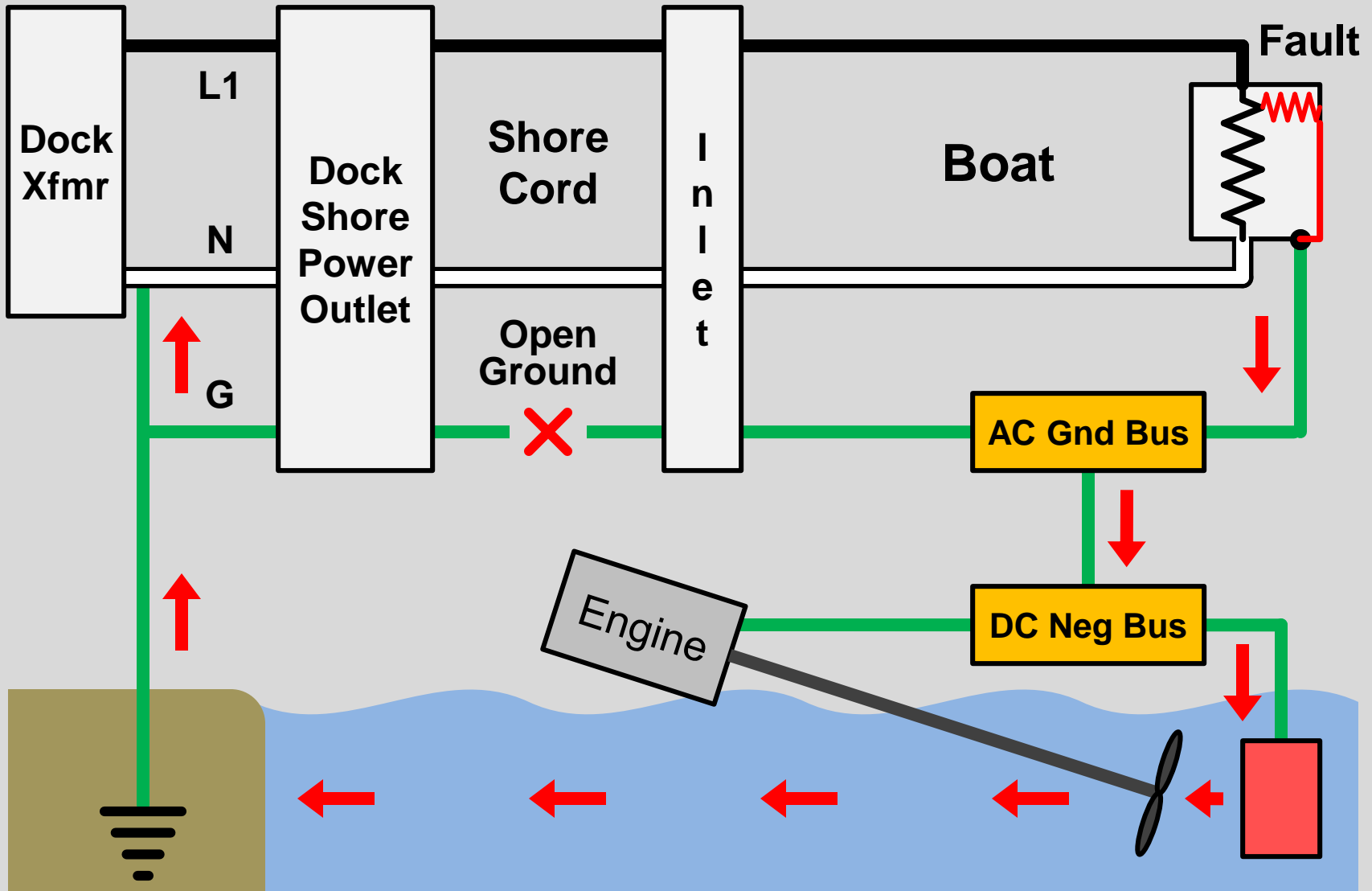
When these conditions exist, significant leakage current (i.e. ground current) is likely to be flowing through the nearby water seeking paths back to the source

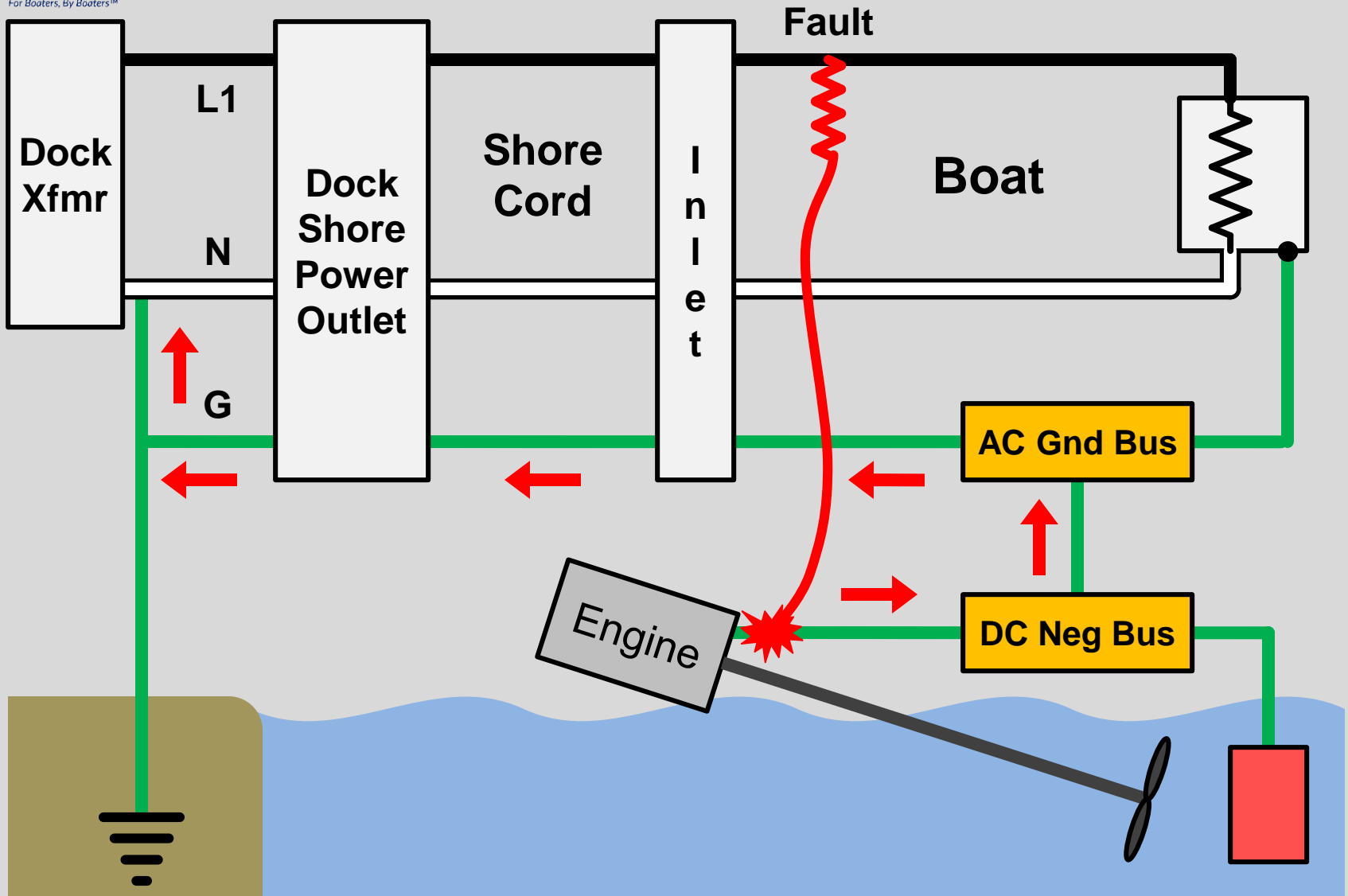


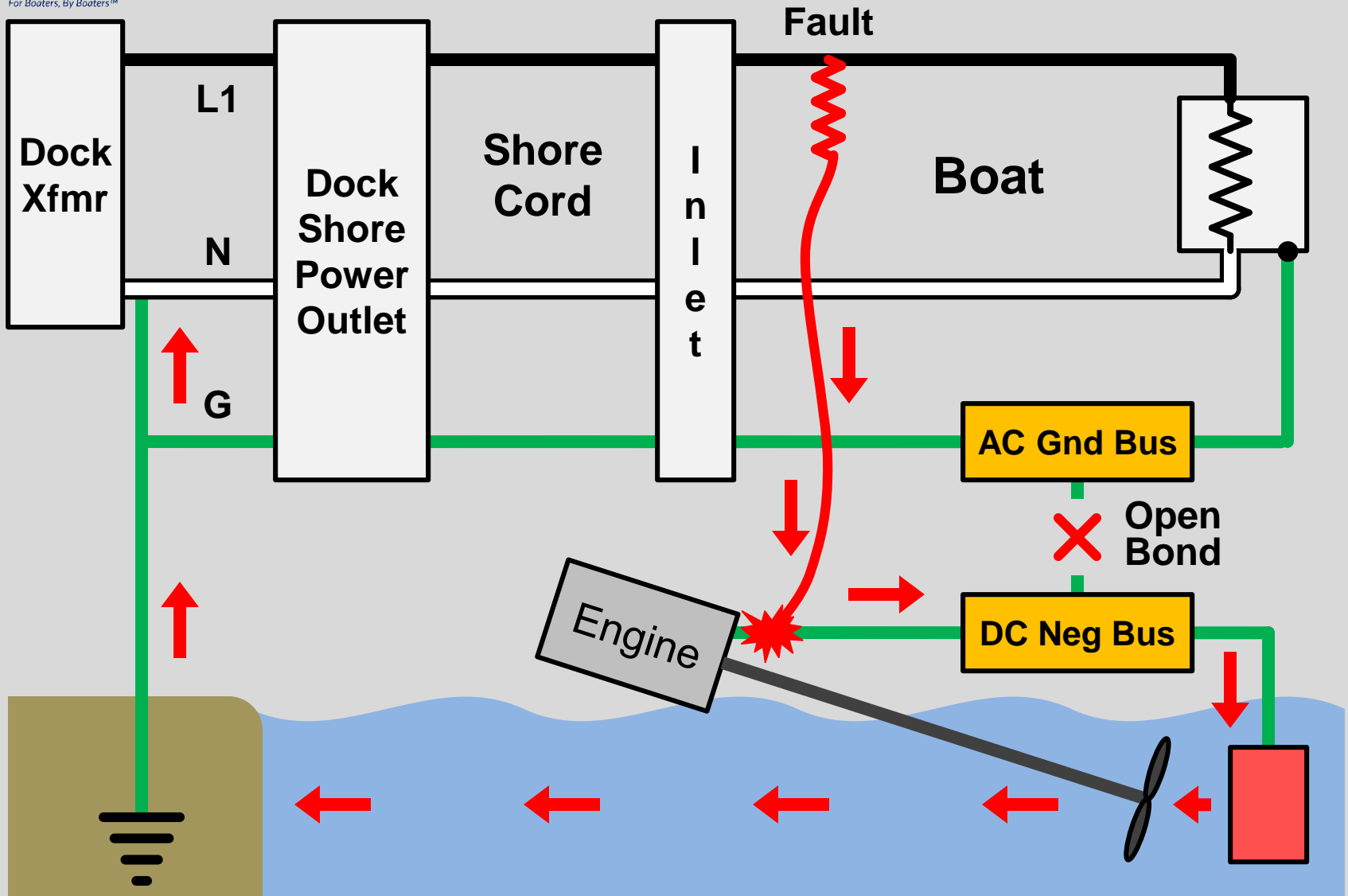






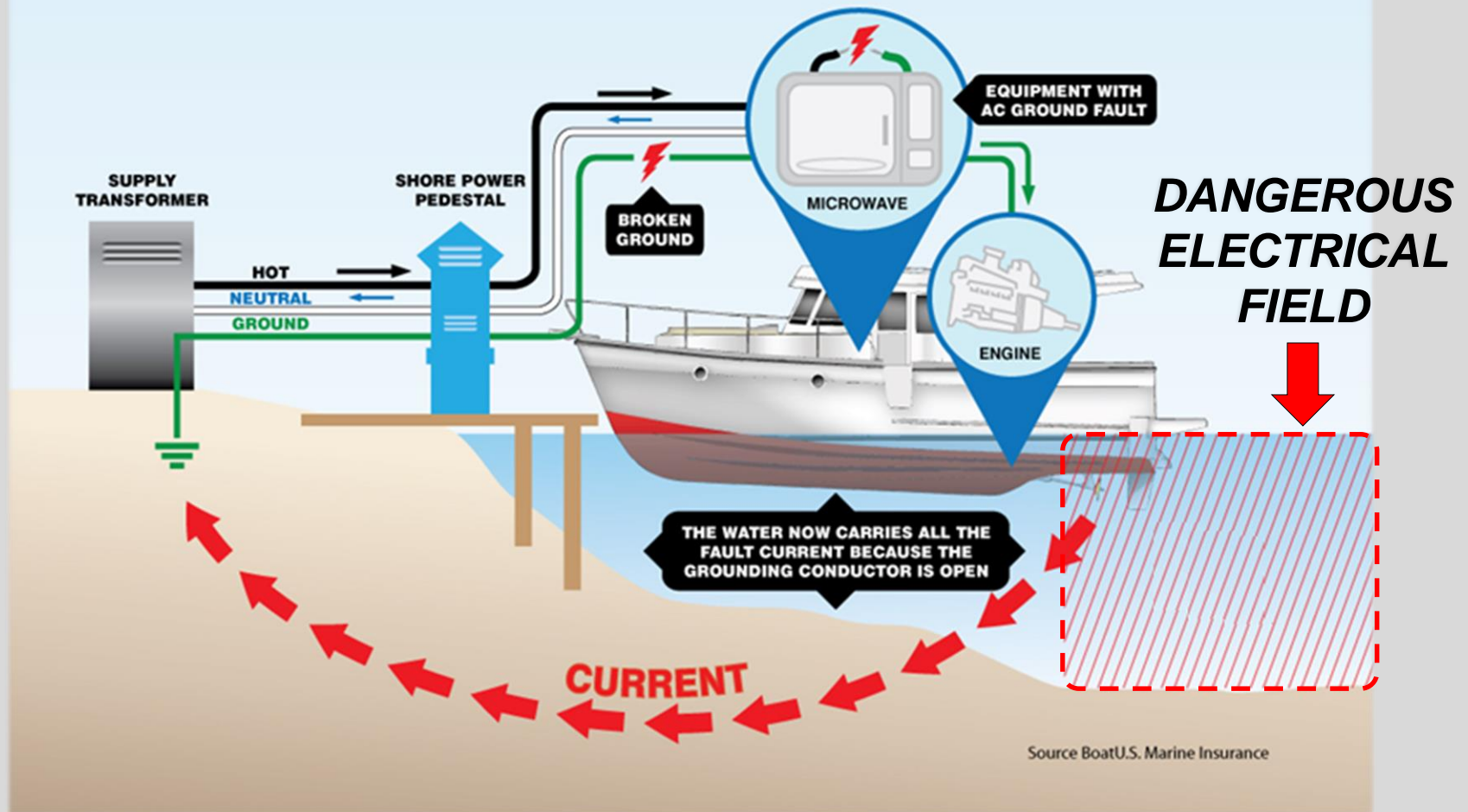


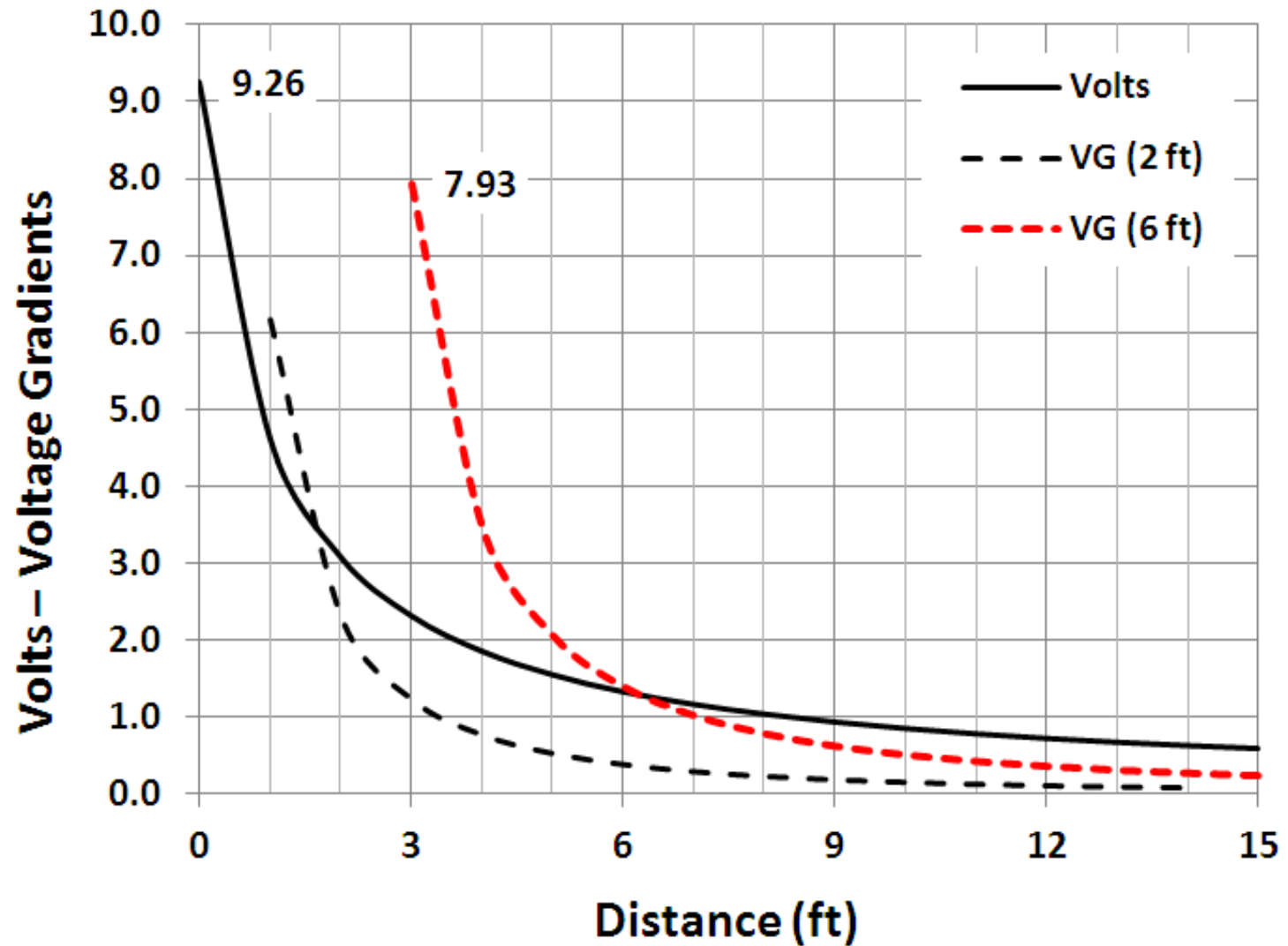


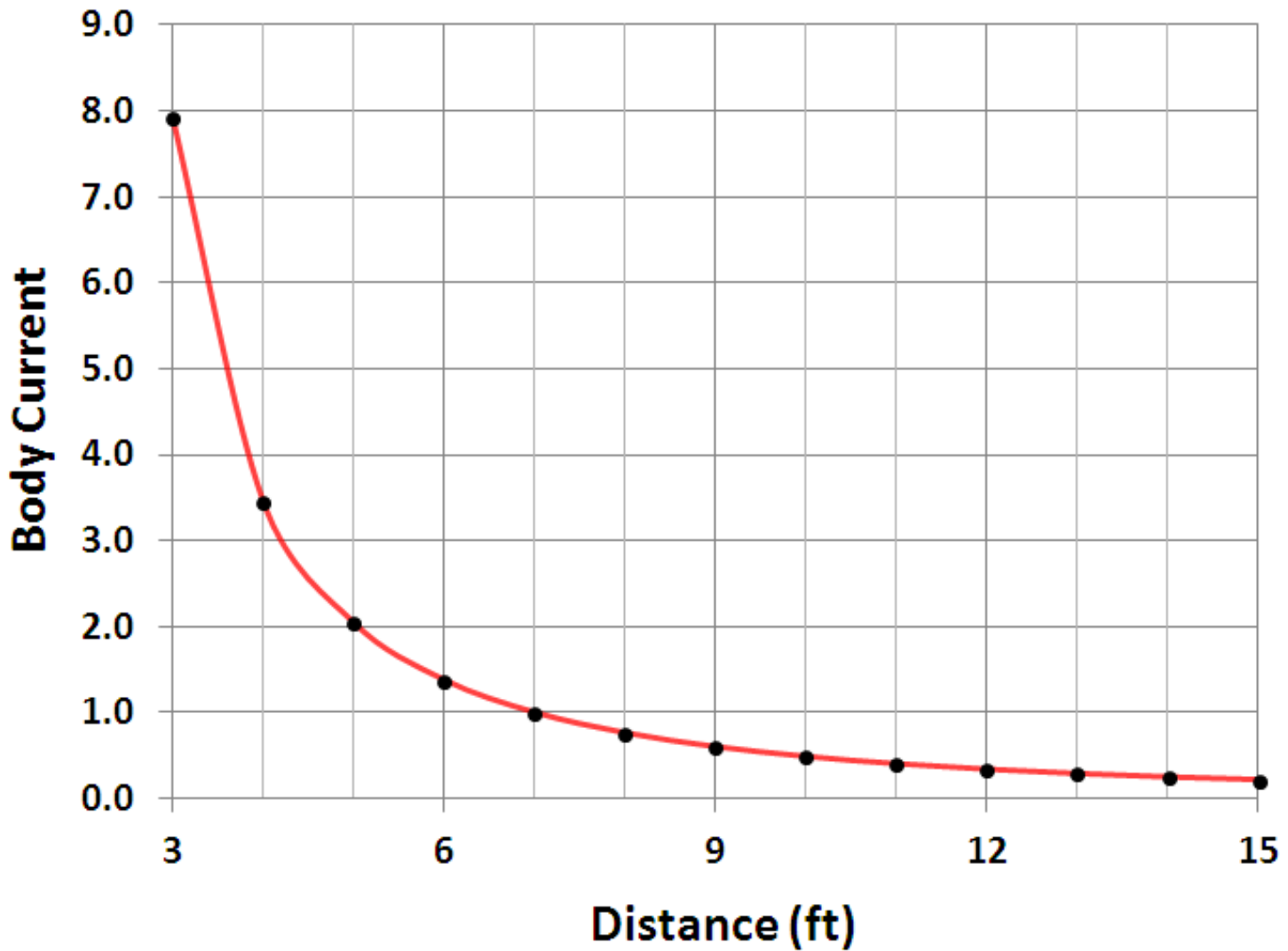




## 3. ELECTRICAL FAULT + SAFETY GROUND FAULT = DANGER!







# Factors that affect voltage gradients

Water Leakage Current

$$V = \frac{I k}{\sigma \sqrt{A}}$$

Water Conductivity  
(Greek letter Sigma)

Surface Area of Energized  
Underwater Metals

## In-Water Leakage Current

## Through- Body Current

**Fresh Water**

**0.3 Amp  
(300 mA)**

**23.8 mA**

**Fresh Water**

**0.1 Amp  
(100 mA)**

**7.9 mA**

**Fresh Water**

**0.03 Amp  
(30 mA)**

**2.4 mA**



The ESD condition in marinas can be caused by faulty equipment or wiring in or on ...

- The marina/dock electrical system
- One or more boat electrical systems
- Electrically operated boat lifts
- Dock lighting
- Other marina equipment

Similar conditions can exist or occur at private docks where electric equipment and wiring are installed or used

*"There are way too many extension cords in use as semi-permanent wiring on private docks" — NEC 400.12 anyone??*

An ESD condition in the water is often the result of a low-level fault current that is too small to trip the circuit breaker

These undetected faults can continue for lengthy periods of time, even indefinitely, without any indication or warning of the potential danger

— *unless GFCI or GFPE protection is installed* —

## Worth Noting...

Ground currents associated with electric power transmission can also produce voltage gradients in the water. Such is the case at the Minnetonka Power Squadron Big Island recreation facility.

# Lost to ESD



## Lost to ESD







## Lost to ESD

April 16, 2016

**Carmen Johnson**  
**15-year-old girl drowns**  
**at Smith Lake, Alabama**

Coroner: Electrocution may have caused  
Priceville cheerleader's drowning, along with a  
2nd injury and 2 more near-deaths

Family members had earlier reported feeling  
tingling sensations in the water



## Lost to ESD

**April 15, 2017**

**Shelly Darling**

**34-year-old wife and lawyer  
dies at Lake Tuscaloosa,  
Alabama**



**Elizabeth Whipple**

**41-year-old wife and lawyer  
dies at Lake Tuscaloosa,  
Alabama**







James D. Shafer  
Capt. David E. Rifkin  
Quality Marine Services, LLC  
2418 Fallen Tree Drive West  
Jacksonville, FL 32246  
904-382-7868  
qualitymarinesvcs@comcast.net

## Electric Shock Drowning Incidents – Marinas® (In-Water electrocution fatalities included)

Rev. 10/16/17

Jim Shafer, the originator of this list, is currently unable to participate in this area. Contact David Rifkin for more information.

Low level ground fault leakage in the marina AC shore power system can cause lethal potentials to appear on any underwater metal surface – either on a boat or on the dock. In fresh water the electric field surrounding this surface can paralyze a swimmer. There is no warning that this condition exists, and it has resulted in a number of drownings. Further, there is no post-mortem evidence that electric shock was the cause. Therefore, many of the fatalities listed below are only the known electric shock caused drownings, which were investigated because of circumstantial evidence, i.e., multiple deaths, eye witnesses, considerable distress, cries for help, shock sensation reported by rescuers, etc.

Our studies have shown that, in salt water, the high voltage gradients required for electric shock drowning could not be established with the available fault current levels. In no cases can we attribute cause of death to electric shock drowning in salt water.

We do not know the exact wiring errors or ground faults that created some of the incidents listed below, but it can be assumed that an energized AC conductor (L1 or L2) came in contact with a bonded (grounded) metal object, and coincidentally, this object was not connected to the shore bonding (grounding) system. This caused a voltage to appear on these under-water metal objects (both on boats and docks). This created a lethal electric field around the object (a person in this electric field can be paralyzed leading to drowning, or direct electrocution). This was true in every case that was investigated.

No database has been found that catalogs "Electric Shock Drowning" – our term for this phenomenon. The incidents listed below came from various sources, i.e., investigation, press, third party, and eye witness reports. Dates and details are missing for some. There is no way to know what fraction of the total fatalities this listing represents, but it may be reasonable to assume that it could be small. We have no reports of fatalities in salt water due to electric shock drowning.

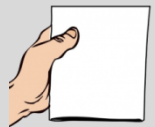
Some of the fatalities listed here were actually caused by ventricular fibrillation (electrocution), because the victim's head was reported not to have been submerged. They are technically not drownings but are listed here since the causes are similar to drowning by electric shock.

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# ESD Incident Documentation

## as of 01-30-2018

- 99 Known Incidents
- 100+ Known Fatalities
- 58 "Near miss" Incidents



It is believed by many that the actual number of ESD fatalities is much higher than reported or documented, possibly hundreds more

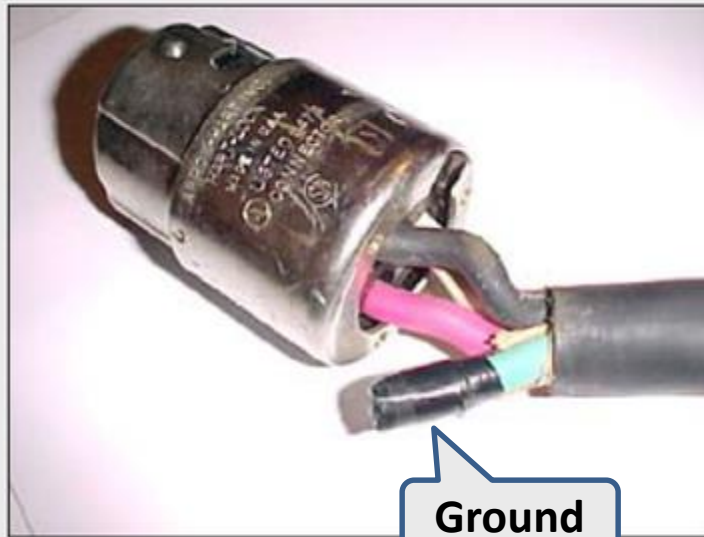
Paralysis resulting from small electric currents passing through the body is generally not recognizable post-mortem as the cause of a drowning



# Is ESD a Growing Problem?

- Increase in the use of electrically operated equipment in and around recreational and non-recreational waters
- Increase in Do-It-Yourself electrical work by unqualified and untrained individuals
- Use of non-approved (non-marine grade) materials and equipment, and non-approved wiring methods on docks and on-board boats

This shore power connector was mis-wired by the owner of the boat, and one result was the ESD death of his wife and daughter



D. Rifkin - J. Shafer



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**Older houseboats should be suspect**

- Lack of electrical inspections  
[especially recurring / periodic]
- Lack of monitoring for dangerous conditions in and around the water
- Boats connected to shore power system without basic checks to verify correct wiring onboard the vessel



# Electric Shock Drowning



- Postponing of dock or boat repairs due to cost or availability of downtime
- Lack of awareness or understanding of the ESD hazard by the general public

# *Electric Shock Drowning*



- Less caution exercised by the today's general public





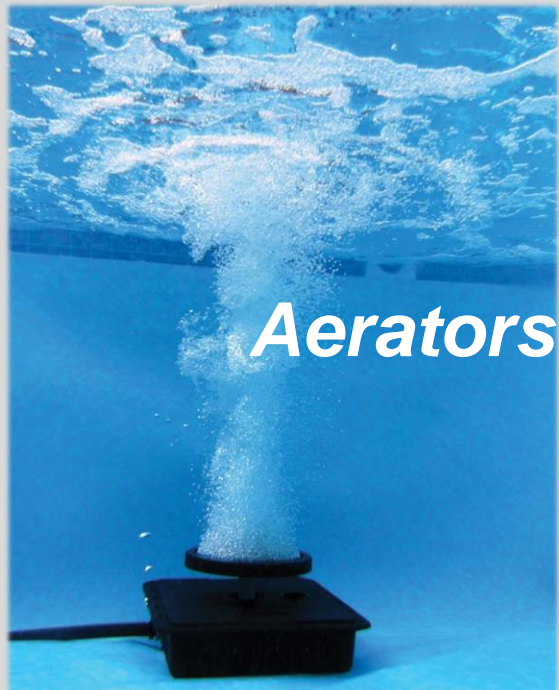
# Other Areas of Concern...





*Swimming Pools*





# **Water and Electricity**

## **A Dangerous Mix**

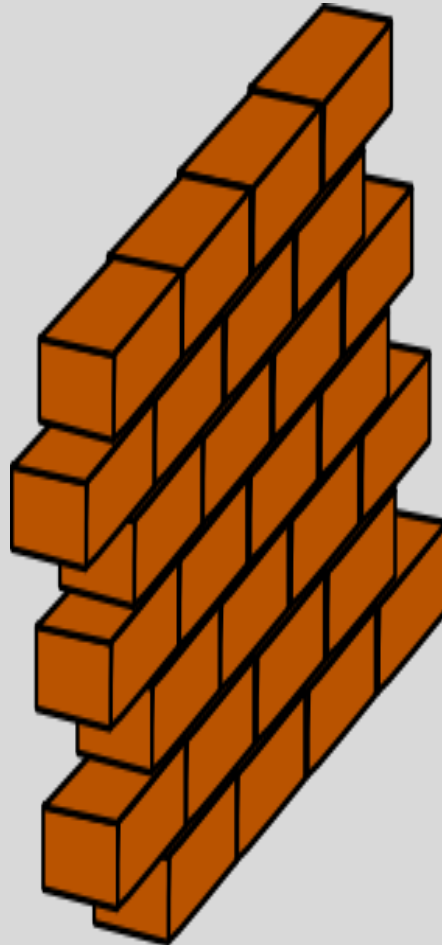
# *Electric Shock Drowning*





# Cultural Barrier when it's Water + Electricity

**Indoors?  
Be Safe!**



**Outdoors  
???**





***Shore Power***





***Boat Lifts***

Use of electric power at docks on lakes and rivers has increased exponentially in recent years. And yet...



Many people are not even remotely aware of Electric Shock Drowning...

Say  
WHAT?





... or the need for important precautions

Question to Lakeshore Property Owner:

*"Is the circuit that powers your  
electrically operated boat lift protected  
by a Ground Fault Circuit Interrupter?"*

Response:

*"I have no idea."*

The NEC has required GFCI protection outdoors since 1971,  
in boathouses since 1987, and for boat hoists since 2005





## Battery Powered Boat Lift w/ Solar Charger

# **Signs That There Is -- or Could Be -- A Serious Problem**



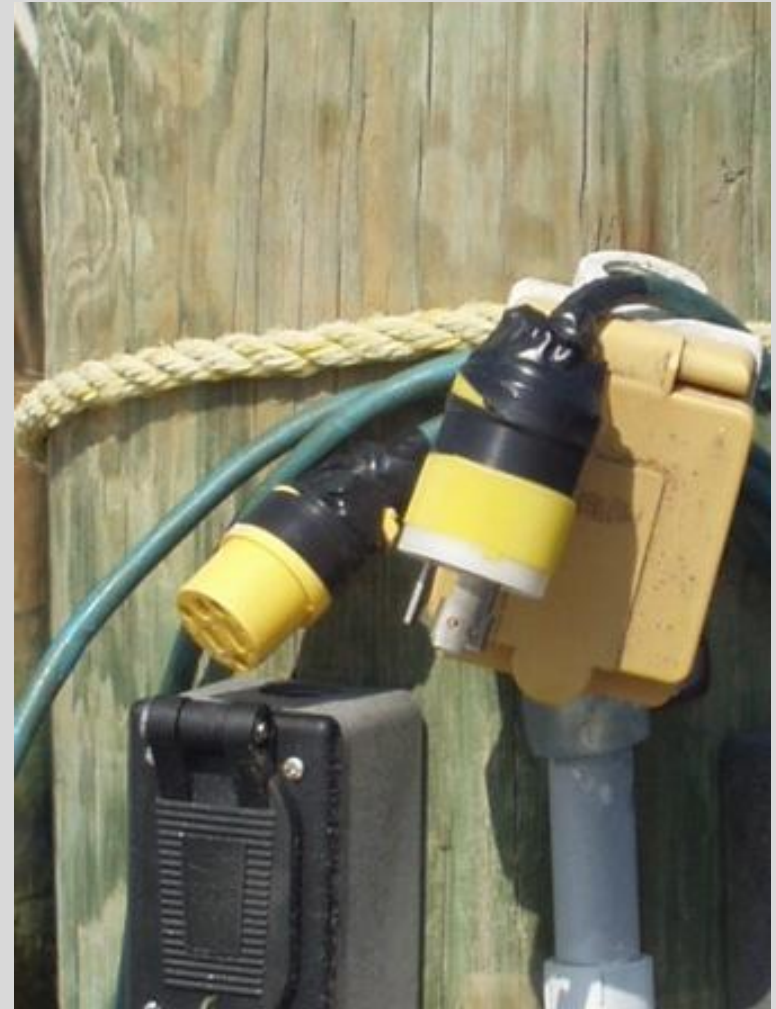
# Electric Shock Drowning





# Electric Shock Drowning







# Electric Shock Drowning



# Electric Shock Drowning





# *Electric Shock Drowning*



# *Electric Shock Drowning*



# The National Electrical Code and ESD



# Article 555 — Marinas, Boatyards, and Commercial and Noncommercial Docking Facilities

- Marinas and Boatyards have been addressed in Article 555 of the NEC since 1968.
- 1968 – Boat Harbor Wiring
- 1971 – Marinas and Boatyards (and residential docks)
- 2002 – Marinas and Boatyards (exempted residential docks)
- 2017 – Marinas, Boatyards, and Commercial and Noncommercial Docking Facilities



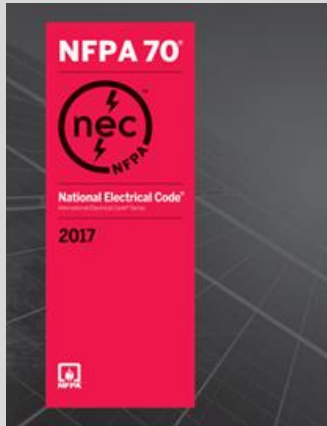
# What Articles of the NEC apply to ESD?

- **Article 555 – Marinas, Boatyards, and Commercial and Noncommercial Docking Facilities**
- **Article 680 – Swimming Pools, Fountains, and Similar Installations**
- **Article 682 – Natural and Artificially Made Bodies of Water**
- **Article 551 – Recreational Vehicles and Recreational Vehicle Parks**
- **Article 553 – Floating Buildings**
- **Article 525 – Carnivals, Circuses, Fairs, and Similar Events**

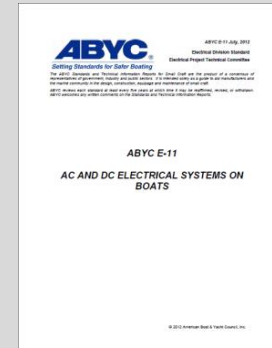




# Electric Shock Drowning



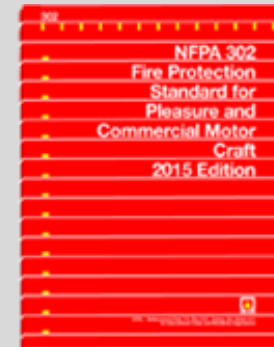
**NFPA 70 — NEC**



**ABYC E-11**



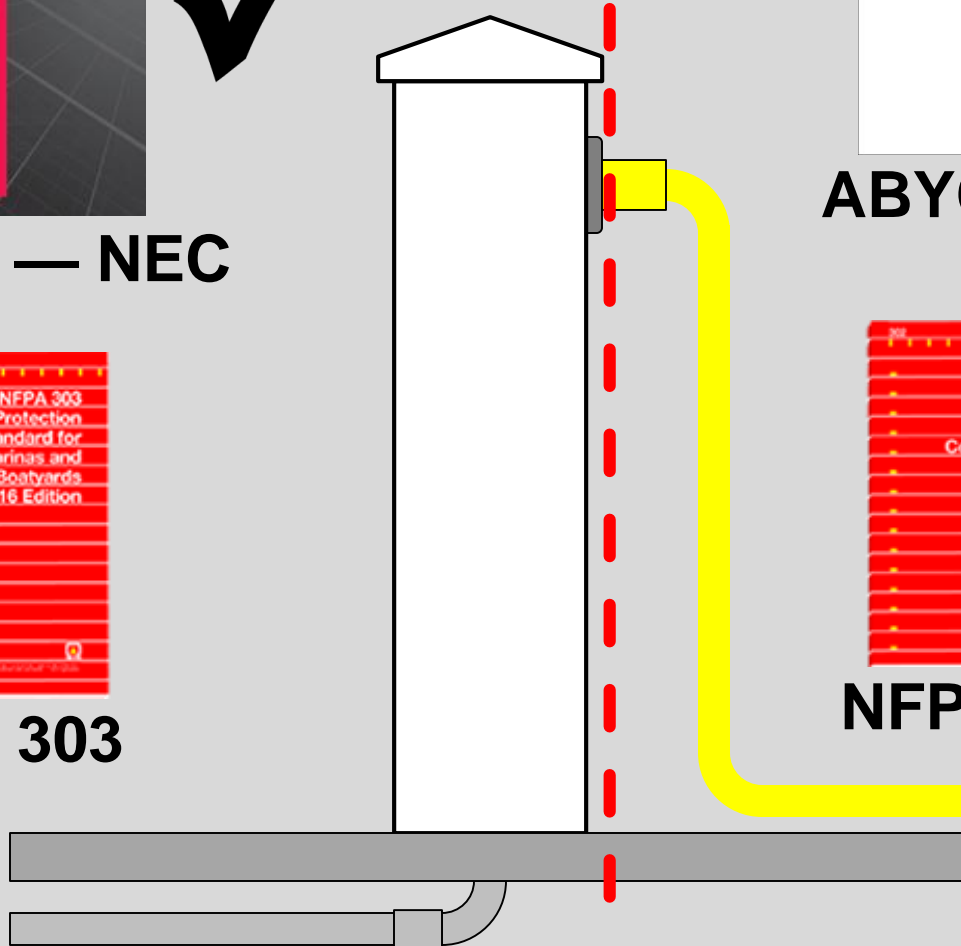
**NFPA 303**



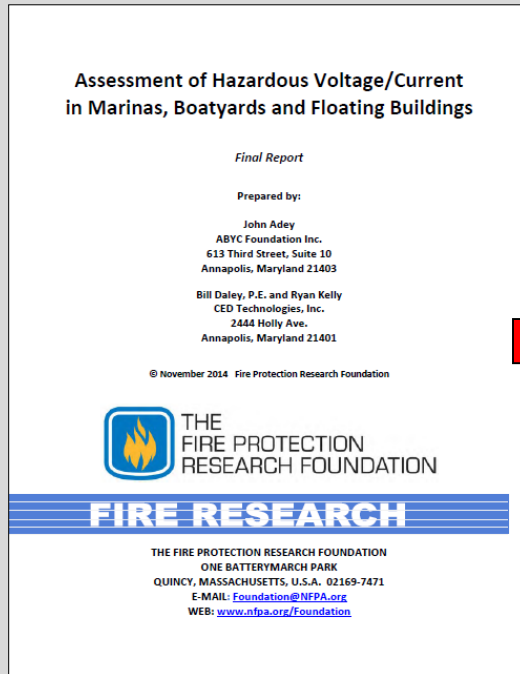
**NFPA 302**

**Shore Cord**

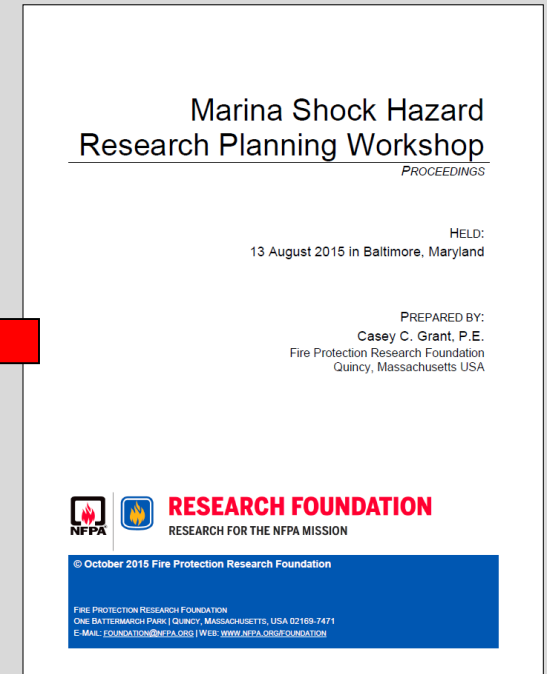
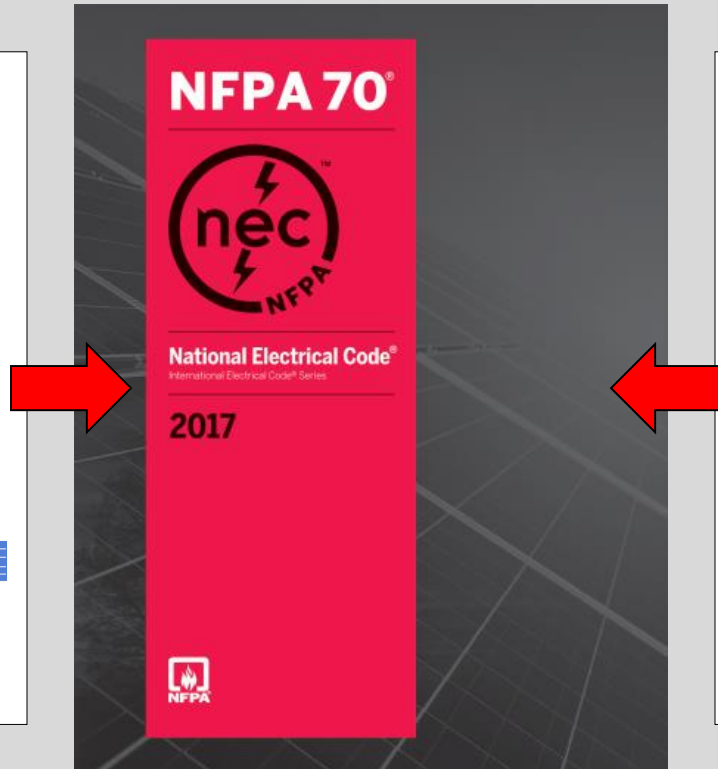
**Marina Power**



## Significant Influence on Article 555

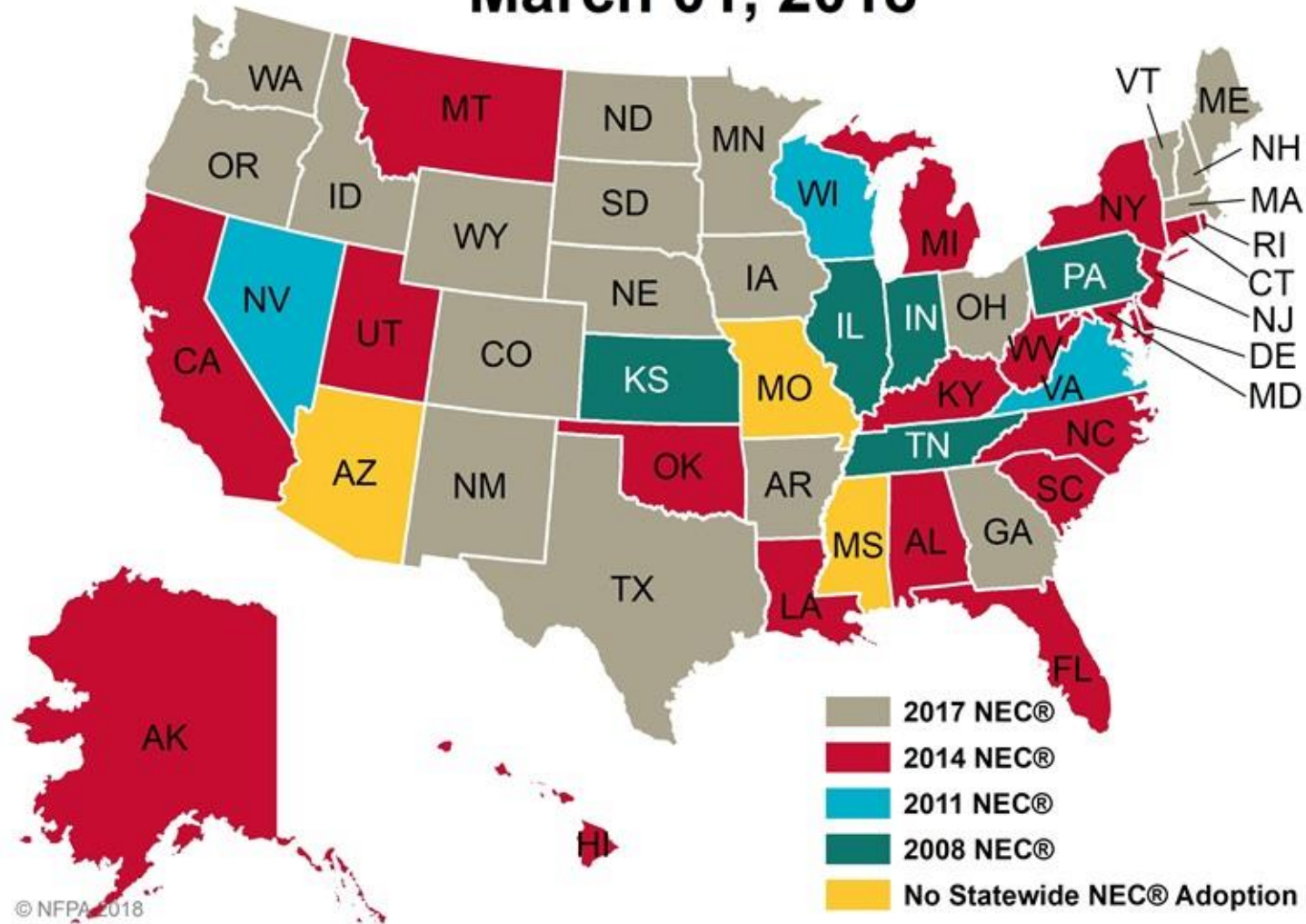


**FPRC Foundation  
November 2014**

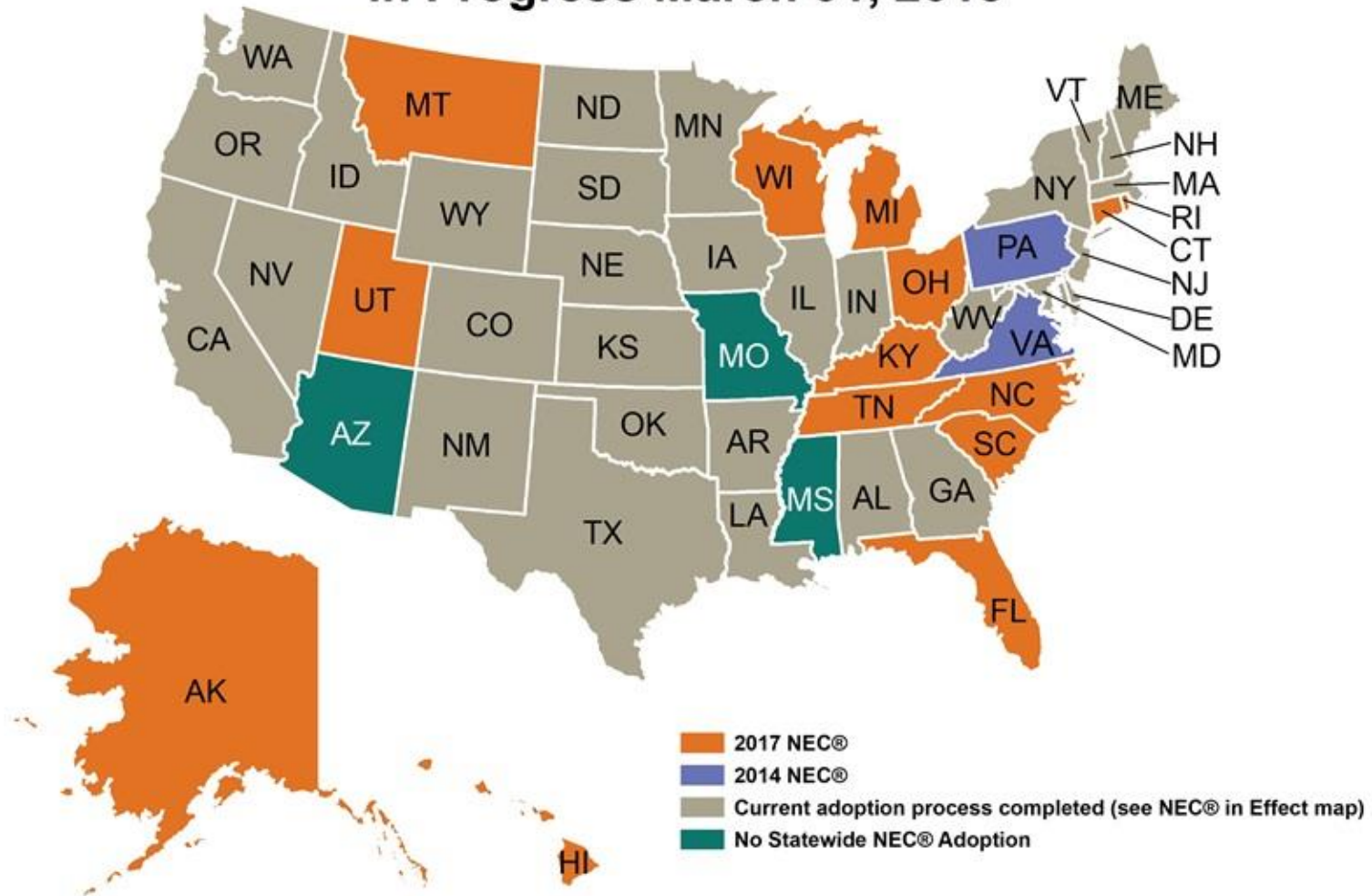


**FPRC Foundation  
October 2015**

**National Electrical Code® in Effect  
March 01, 2018**



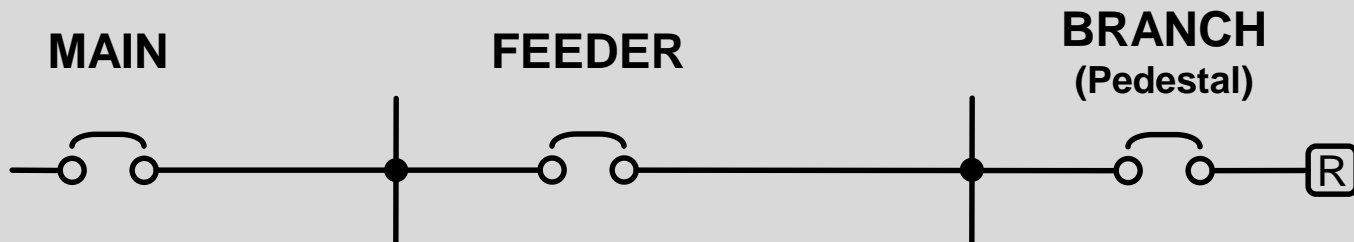
## National Electrical Code® Adoption Process In Progress March 01, 2018



© NFPA 2018

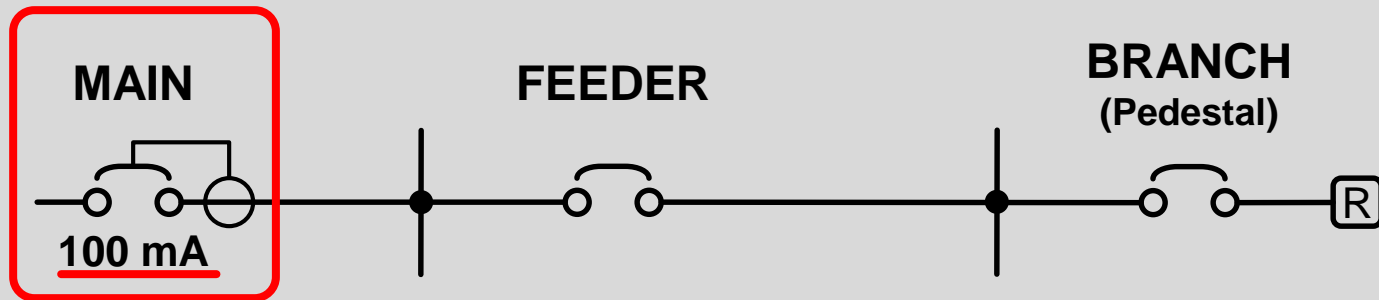


## Typical Dock Electrical Distribution Prior to 2011



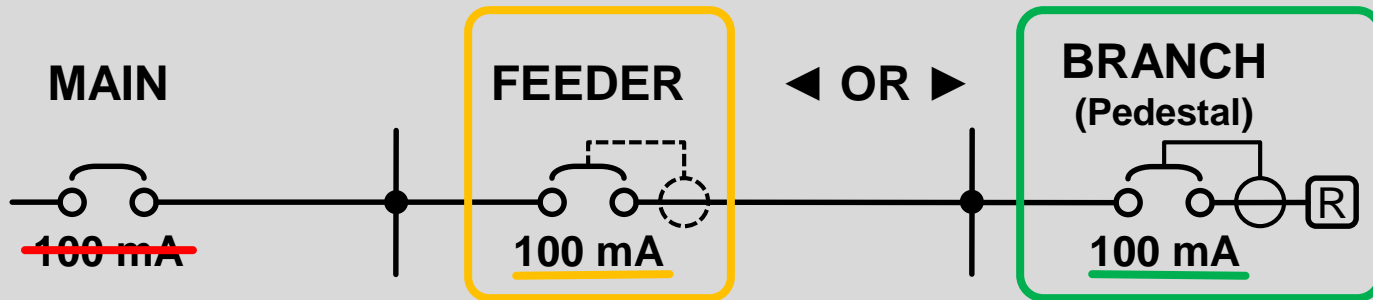
No ground-fault protection required for marina main service or for shore power service

## Typical Dock Electrical Distribution 2011 and 2014 NEC



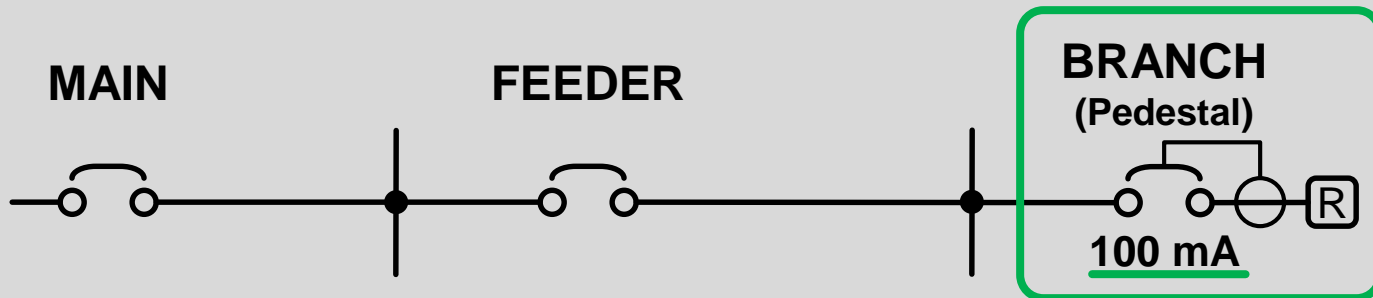
**555.3 Ground-Fault Protection.** The main overcurrent protective device that feeds the marina shall have ground fault protection not exceeding 100 mA. Ground-fault protection of each individual branch or feeder circuit shall be permitted as a suitable alternative.

## Typical Dock Electrical Distribution 2011 and 2014 NEC



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

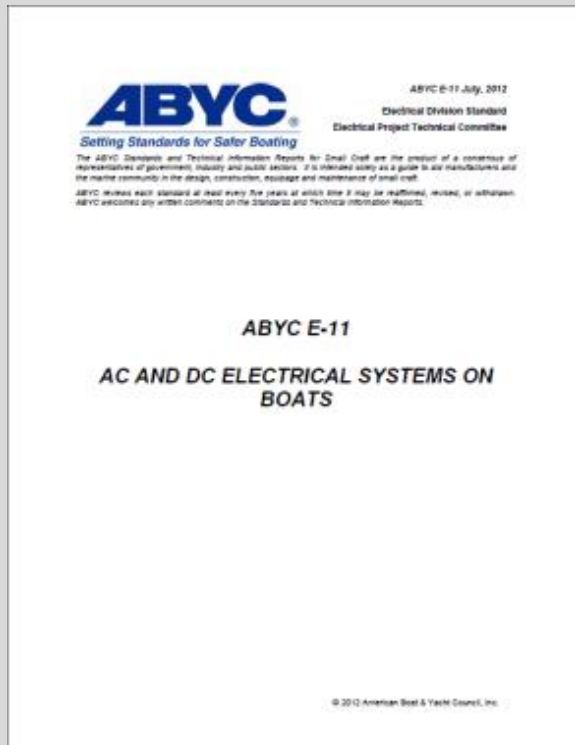
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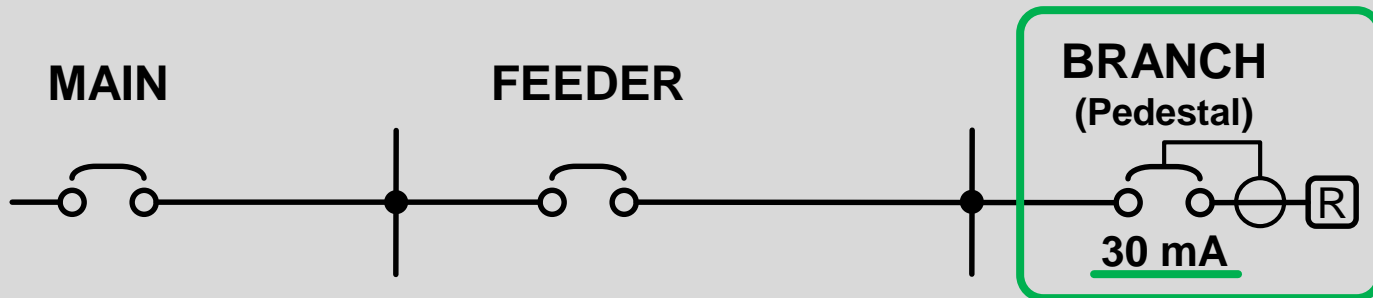


## On-Board ELCI (30 mA Trip)



*Required by ABYC Standard E-11 for AC equipped recreational boats built after December 31, 2012*

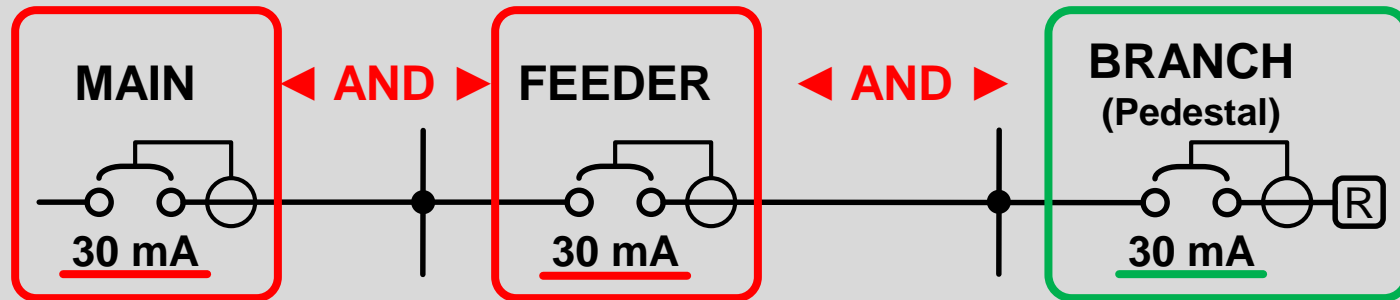
## Typical Dock Electrical Distribution 2011 and 2014 NEC



*Equipment Leakage Circuit Interrupter: required by ABYC Standard E-11 for AC equipped recreational boats built after December 31, 2012*



## Typical Dock Electrical Distribution 2017 NEC



**555.3 Ground-Fault Protection.** The overcurrent protective devices that supply the marina, boatyards, and commercial and noncommercial docking facilities shall have ground-fault protection not exceeding 30 mA.

## Marina Ground Fault Leakage Current and the NEC

Ed Lethert

January 3, 2017

Article 555 of the 2014 National Electrical Code, "Marinas and Boatyards", has been re-titled in the 2017 edition to "Marinas, Boatyards, and Commercial and Noncommercial Docking Facilities". Along with the new title, there are important changes and additions including a very important revision. The revised rule, Section 555.3, has reduced the maximum permitted ground-fault trip level from 100 mA to 30 mA. This applies to the equipment ground fault protection (GFCI) devices installed in any facility from a main service to the shore.

# Marina Ground Fault Leakage Current and the NEC

**555.3 Ground-Fault Protection.** The overcurrent protective devices (OCPDs) that supply the marina, boatyards, and commercial and noncommercial docking facilities shall have ground-fault trip level not exceeding 30 mA.<sup>a</sup>

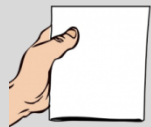
<sup>a</sup>2017 National Electrical Code, ARTICLE 555 — Marinas, Boatyards, and Commercial and Noncommercial Docking Facilities

The 2014 code rule required the ground-fault trip level exceeding 100 mA be applied at the main service feeding the marina, but permitted placement at each individual branch circuit breaker (typically at the pedestal) or the feeder circuit breaker as a suitable alternative. The new 2017 code rule requires that *ALL* overcurrent protective devices in marinas, boatyards, and at commercial and noncommercial docking facilities include ground-fault protection not exceeding 30 mA. Reading further, the code states that this requirement does not override the requirement for Class A GFCI protection (5 mA) for almost all marina and dock convenience receptacles. This reduction in the ground-fault trip level was driven in large part by the The Fire Protection Research Foundation. The rationale for their conclusions and list of participants is found in their report *Assessment of Hazardous Voltage/Current in Marinas, Boatyards and Floating Buildings*.<sup>2</sup>

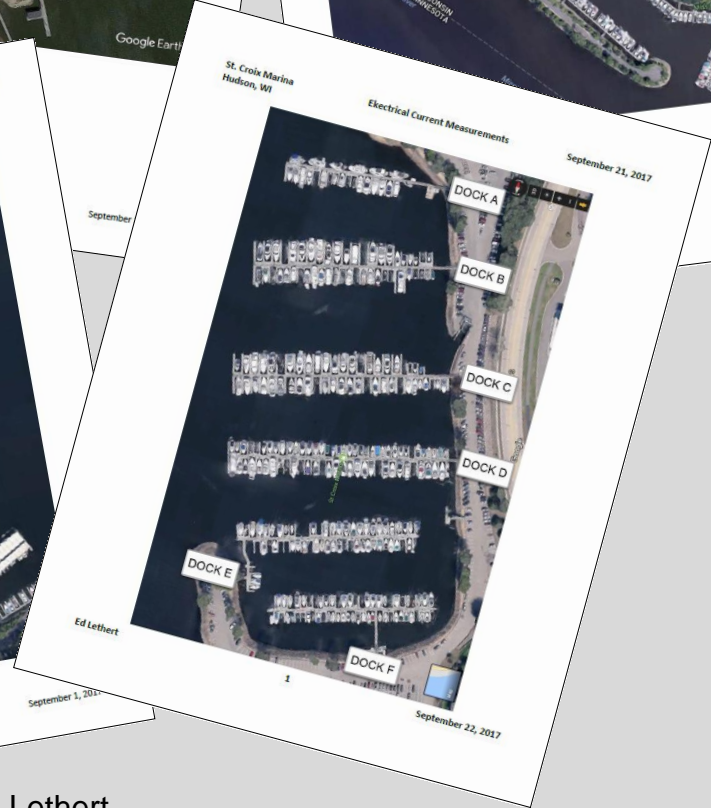
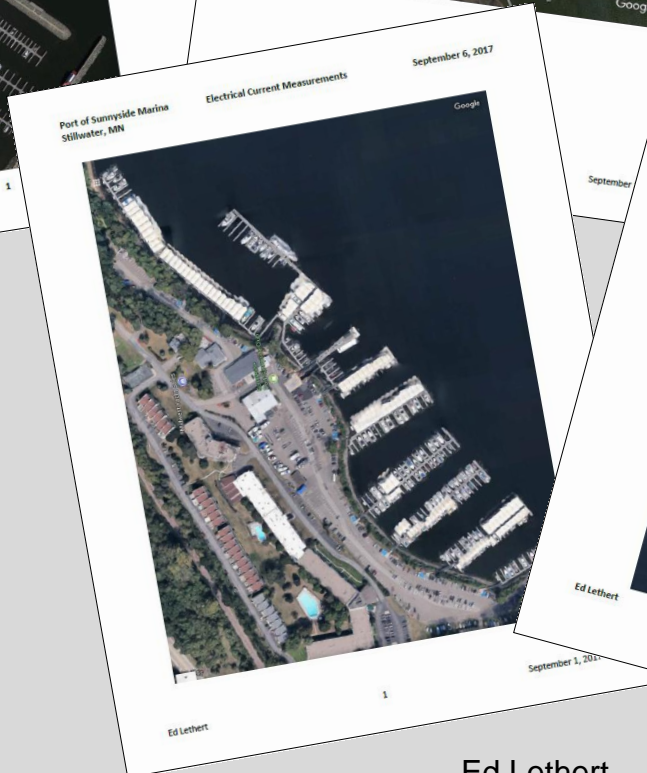
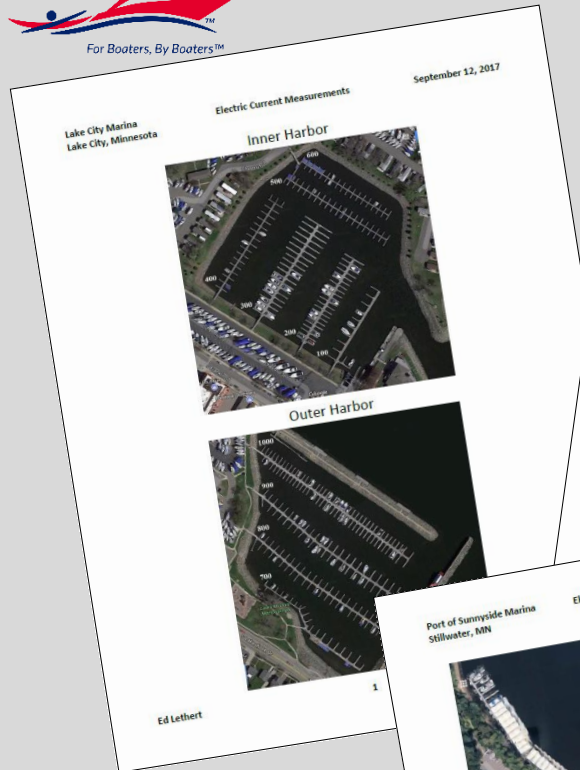
Anyone involved with marina electrical installations and their operation must consider the potential negative consequences that could result if this new rule is not applied thoughtfully and reasonably in the field, especially as it relates to shore power service to watercraft. It is also important to note that Article 555 makes no distinction between freshwater and saltwater marine environments, even though there are significant differences, electrically speaking.

<sup>1</sup>milliamperes

<sup>2</sup>Assessment of Hazardous Voltage/Current in Marinas, Boatyards and Floating Buildings, Final Report, November 2014, Fire Protection Research Foundation







Location	Feeders Measured	Ground-Fault Current		
		Feeders Exceeding 30 mA	Feeders Exceeding 100 mA	Feeders Exceeding 1.0 A
Miss Croix Yacht Harbor	6	5	2	0
River Heights Marina	9	9	6	2
Port of Sunnyside Marina	18	12	11	2
Lake City Marina	15	7	6	0
St. Croix Marina	16	15	15	6
Totals	64	48	40	10
Majority of feeders are 120/240 Volts - 200 Amps.				
Measurements averaged over 2-3 minutes.				

## ELECTRICAL CURRENT MEASUREMENTS

### FOSS HARBOR MARINA

821 DOCK ST.  
TACOMA, WA 98402

LOCATION	# OF SLIPS	FEEDER SIZE	L1 + L2 + L3 + NEUTRAL	L1 + L2 + L3 + NEUTRAL + GROUND	GROUND ONLY	WOULD 100 mA BREAKER TRIP?	WOULD 30 mA BREAKER TRIP?
B-DOCK #1	4	125A	1,510 mA	190 mA	130 mA	YES	YES
B-DOCK #2	4	125A	8,400 mA	400 mA	8,720 mA	YES	YES
B-DOCK #3	5	150A	8,930 mA	1,100 mA	6,470 mA	YES	YES
B-DOCK #4	4	125A	2,600 mA	340 mA	2,430 mA	YES	YES
C-DOCK - ODD	13	100A	1,300 mA	400 mA	1,960 mA	YES	YES
C-DOCK - EVEN	13	100A	540 mA	600 mA	650 mA	YES	YES
D-DOCK - ODD	14	125A	920 mA	2,250 mA	2,000 mA	YES	YES
D-DOCK - EVEN	10	125A	2,600 mA	3,300 mA	1,640 mA	YES	YES
F-DOCK - ODD	14	125A	700 mA	830 mA	650 mA	YES	YES
F-DOCK - EVEN	13	125A	9,800 mA	2,850 mA	7,950 mA	YES	YES
G-DOCK - ODD	12	125A	7,030 mA	1,180 mA	3,820 mA	YES	YES
G-DOCK - EVEN	12	125A	2,320 mA	840 mA	4,950 mA	YES	YES
H-DOCK - ODD	15	125A	0 mA	800 mA	270 mA	NO	NO
H-DOCK - EVEN	15	125A	9,500 mA	3,800 mA	2,900 mA	YES	YES
I-DOCK - ODD	13	125A	120 mA	930 mA	120 mA	YES	YES
I-DOCK - EVEN	13	125A	11,280 mA	1,450 mA	10,200 mA	YES	YES
J-DOCK - ODD	13	125A	350 mA	300 mA	380 mA	YES	YES
J-DOCK - EVEN	13	125A	110 mA	110 mA	590 mA	YES	YES
K-DOCK - ODD	15	125A	160 mA	3,330 mA	3,330 mA	YES	YES
K-DOCK - EVEN	15	125A	6,140 mA	390 mA	6,000 mA	YES	YES
L-DOCK - ODD	15	125A	130 mA	460 mA	230 mA	YES	YES

D.F. ELECTRIC, INC.

12/4/17

## ELECTRICAL CURRENT MEASUREMENTS

### FOSS HARBOR MARINA

821 DOCK ST.  
TACOMA, WA 98402

Total Feeders	35			
Total Slips	411			
Totals		4350	131960	131.960
Averages			3770	3.770
Average/Slip			321	0.321

### Leakage:

> 30 mA (0.03 A)  
> 100 mA (0.1 A)  
> 500 mA (0.5 A)  
> 1.0 A  
> 5.0 A  
> 10.0 A

### Feeders:

33 (94%)  
33 (94%)  
24 (69%)  
19 (54%)  
12 (34%)  
2 (5.7%)

### Slips:

24 (69%)  
18 (51%)  
12 (34%)  
3 (9%)  
—  
—

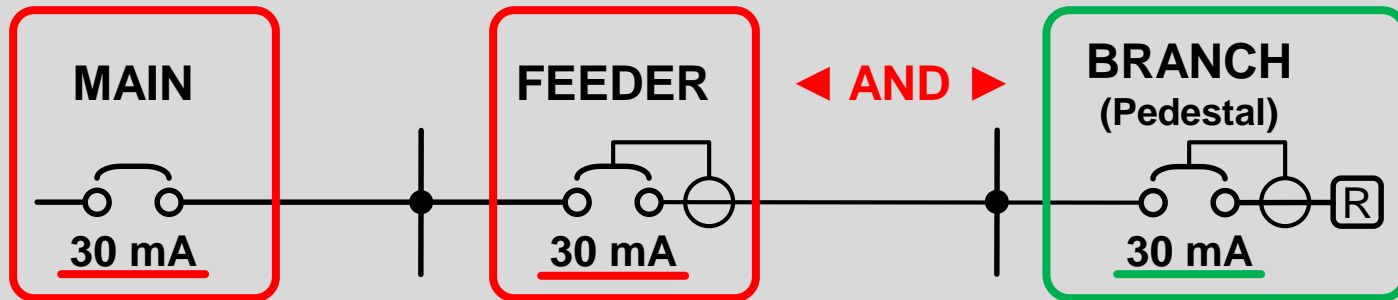
K-DOCK - ODD	15	125A	100 mA	3,330 mA	3,330 mA	YES	YES
K-DOCK - EVEN	15	125A	6,140 mA	390 mA	6,000 mA	YES	YES
L-DOCK - ODD	15	125A	130 mA	460 mA	230 mA	YES	YES

D.F. ELECTRIC, INC.

12/4/17

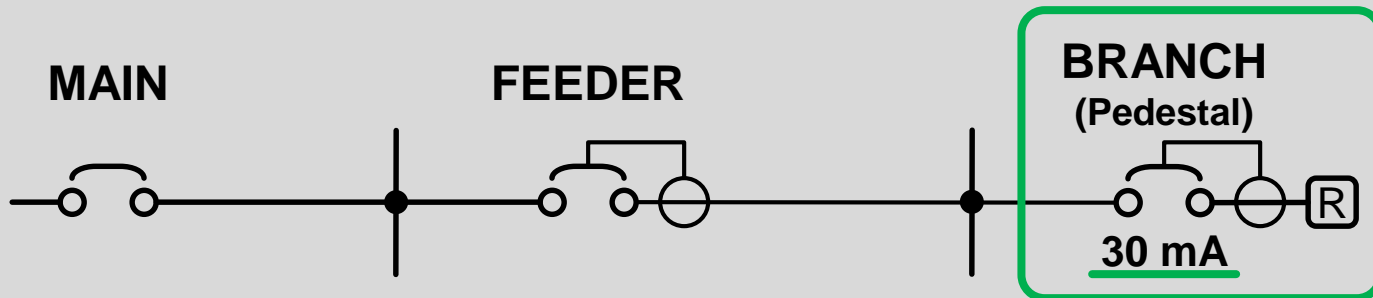


## Typical Dock Electrical Distribution 2017 NEC



Tentative Interim Agreement 17-15  
(*TIA Log #1348*)

## Typical Dock Electrical Distribution 2020 NEC (*Proposed*)



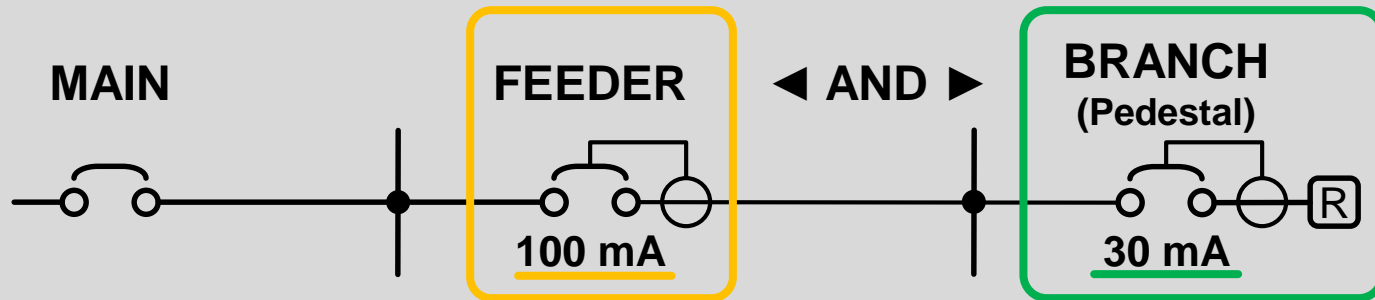
### 555.35 Ground-Fault Protection of Equipment (GFPE) ...

**(A) Ground-Fault Protection.** ... , ground-fault protection for docking facilities shall be provided in accordance with the following:

#### **(1) Receptacles Providing Shore Power.**

Receptacles installed in accordance with 555.19(A) shall have individual GFPE set to open at currents not exceeding 30 milliamperes.

## Typical Dock Electrical Distribution 2020 NEC (*Proposed*)



### 555.35 Ground-Fault Protection of Equipment (GFPE) ...

**(A) Ground-Fault Protection.** ... , ground-fault protection for docking facilities shall be provided in accordance with the following:

**(3) Feeder and Branch Circuit Conductors With GFPE.** Feeder and branch circuit conductors that are installed on docking facilities shall be provided with ground-fault protection of equipment (GFPE) set to open at currents not exceeding 100 mA. Coordination ...

***Received by Mike Holt on Friday, April 27, 2018 6:17 PM***

## **catalinaislandtime**

I just moved into a marina that has GFCI on each shore power connection (10mA protection). IT'S THE WORST!!! This shore power is useless, it so sensitive around a wet environment! I swear, when the fog comes in too dense the damn breaker trips and I lose shore power. My refrigeration goes out and my batteries die. The idiot that came up with this crap thinks he's a saint (saving lives, blah blah blah; sounds like an ego thing to me) I have never heard of a death in any of our (ocean) marinas, we have divers, and all swim in them.



***Received by Mike Holt on Friday, April 27, 2018 6:17 PM***

## **Catalinaislandtime (cont'd)**

The unintended consequences of damaged marine equipment from shore power cutting out when boat owners are not around is going to get marinas, cities and code writers sued. Just wait, the marine industry is just starting to realize the problems from GFCI shore power, lawsuits are looming on the horizon. This new code has made shore power completely unreliable.

# Reactions to the 2017 NEC



THE STATE  
of **ALASKA**  
GOVERNOR BILL WALKER

## Department of Labor and Workforce Development

Labor Standards and Safety

Post Office Box 111149  
Juneau, Alaska 99811  
Main: 907.465.4855  
Fax: 907.465.6012

April 21, 2017

The Honorable Representative Sam Kito III  
Alaska House of Representatives  
120 Fourth Street, Room 403  
Juneau, AK 99801

Dear Representative Kito,

This letter is in response to concerns received by your office about a provision in the upcoming 2017 edition of the National Electrical Code. An erroneous interpretation of this code would create an unrealistic requirement for dock, marina, and boatyard owners. The Department of Labor and Workforce Development interprets the National Electrical Code according to the developers' intent, and hopes to allay any concerns that it might do otherwise.

Under AS 18.60.580, the National Electrical Code (NEC), developed and published by the National Fire Protection Association (NFPA), constitutes the minimum electrical safety standards of the state, applying to new installations and alterations to existing installations. The Alaska Department of Labor and Workforce Development may adopt the most recent version by regulation. The department may only adopt amendments issued by the American National Standards Institute, the body that approves the NEC. Any other amendments must be made in Alaska statute.

The department updates to a new NEC edition on a three-year cycle. The 2014 edition is the current version adopted in 8 AAC 70.025. The process of adopting the 2017 edition will begin in the spring of 2018, with an expected effective date near the end of 2018. This timeframe allows public and industry analysis of the new version, with ample time for legislation if amendments are necessary to adapt the code to Alaska's environment.

Several local organizations have expressed concern about a provision of the 2017 edition. Section 555.3 defines ground-fault protection requirements for marinas, boatyards, and commercial and noncommercial docking facilities. It reads:

"555.3 Ground-Fault Protection. The overcurrent protective devices that supply the marina, boatyards, and commercial and noncommercial docking facilities shall have ground-fault protection not exceeding 30 mA."

There is concern that the department may interpret this provision as requiring 30 mA ground-fault protection for all overcurrent protective devices in an affected facility, up to and including the main feeder. According to industry representatives, a 30 milliamp protection requirement at

of nuisance trips due to the cumulative effect of boatyard.

Technical representatives, the department has the section. Instead, the intent is to require 30 point in the marina. This may be achieved circuits.

The committee that revised Section 555.3 stated in its report that it is consistent with that recommendation in the Fire Protection Fundamentals Handbook, Chapter 10, Section 10.1.1, "Hazardous Voltage/Current in Marinas, Boatyards, and Docking Facilities." The report is available to the public and industry. The final sentence of that report states: "The final sentence of that report is on main feeder protection, citing the need for a level may be determined."

In the new Section 555.3, several organizations have submitted a Fine Print Note to Alaska's adoption of the

applied to all feeder circuits or all branch circuits device."

Engineer Mark Morris, stated in an October 2016 letter to the National Electrical Code, it is just a matter of time before the code is changed to require the code." The department agrees with his statement. Assistance in interpreting the code is available. The NFPA offers its members one-on-one help sources available from private code consultants, who provide assistance when questions arise. The department is certain in this matter, Mechanical Inspection will recognize and clarify misconceptions surrounding

The National Electrical Code for the State, the Department of Labor and Workforce Development will enforce the code according to the intent of the National Fire Protection Association. The department will not enforce an erroneous interpretation requiring 30

D:\A2016\_NEC-P19\_FD\_ballotfinal.pdf, p. 81  
resources/research-foundation/research-foundation-  
in-marinas-boatyards-and-floating-buildings.pdf?la=en  
pa-technical-questions

at device. We will continue to educate and

technical questions or concerns.

Department of Labor and Workforce Development  
Inspection

Chairman, Port of Juneau  
of Sitka  
Harbormasters and Port Administrators



Recreational Boating  
Association of  
Washington  
The Voice of Northwest Boating

NORTHWEST  
MARINE  
TRADE  
ASSOCIATION

December 11, 2017

Mr. Joel Sacks, Director  
Washington State Department of Labor & Industries  
P.O. Box 44000  
Tumwater, WA 98504-4000

ATTN: Labor & Industries team (Mr. Stephen D. Thornton, Mr. Rod Mutch, Ms. Maggie Leland, Ms. Tammy Fellin)

**RE:** Proposal asking Labor & Industries to retain, beyond July 1, 2018, the current standard in WAC 296-46B-555(1) and to insert a provision that addresses stray current at the pedestal.

Dear Director Sacks:

Northwest Marine Trade Association (NMTA) and the Recreational Boating Association of Washington (RBAW) are jointly submitting these written comments on the Department of Labor & Industries (L&I) consideration of the National Electrical Code (NEC) as it relates to marinas, boatyards, and commercial and non-commercial docking facilities. This part of the code can be found at Article 555.3 NFPA 70 – 2017 NEC, with the State's adoption at WAC 296-46B-555(1).

By way of background, both NMTA and RBAW are national leaders. NMTA recently marked its 70<sup>th</sup> year of service and is now the nation's oldest and largest regional marine trade association with 725 member businesses and public ports, including 70 marinas and 55 boatyards. As for RBAW, they celebrated their 60<sup>th</sup> anniversary in 2016. They act as a legislative and regulatory voice for recreational boaters, with 1,300 individual members and about 8,000 more members spread across 50 boating and yacht clubs in Washington.

Both organizations have a proud safety record. Led by former RBAW President Steve Greaves and NMTA volunteer leaders, industry and boaters brought forward the current mandatory boater education law in Washington state. We have long realized that safe boating is fun boating.

With respect to the NEC, please remember that it is not a regulatory document. It is a safety standard that is intended to be suitable for mandatory application by government bodies that exercise legal jurisdiction over electrical installations. This guidance is provided in NEC Section 90.4.

1

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, who attended both meetings with  
to see what is actually happening on  
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December 15, 2017

Ms. Kerry M. Bell, Chair  
National Fire Protection Agency Standards Council  
1 Batterymarch Park  
Quincy, MA 02169-7471

Re: AMI Comment submission re Tentative Interim Agreement 1348 (TIA 1348)

Dear Ms. Kerry Bell,

The Association of Marina Industries (AMI) desires to be an industry leader in the area of minimizing the dangers in marinas due to Electric Shock Drowning (ESD). AMI addresses the ground-fault application in marinas as a positive step toward mitigating the effects of ESD. AMI membership also strives to ensure that the language in Federal guidelines such as the National Electric Code (NFPA 70) provides realistic operational and functional parameters in order to manage a safe and efficient marina. At this time, AMI does not agree with the language proposed in TIA 1348(2). This TIA does not address or resolve the shore power electrical system reliability issues marinas will face because of the overly restrictive requirement of Section 555.3 of the 2017 NEC (NFPA 70). While the AMI agrees that ground-fault protection is not essential (and not practicable in most situations) at the marina main service, the requirement for ground-fault protection not to exceed 30 mA for the (dock) feeders and branch circuits, along with the potential for problems it poses, is not addressed. Adoption of TIA 1348 will only lend further credence to the belief that ground-fault protection not to exceed 30 mA at the dock feeder OCPD will not be detrimental to reliable system operation. In our opinion, and based on the evidence we have, it could well be very detrimental.

AMI is the largest nationwide membership organization devoted directly to the marina, boatyard and yacht club industry. Of its 1250 members, 885 are marinas, boatyards or yacht clubs. Represented by the organization is 29% of the estimated 35,000 full and part-time employees in the industry and over 300,000 boaters using 164,000 boat slips at AMI member facilities.

#### Commentary:

There is increasingly broad concern in the marina industry that overly restrictive ground-fault protection requirements for marinas, and specifically for dock wiring, will result in serious operational problems while not significantly improving electrical safety in the marina environment.

There is also a concern that some marina operators will find it necessary to bypass newly required safety provisions and might do so after completion of any electrical inspections. Such actions could create conditions that are even more hazardous.

Also, there is growing evidence that the ground-fault current existing on dock feeder circuits in marinas can be substantial in nature and yet not create conditions in the water that are hazardous to human beings. Data providing expected or actual ground-fault leakage for marina dock feeders is scarce, to say the least. This past summer, a private individual in Minnesota measured the ground-fault current on approximately 64 dock feeder circuits in five Minnesota and Wisconsin marinas, all located on the Mississippi and St. Croix Rivers. Forty-eight of these measured currents were well in excess of 30 mA—even 100 mA—and yet no serious voltage gradients were found in the water surrounding boats connected

AMI Comment on TIA 1348

1

December 15, 2017

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December 15, 2017

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December 15, 2017

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mber 15, 2017



*State by State  
Marina by Marina*

*NEC*

*More investigation  
of marina ground  
currents required*

*So Now What ?*

# Signage

## 3 Warning Signs required stating **"WARNING - POTENTIAL SHOCK HAZARD - ELECTRICAL CURRENTS MAY BE PRESENT IN THE WATER."**

**555.24 Signage.** Permanent safety signs shall be installed to give notice of electrical shock hazard risks to persons using or swimming near a boat 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 signs shall state "WARNING — POTENTIAL SHOCK HAZARD — ELECTRICAL CURRENTS MAY BE PRESENT IN THE WATER." [555.24 is a new section added to the 2017 NEC]





**A sign could have made a difference**

# Electric Shock Drowning Prevention Association



**Awareness**  
**Education**  
**Mitigation**

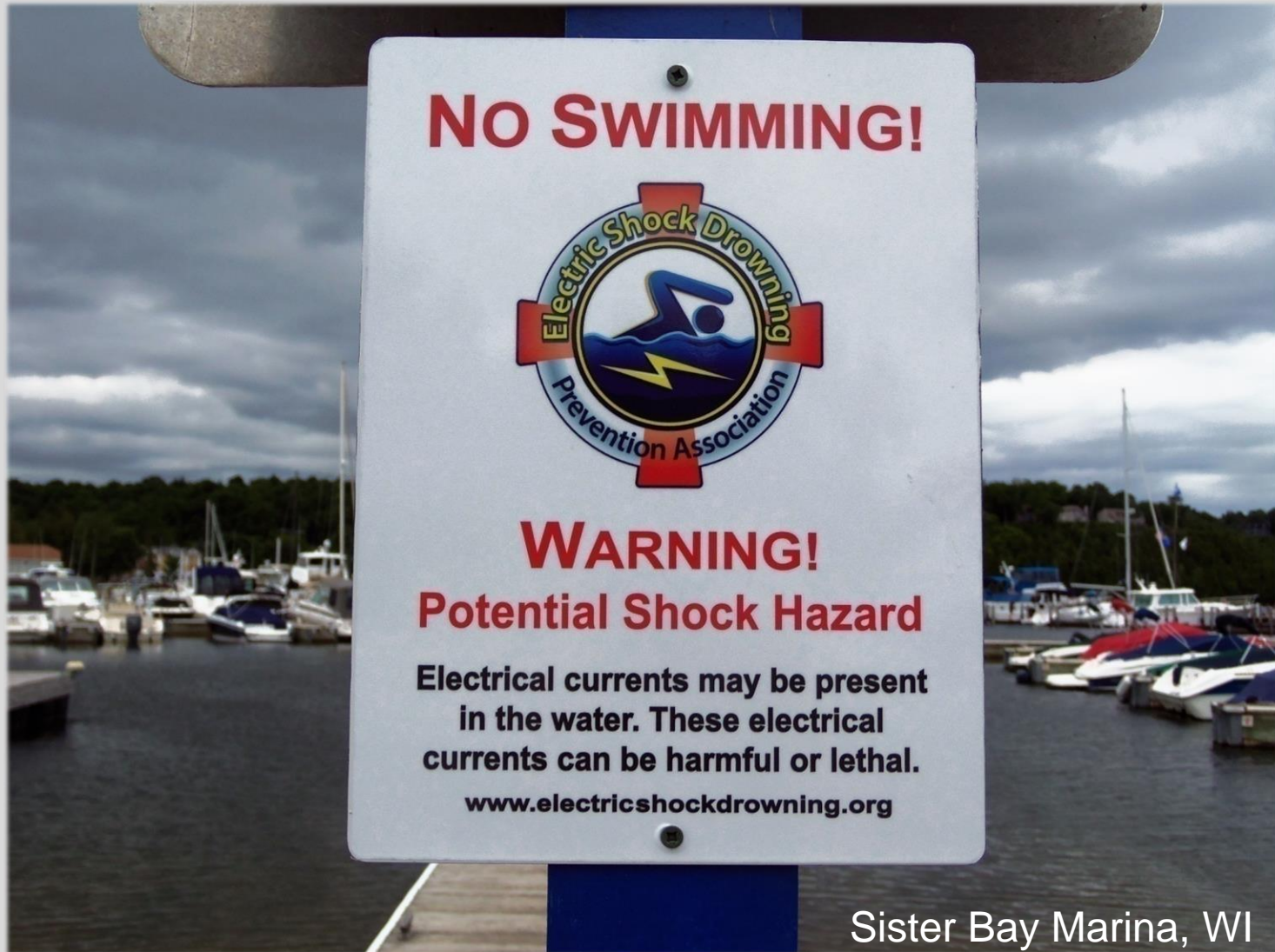
Founded on July 15th 2011





03/25/2009

Harbor Cove Marina, Duluth, MN





# Electric Shock Drowning Prevention Association



**Awareness**  
**Education**  
**Mitigation**

Founded on July 15th 2011

## Significant Coverage by Boating and Marina Publications



## Increasing Coverage by Media



**WCCO-TV CH 4, 10 PM News, June  
28, 2016**



**UK Daily Mail,  
May 21, 2016**



# Electric Shock Drowning Prevention Association



**Awareness**  
**Education**  
**Mitigation**

Founded on July 15th 2011

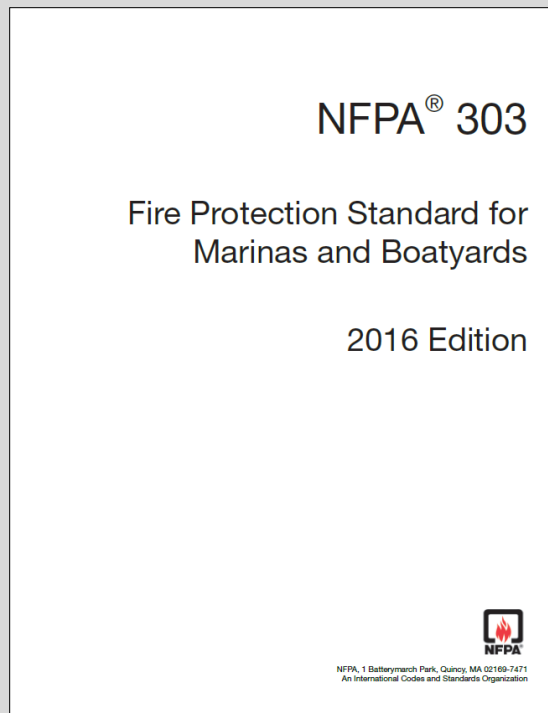
## **Proactive Mitigation is essential to protect**

- those in the water unintentionally
- the uninformed (includes animals)
- the misinformed
- the disbelieving
- those careless regarding their well-being and the well-being of others
- And even trespassers

## **Electrical safety goals should include**

- ✓ Enforceable safety standards
- ✓ Quality and skilled workmanship
- ✓ Inspection by competent authority
- ✓ Mandatory recurring inspection
- ✓ Continuous monitoring?
- ✓ Routine testing and maintenance
- ✓ EDUCATION OF THE PUBLIC

## **Stricter requirements have been or are being enacted in some states**



- West Virginia
- Tennessee
- Kentucky
- Missouri
- Arkansas



# SHOCK ALERT



# Electric Shock Drowning



# When Is It "Safe" to Go Into the Water?

**'Safe'** is defined in Noah Webster's 1828 Dictionary as

1. Free from danger of any kind
2. Free from hurt, injury or damage
5. Placed beyond the power of doing harm

The term "**safe**" to enter the water can be misleading and should never be used in the context of water safety where electric equipment and wiring are installed

The phrase "**degree of risk**" would be more suitable and avoids any inference that absolute safety is assured



## **When is the risk of ESD "very low"?**

The Electric Shock Drowning Prevention Association recommends maintaining a minimum distance of **150 feet** from all AC electrical equipment and wiring

This separation should reduce the risk of an ESD accident to a very low level for any in-the-water recreational and non-recreational activities

## Electric Shock Drowning Prevention Association



Electrical  
equipment  
or wiring

10 feet

**Very High Risk  
of ESD  
Accident**

**Conditions are always subject to change**

## Electric Shock Drowning Prevention Association



Electrical  
equipment  
or wiring

150 feet

**Very Low  
Risk of ESD  
Accident**



**Conditions are always subject to change**

## Electric Shock Drowning Prevention Association



Electrical  
equipment  
or wiring

??? feet

**Very Low  
Risk of ESD  
Accident**



**Conditions are always subject to change**

# July 4, 2014

## Lake of the Ozarks, MO – 7 mi marker

Several people were swimming at a private dock when they started feeling tingles.

Turning off the power at the dock did not solve the problem. A contractor found an electrical short at an abandoned boat ramp about **100 yards** away. The power was disconnected and the electricity [tingles] in the water ceased.

"Near Miss" Case No. 5



# Recommendations

## **A Proposed Minimum Requirement**

All facilities, from the largest marina to the smallest residential dock, should have instructions posted in a conspicuous location that indicate where and how to disconnect the power to all equipment in, on, over, or near the water

## **A Proposed Minimum Requirement**

Marinas should have an emergency response plan and all staff should be familiarized with that plan and trained in proper response procedures

Marinas should familiarize their customers with ESD hazards along with other items of importance



## EPO Switch for Marinas and Docks?

## Emergency Electrical Disconnects



**Public Input No. 2894-NFPA 70-2017 [ New Section after 555.17 ]**

555.16 Emergency Electrical Disconnects. Permanent dock installations, including fixed and floating docks, shall be provided with a clearly identified emergency shutoff device or electrical disconnect at the feeder disconnecting means. Such devices or disconnects shall be installed at or near the feeder disconnecting means and not less than 3 m (10 ft) from the dock that it serves. Emergency shutoff devices or electrical disconnects shall disconnect power to all electrical service to the dock; to all associated shore power, control, and signal circuits; and to all other electrical equipment associated the dock. When more than one emergency shutoff device or electrical disconnect is provided, all devices shall be interconnected. Resetting from an emergency shutoff condition shall require manual intervention and the manner of resetting shall be approved by the authority having jurisdiction.

### Statement of Problem and Substantiation for Public Input

A significant number of marina-related deaths and injuries have occurred in recent years that were the direct result of electrical faults and other electrical problems in and around marina facilities. Would-be rescuers have also become victims when entering the water to aid a victim or victims before shore power to boats or other equipment was disconnected. In a great many cases, the location of the disconnecting means is either inaccessible or unknown. A readily accessible and clearly marked disconnecting means similar to that found in fuel dispensing facilities could help to reduced the number of deaths and injuries by increasing awareness of the potential danger and by providing the readily accessible means necessary to disconnect all electrical power to the boats and other electrical equipment.

### Submitter Information Verification

**Submitter Full Name:** Edward Lethert

**Organization:** Ed Lethert Assoc Inc

**Street Address:**

**City:**

**State:**

**Zip:**

**Submittal Date:** Mon Aug 28 17:18:20 EDT 2017

#### Copyright Assignment

I, Edward Lethert, hereby irrevocably grant and assign to the National Fire Protection Association (NFPA) all and full rights in copyright in this Public Input (including both the Proposed Change and the Statement of Problem and Substantiation). I understand and intend that I acquire no rights, including rights as a joint author, in any publication of the NFPA in which this Public Input in this or another similar or derivative form is used. I hereby warrant that I am the author of this Public Input and that I have full power and authority to enter into this copyright assignment.



By checking this box I affirm that I am Edward Lethert, and I agree to be legally bound by the above Copyright Assignment and the terms and conditions contained therein. I understand and intend that, by checking this box, I am creating an electronic signature that will, upon my submission of this form, have the same legal force and effect as a handwritten signature



"That's a great idea to have an emergency pushbutton at all docks with electricity, ...



Mike Holt, Electrical Trainer, Consultant, Author, Publisher  
Private communication – 05-30-2016



## How about swimming pools?

# In Conclusion

# Remember & Remind:

In-the-water shock hazards can exist—or occur suddenly without notice or warning—wherever shore-powered AC electrical equipment is located in, on, over, or near the water!



## The ESDPA recommends:

DO NOT enter the water in the vicinity of shore powered watercraft or equipment, for any reason — **EVER!**

Stay at least 150 feet away from all electrical equipment and wiring !



## Responding to An Electric Shock Drowning Incident

*This is important and useful information for law enforcement officers, firefighters, emergency medical technicians, marina staff, boaters, lake property owners, and the general public.*

*The combination of humans (or pets), water and electricity can be deadly. An in-the-water shock hazard can exist wherever shore-powered AC electrical equipment is located in the water, over the water, or near the water. See links at bottom of page for additional information.*

### Typical Electric Shock Drowning Scenario

- The victim enters electrically charged water (i.e. swims, wades, jumps, paddles or falls).
- The victim may feel a tingling sensation; or may become partially or totally disabled.
- The victim may or may not remain conscious.
- The victim may or may not remain on the surface.
- The victim may or may not call for help or make sounds indicating distress (scream, etc.).
- The victim's situation may worsen when seeking a "safe haven." This is likely if they move toward rather than away from the source of the electrical current

### Recommended Actions for ESD Victims

- The victim should, if able, keep their arms and legs close to their body (this action will reduce exposure to the voltage gradients in the water).

# Responding to an ESD incident

- must fight the instinct to enter the water to assist the victim — many well-meaning rescuers have died while trying to rescue humans and animals from electrically charged waters.
- should disconnect (switch OFF or unplug) all dock and shoreline electrical power as close as possible to the electrical power source.
- should, where applicable, disconnect the boat's shore power cord at the pedestal receptacle.
- should throw life ring or other flotation device to a conscious and able victim.
- should push the victim away from the presumed current source with an insulated pole.
- should call for help immediately — Dial 911 or call on VHF Channel 16 as appropriate.
- should attempt first aid/CPR where the victim can be safely removed from the water.
- must not throw a line to the victim and then pull the victim closer to the current source.
- must not grab onto metal dock hardware while reaching for a nearby victim.

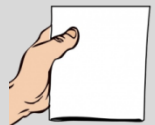
There is portable test equipment that will detect a hazardous electrical condition in the water in some cases. Typically, this equipment is not readily available, and its correct use requires special knowledge and training — Disconnecting the electrical power is always the recommended action.



**Remember:** An in-the-water shock hazard can exist, or occur suddenly, wherever shore-powered AC electrical equipment of any kind is located in the water, over the water, or near the water.

Additional resources including supporting information may be found at: [www.electricschockdrowning.org](http://www.electricschockdrowning.org); [www.electricschockdrowningmn.com](http://www.electricschockdrowningmn.com); [www.qualitymarineservices.net](http://www.qualitymarineservices.net); and [www.boat-us.com/seaworthy/ESD.asp](http://www.boat-us.com/seaworthy/ESD.asp).

Read purpose and disclaimer on reverse side of page.





**More Information**



## Electric Shock Drowning



You are a safe, skillful boater.

You keep your vessel and its support equipment in tip-top operating condition.

You take all the required precautions against fire or explosion during and after refueling.

Despite all of this, you and your guests may not realize there may be another threat as you settle into another fun day on your boat while tied up in your transient or home slip.

The threat is electric shock drowning.

While your boat is in the slip, you may decide to jump off the swim platform to check out a prop that vibrated during the cruise, or recover a precious smart phone, sunglasses or tool. Any of those decisions could be a deadly mistake.





## **ELECTRIC SHOCK DROWNING PREVENTION ASSOCIATION**

**[www.electricshockdrowning.org](http://www.electricshockdrowning.org)**

**Ed Lethert's MN ESDWeb Site**  
**[www. electricshockdrowningmn.com](http://www.electricshockdrowningmn.com)**

**Electric Shock Drowning  
Prevention Association**  
**[www.electricshockdrowning.org](http://www.electricshockdrowning.org)**

**Ed Lethert's MN ESD Web Site**  
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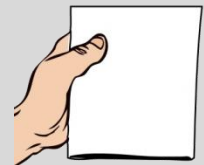


**Electric Shock Drowning Resource Center**  
**[www.boatus.com/seaworthy/ESD.asp](http://www.boatus.com/seaworthy/ESD.asp)**

## ***"The Electric Shock Drowning of Samantha Chipley"***

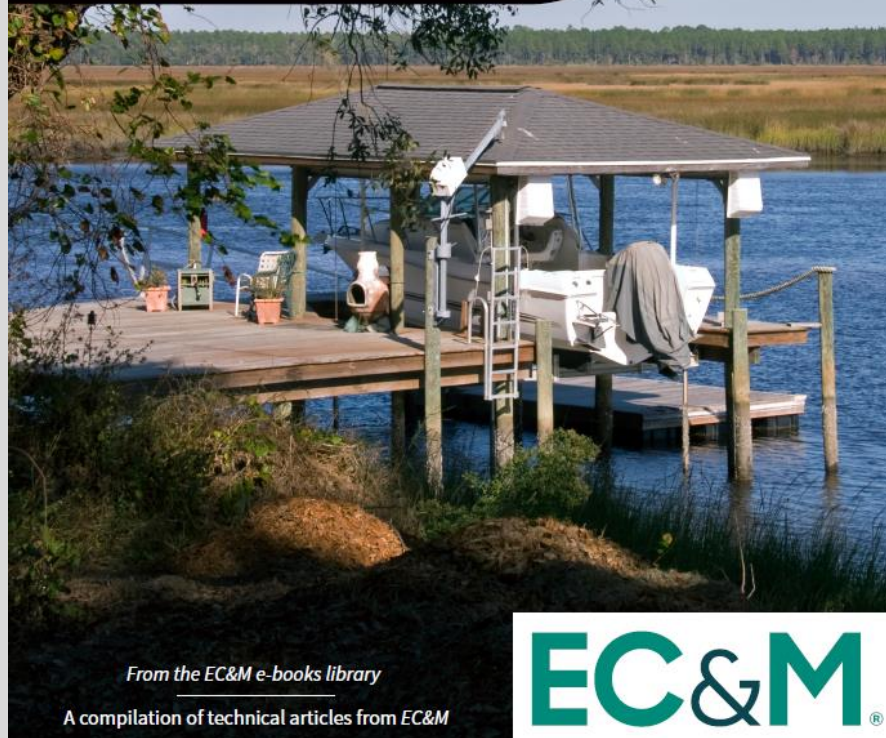


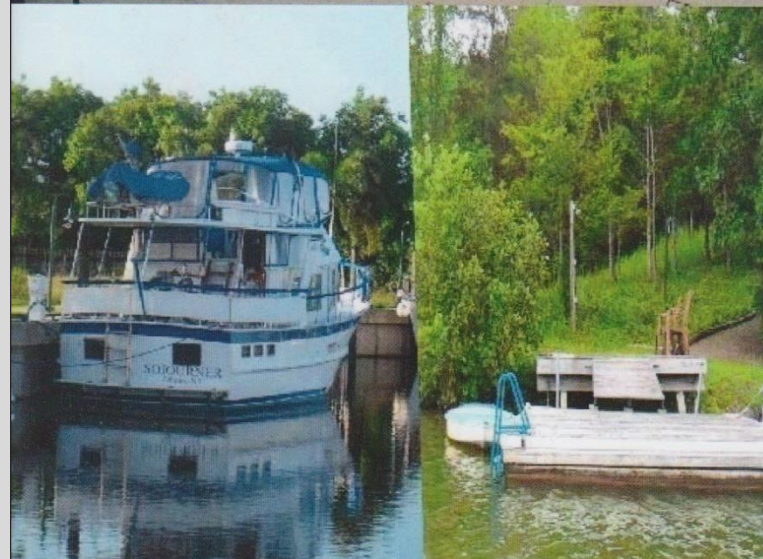
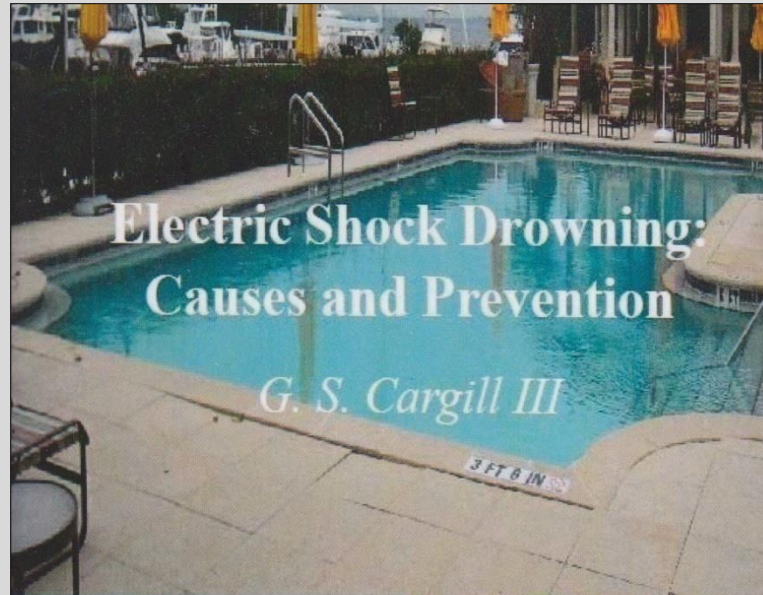
***Article by Attorney B. Clark Batten II***



## ELECTRIC SHOCK DROWNING

*The Truth Behind the Tragedies*









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*In-Water Shock Hazard Mitigation  
Strategies*  
Final Report October 1, 2008



**ABYC**  
Setting Standards for Safer Boating



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