A photograph of a wooden dock with a gazebo on a lake. The dock is made of light-colored wood and has a dark metal railing. The gazebo has a brown tiled roof and is situated at the end of the dock. The water is calm and reflects the surrounding green trees. The text "Electric Shock Drowning and the NEC" is overlaid in large white letters with a black outline.

Electric Shock Drowning and the NEC



Edward "Ed" Lethert

Electric Shock Drowning Safety Specialist



Member of the
Electric Shock Drowning
Prevention Association



Dean Hunter
Assistant Chief
Electrical Inspector



*Construction Codes
and Licensing Division*



Electric Shock Drowning



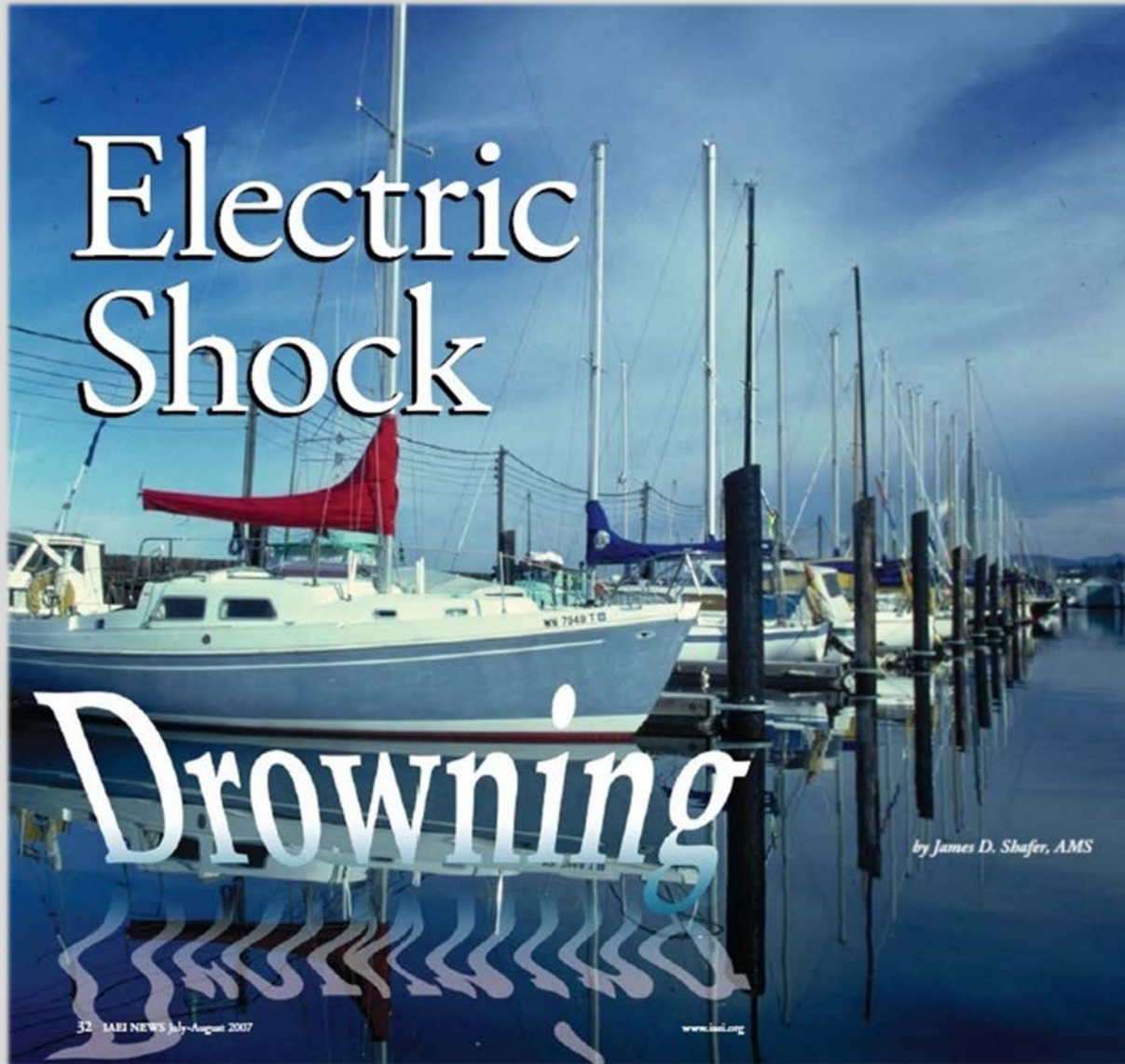


Electric Shock Drowning



James D. Shafer
Accredited Marine Surveyor

Began investigating marine leakage currents in 1999



IAEI NEWS July-August 2007



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...

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



Depending on the magnitude, thru-the-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)



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





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

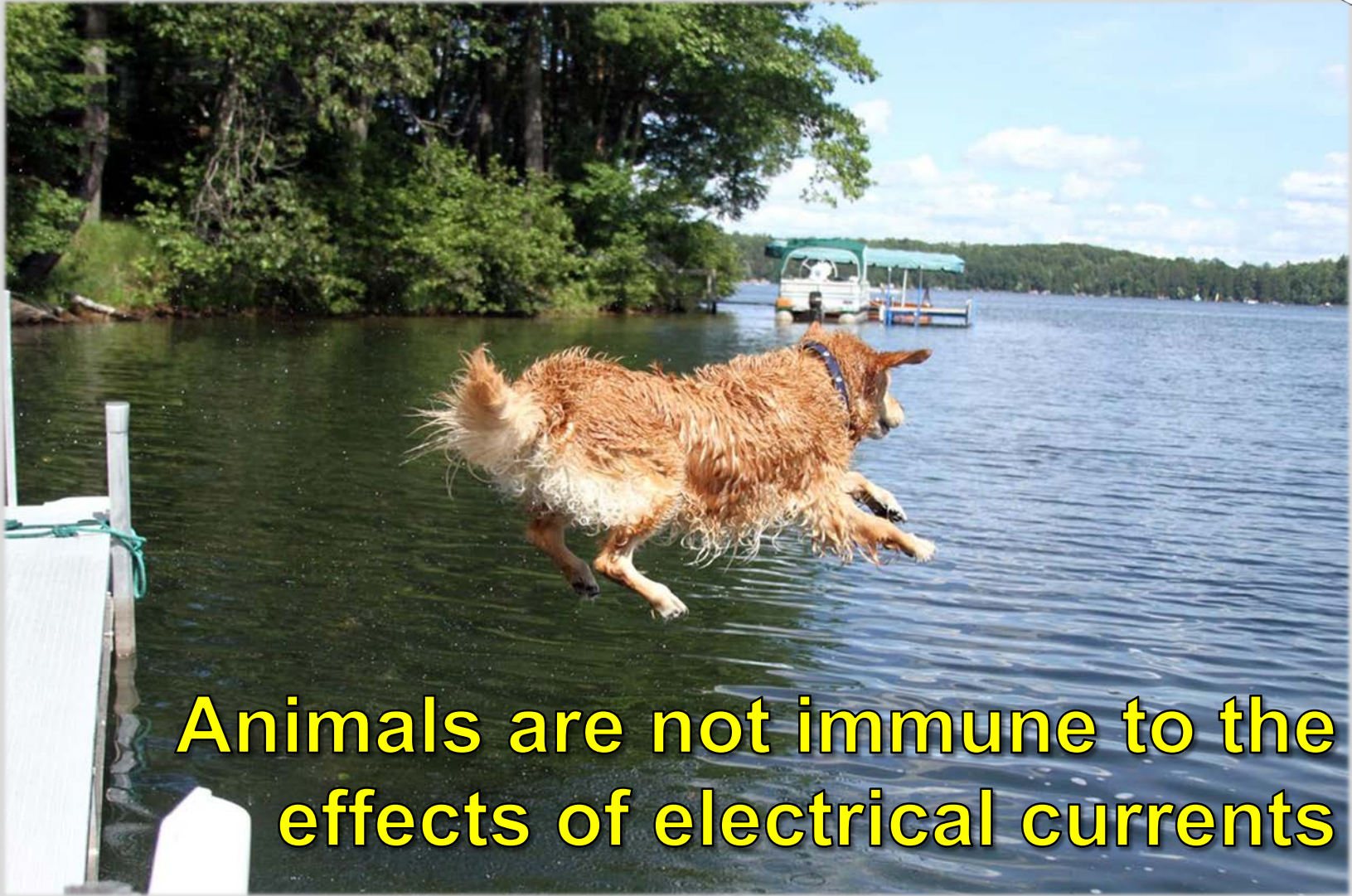


ESD is a Fresh Water Phenomenon

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

Note: $1/20^{\text{th}}$ of the saltwater leakage current results in more than 20 times the body current

Electric Shock Drowning



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

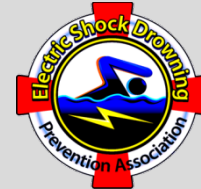
Blackfoot, Idaho





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

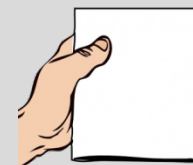
In-water electrocutions are included in the ESDPA's statistics because they are caused by the same electrical conditions that cause an ESD fatality



"The Electric Shock Drowning of Samantha Chipley"



Article by Attorney B. Clark Batten II





What Causes the Shock Hazard?



Electric Shock Drowning



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



Electric Shock Drowning

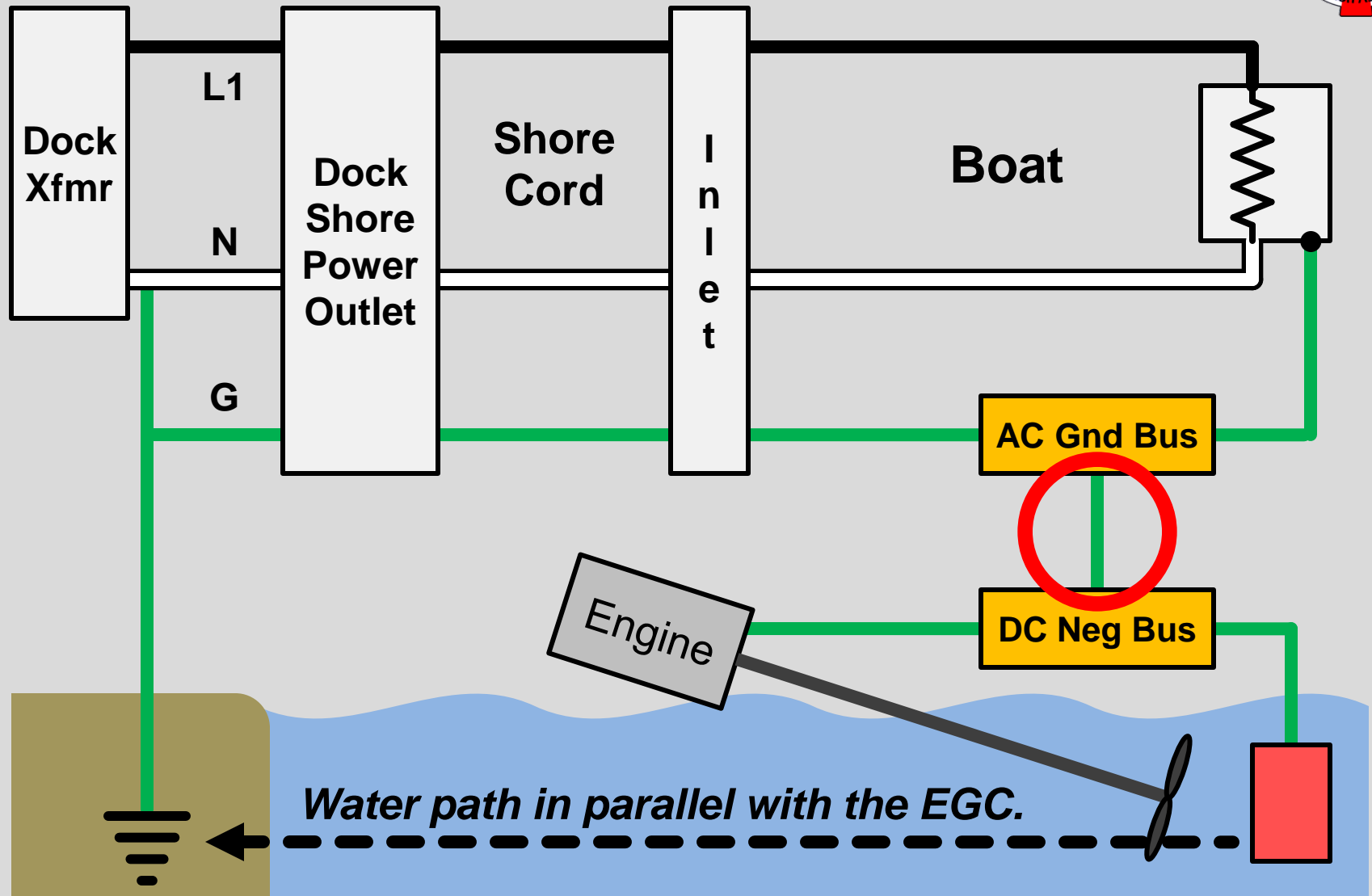


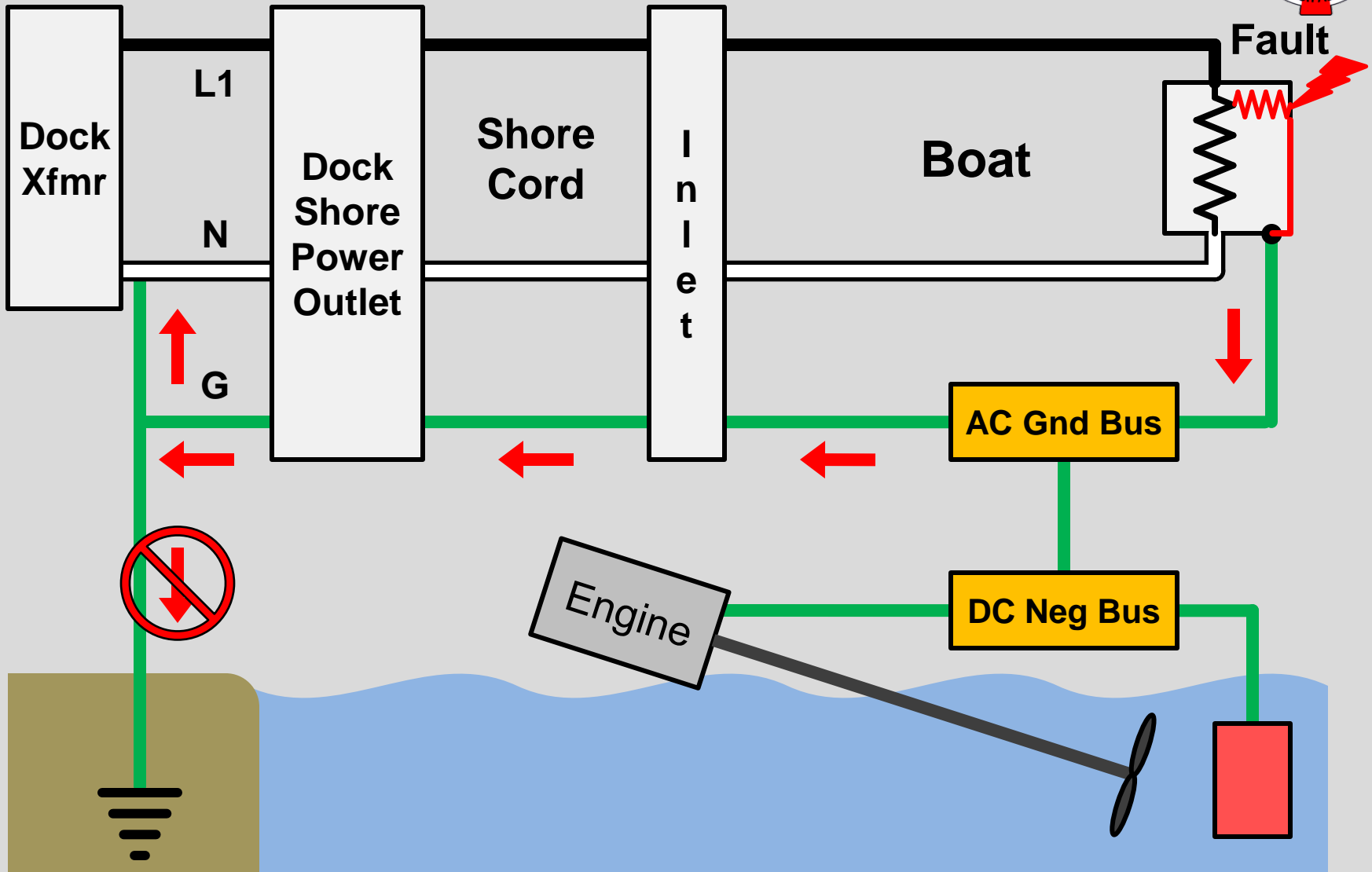
1st — there must be some form of electrical fault (hot to ground) at some point in the AC system or AC powered equipment (on the dock or on a boat)

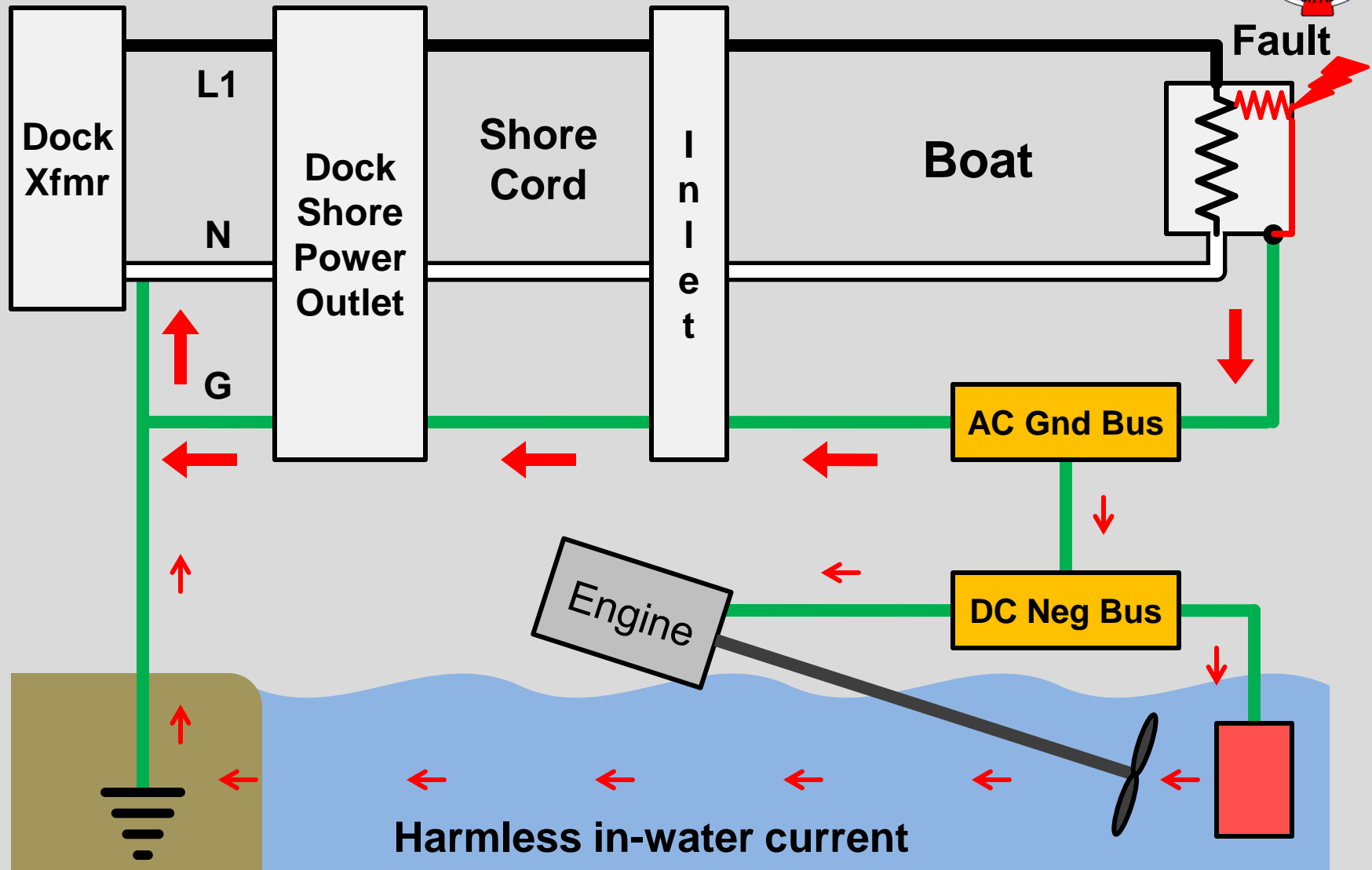
2nd — There must be a failure or loss of the equipment grounding conductor (on a dock or on a boat)

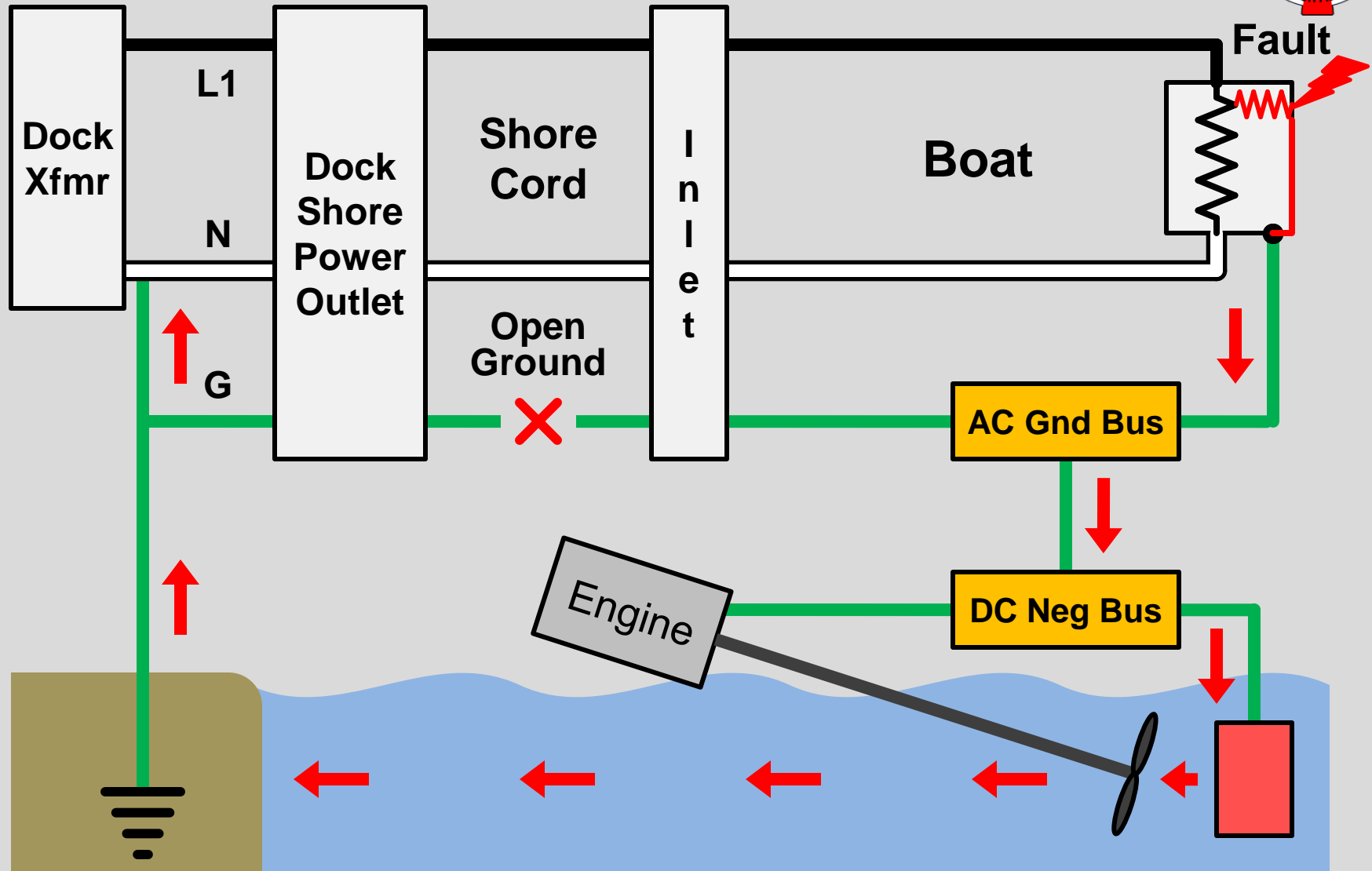


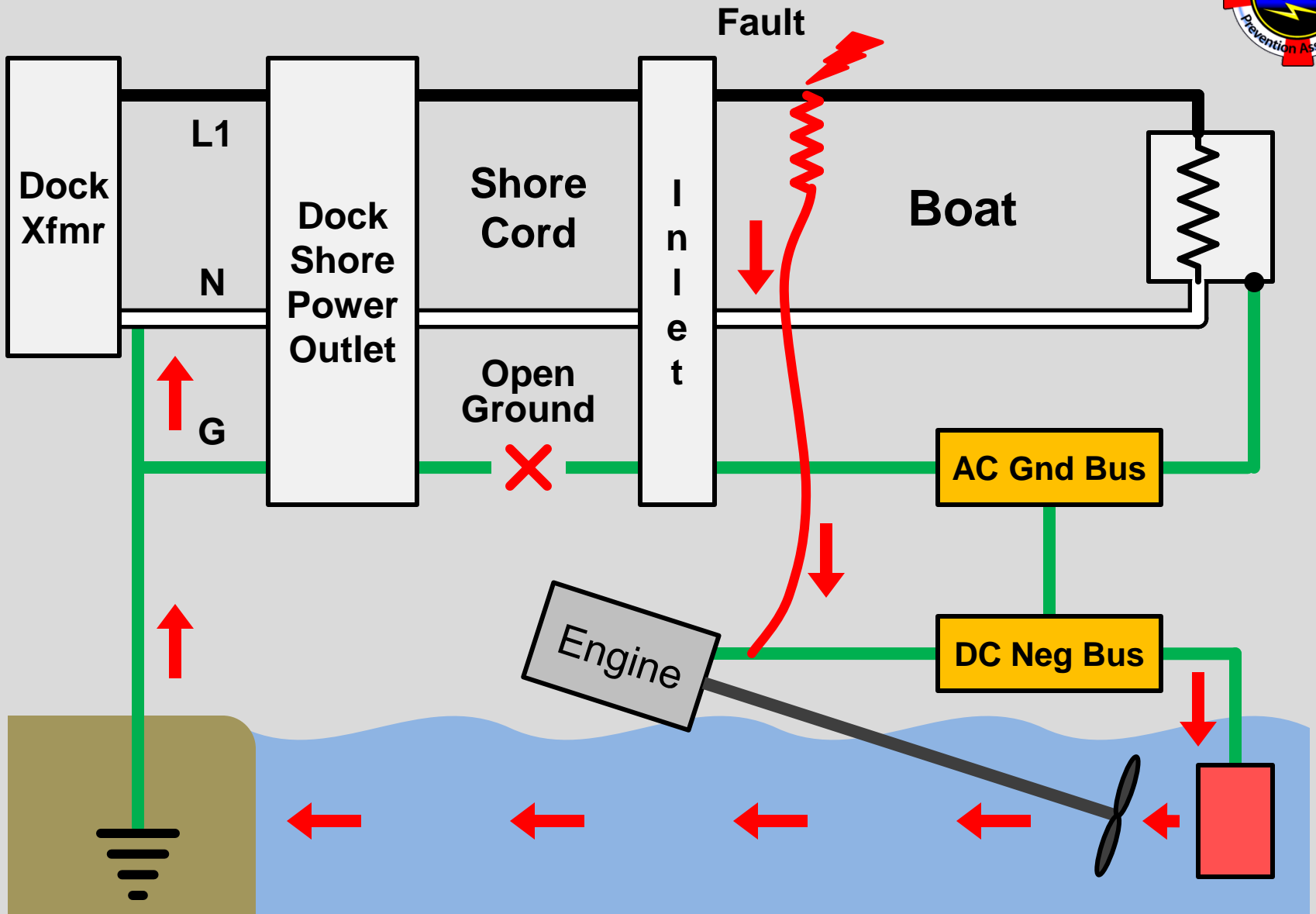
When these conditions exist, a significant amount of water leakage current (i.e. ground current) will flow through the water seeking its way back to the source

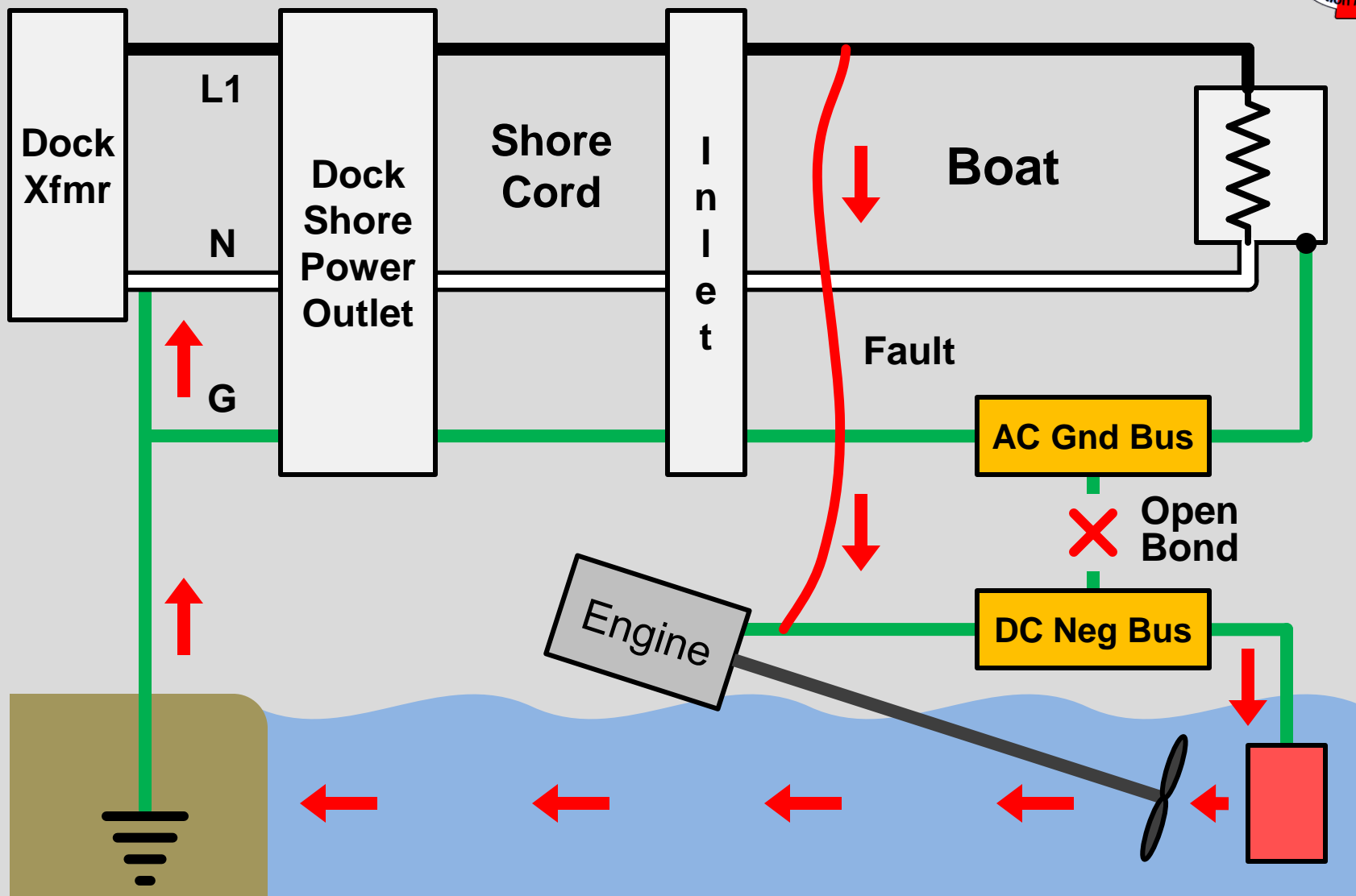








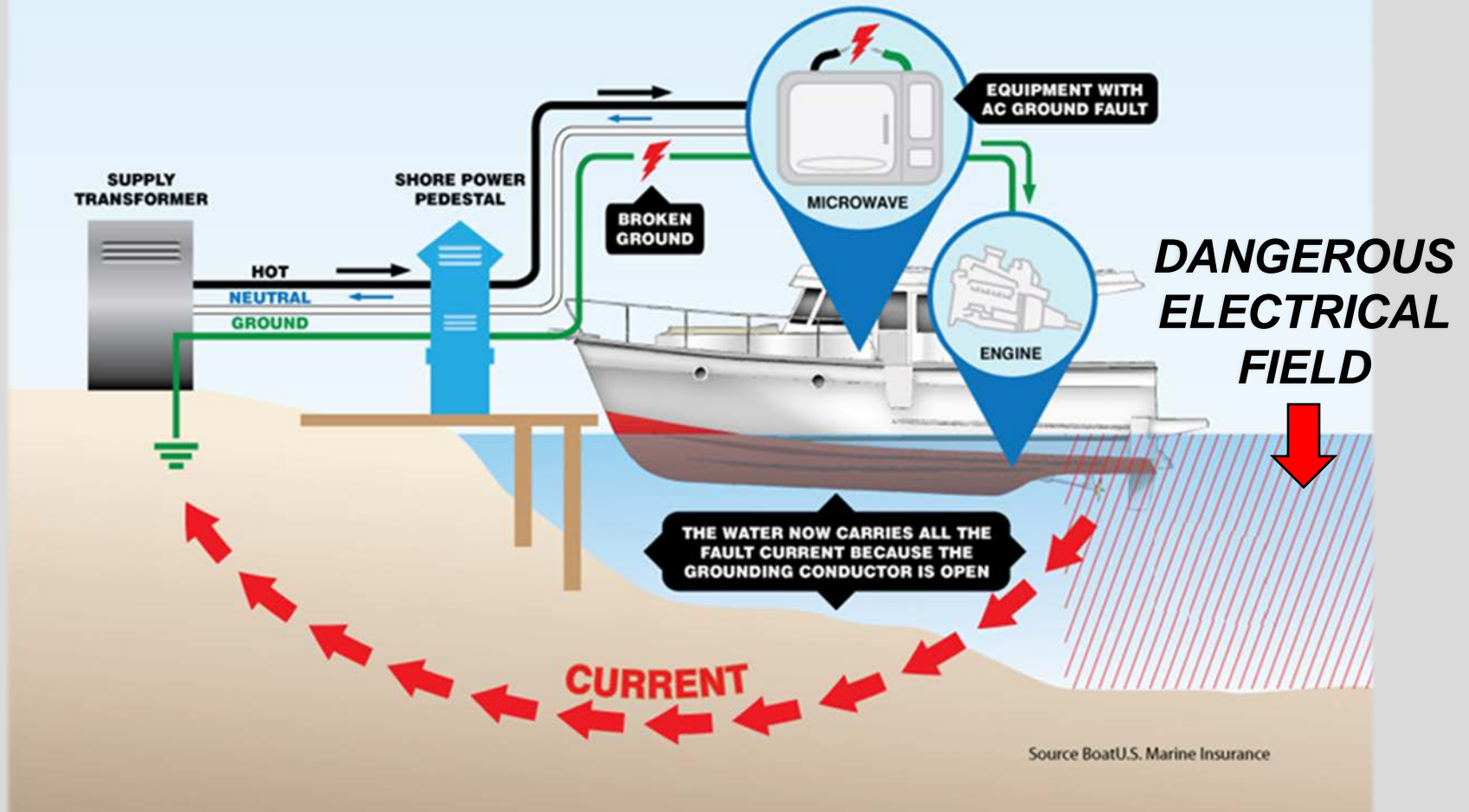


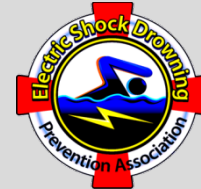


Electric Shock Drowning



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



Electric Shock Drowning



In-Water
Leakage
Current

Through-
Body
Current

Fresh Water

**0.3 Amp
(300 mA)**

23.8 mA

Fresh Water

**0.1 Amp
(100 mA)**

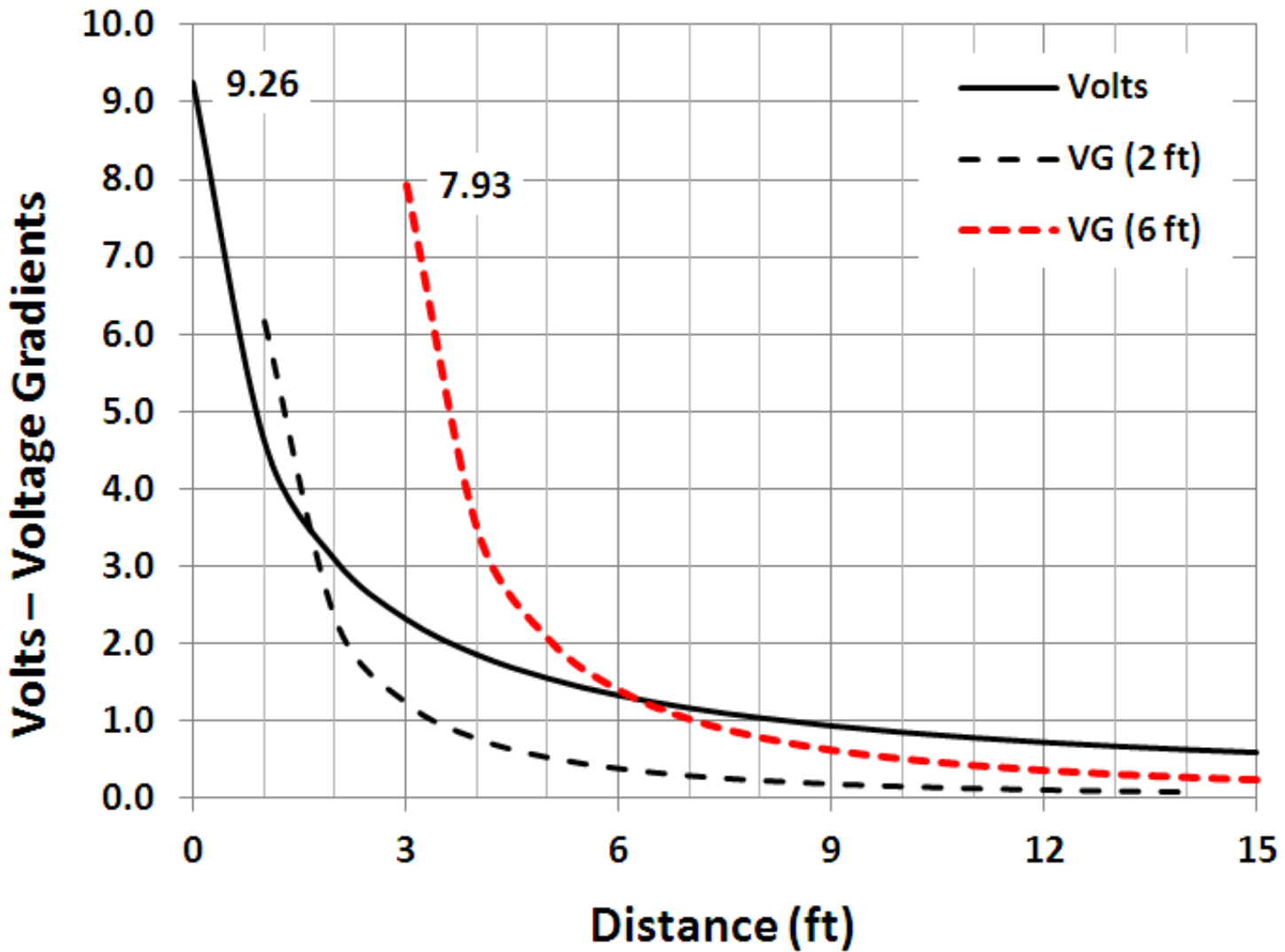
7.9 mA

Fresh Water

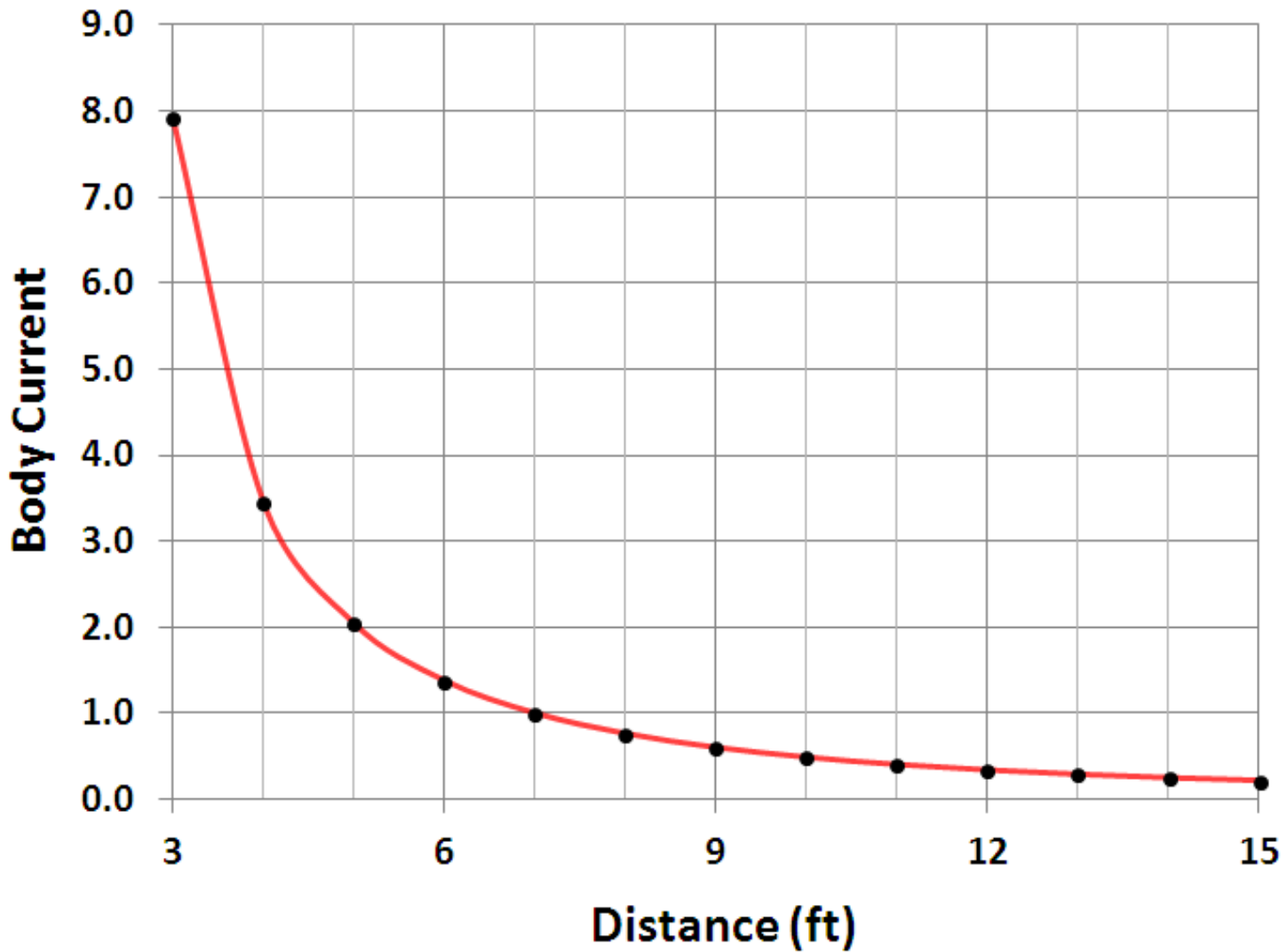
**0.03 Amp
(30 mA)**

2.4 mA

Electric Shock Drowning



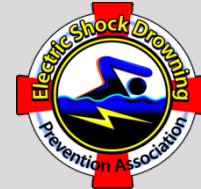
Electric Shock Drowning





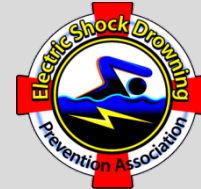
The ESD condition in marinas can be caused by faulty equipment or wiring in or on ...

- 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



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]



Lost to ESD





Lost to ESD

March 27, 2016

**Electric shock in pool
kills man, injures 5 kids**

A father is dead and his daughter hospitalized in critical condition after suffering an electric shock in a Palm Springs swimming pool on Easter Sunday

Four others were treated and released and a fifth remains hospitalized in stable condition



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

June 17, 2016

Donna Berger

**53-year-old mom dies while
rescuing her son at Lake
Chickamauga, Tennessee**



Randy Freeney

**74-year-old man dies while
helping mom who was
rescuing her son at Lake
Chickamauga , Tennessee**



Lost to ESD

September 3, 2016

Rachel Rosoff

**17-year-old lifeguard
drowns in North Carolina
swimming pool**



Fault in pump motor and broken ground connection resulted in death. Person attempting rescue reported feeling tingling sensations when trying to enter 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**



Electric Shock Drowning



Electric Shock Drowning



Put-in-Bay, Ohio



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.

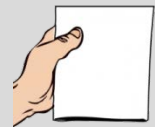
Some of the fatalities listed here were actually caused by ventricular fibrillation (electrocution), because the victim's head was reported not to have been submerged. They are technically not drownings but are listed here since the causes are similar to drowning by electric shock.

Page 1 of 16

ESD Incident Documentation

as of 10-16-17

- 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



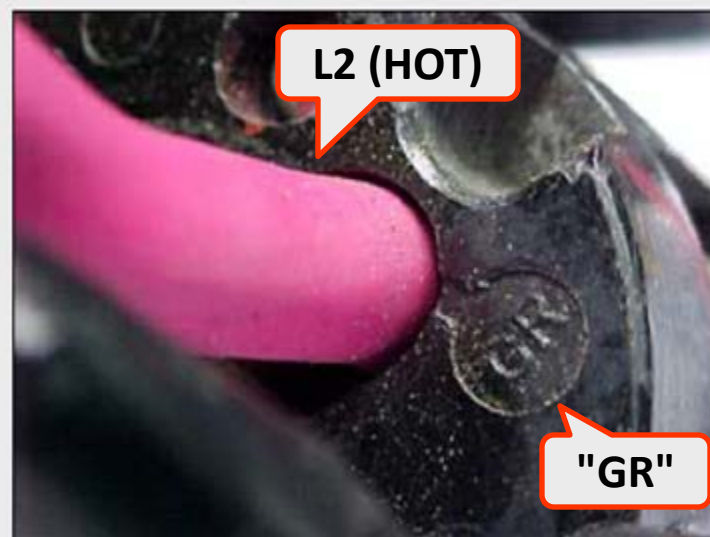
Electric Shock Drowning



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

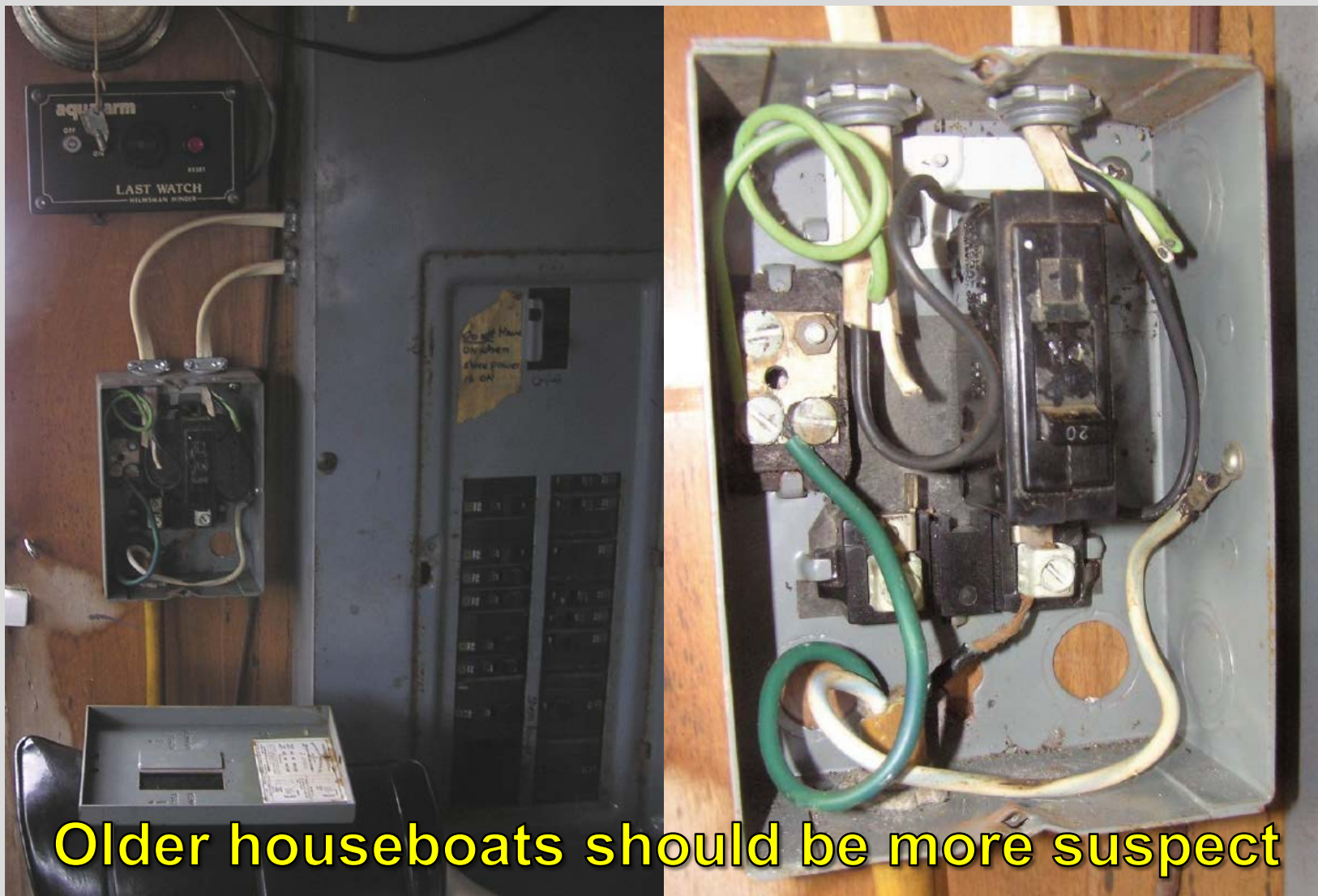
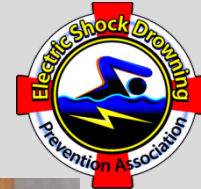


D. Rifkin - J. Shafer





Electric Shock Drowning

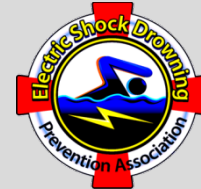




Electric Shock Drowning



- 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



- 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
- Less caution exercised by the today's general public



Also A Concern...

Electric Shock Drowning



Swimming Pools

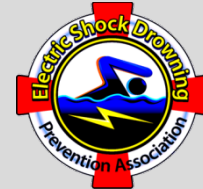
Electric Shock Drowning



Swimming Pools



Electric Shock Drowning



Fountains

Electric Shock Drowning



Decorative Pools and Ponds

Electric Shock Drowning



Aerators



Electric Shock Drowning



"Weed Eaters"



Water and Electricity

A Dangerous Mix



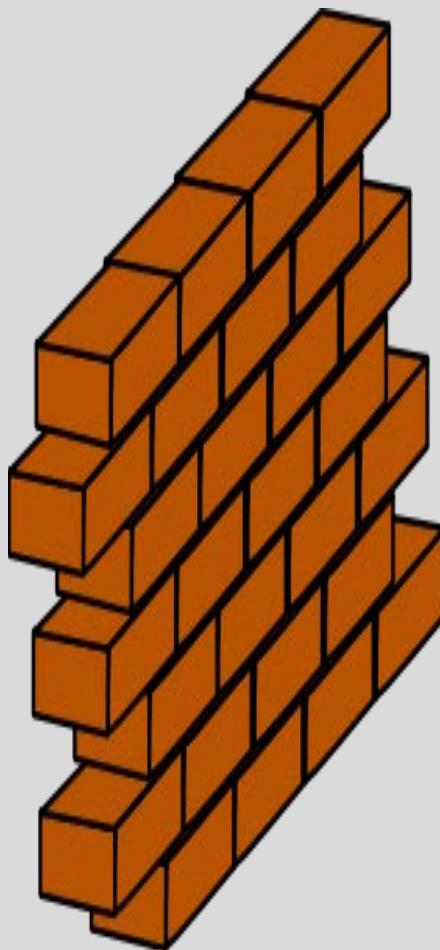
Electric Shock Drowning





Cultural Barrier when it's Water + Electricity

**Indoors?
Be Safe!**



**Outdoors
???**





Electric Shock Drowning



Shore Power

Electric Shock Drowning



Boat Lifts



Electric Shock Drowning



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

And yet...





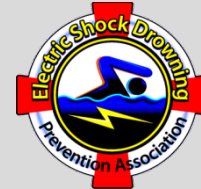
Electric Shock Drowning



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

Electric Shock Drowning



Battery Powered Boat Lift w/ Solar Charger



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

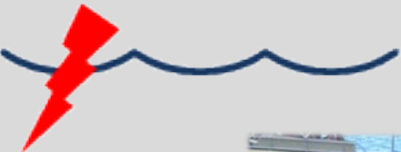


Electric Shock Drowning



Electric Shock Drowning





Electric Shock Drowning





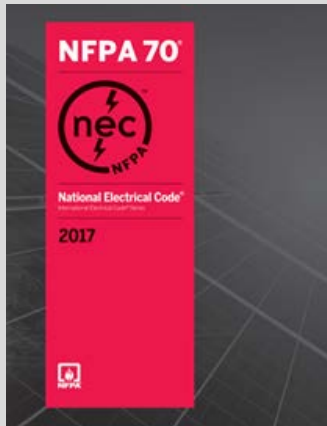
Electric Shock Drowning



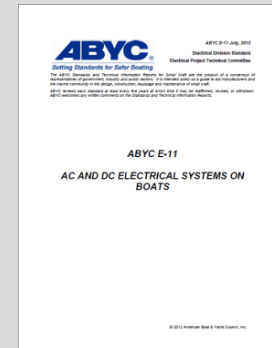


The National Electrical Code and ESD

Electric Shock Drowning



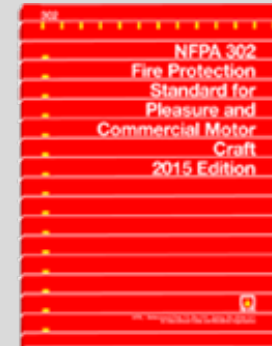
NFPA 70 — NEC



ABYC E-11



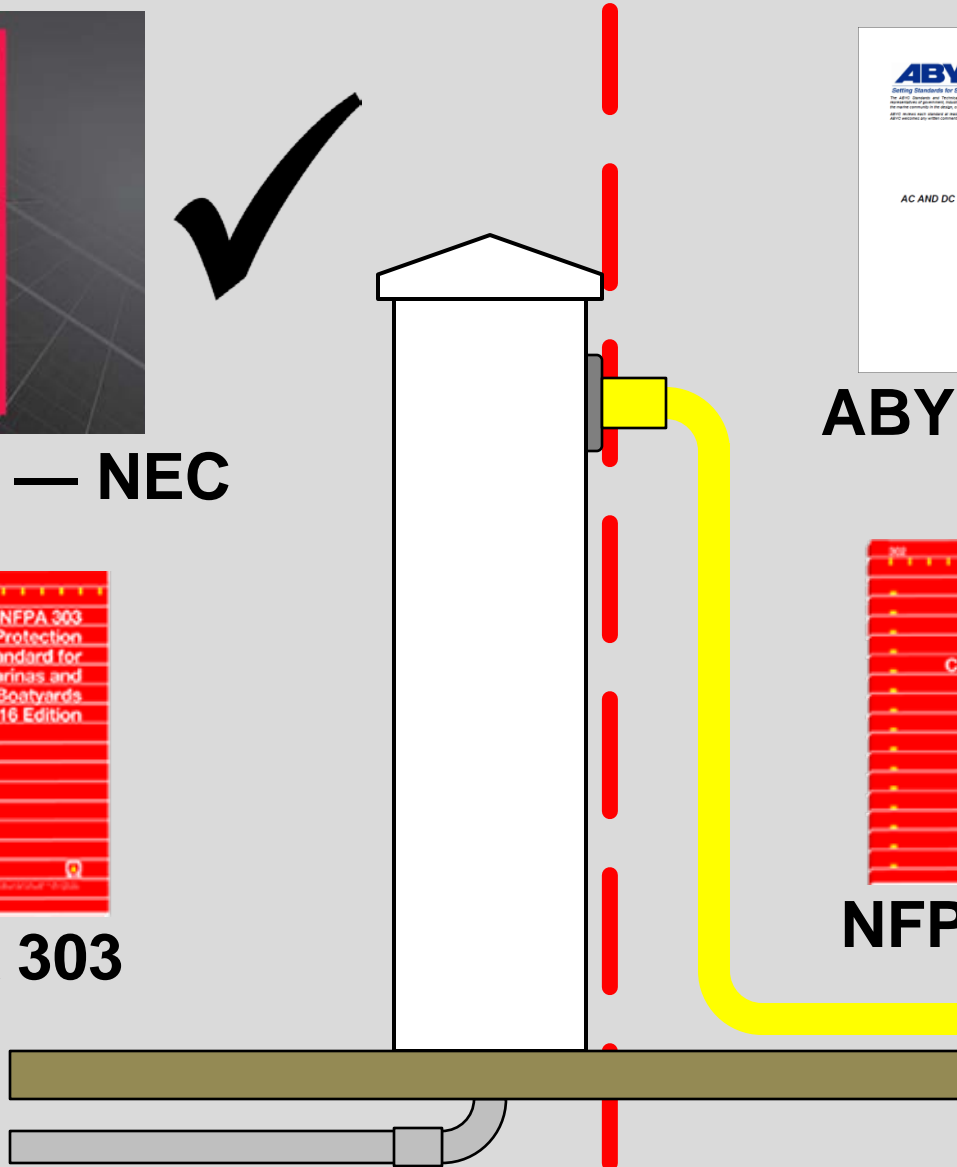
NFPA 303



NFPA 302

Shore Cord

Marina Power



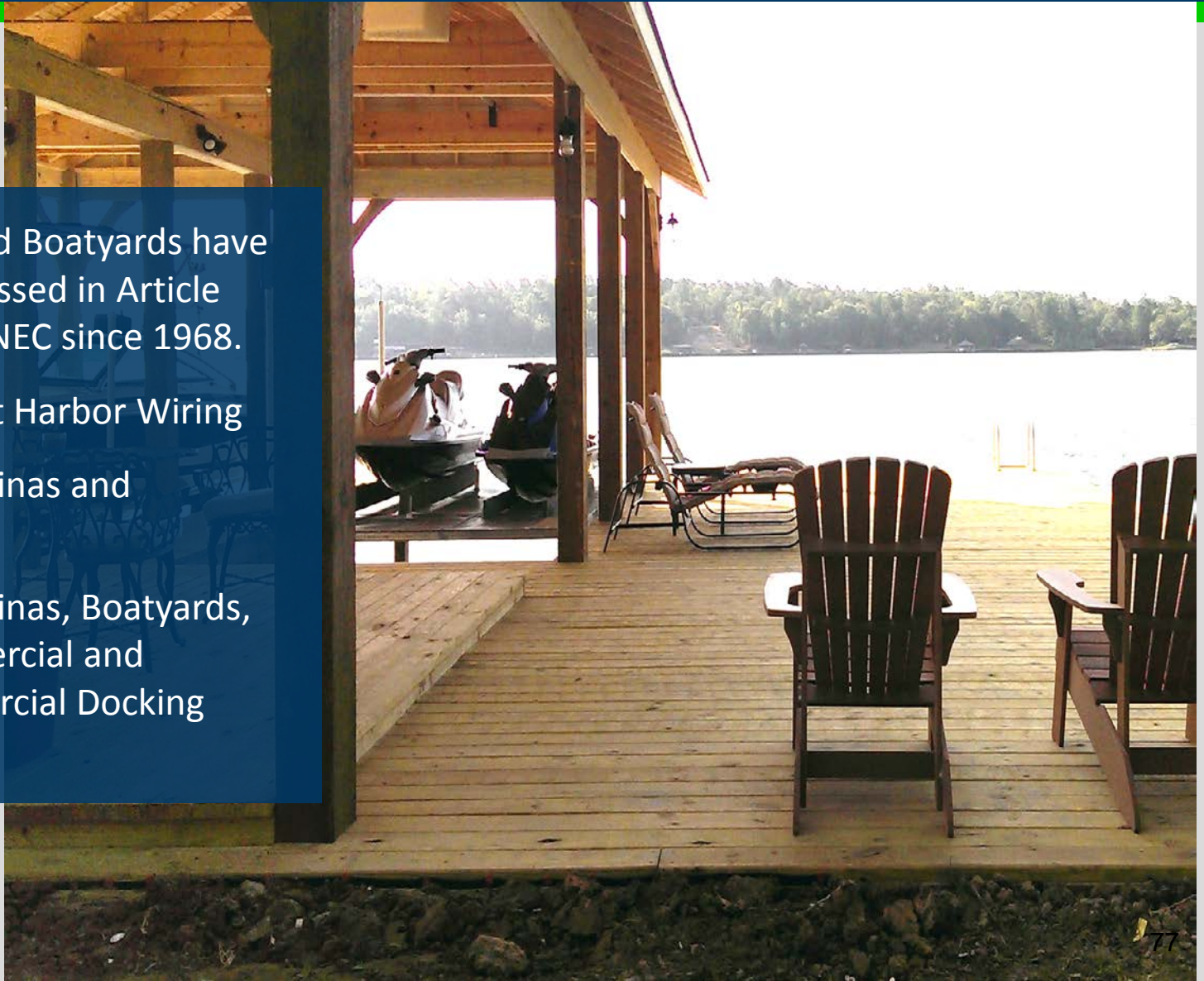
What Articles of the NEC apply to ESD?

- **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



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
- 2017 – Marinas, Boatyards, and Commercial and Noncommercial Docking Facilities

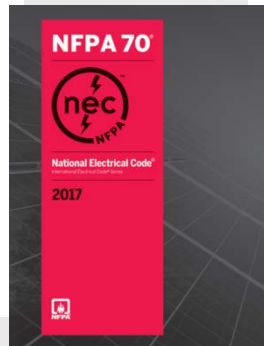


- Title of Article 555 was changed from “Marinas and Boatyards” to “Marinas, Boatyards, and Commercial and Noncommercial Docking Facilities”
- The scope was changed to reflect the addition of one, two and multifamily dwellings

ARTICLE 555 Marinas, Boatyards, and Commercial and Noncommercial Docking Facilities

555.1 Scope. This article covers the installation of wiring and equipment in the areas comprising fixed or floating piers, wharves, docks, and other areas in marinas, boatyards, boat basins, boathouses, yacht clubs, boat condominiums, docking facilities associated with one-family dwellings, two-family dwellings, multifamily dwellings, and residential condominiums; any multiple docking facility or similar occupancies; and facilities that are used, or intended for use, for the purpose of repair, berthing, launching, storage, or fueling of small craft and the moorage of floating buildings.

Informational Note: See NFPA 303-2011, *Fire Protection Standard for Marinas and Boatyards*, for additional information.



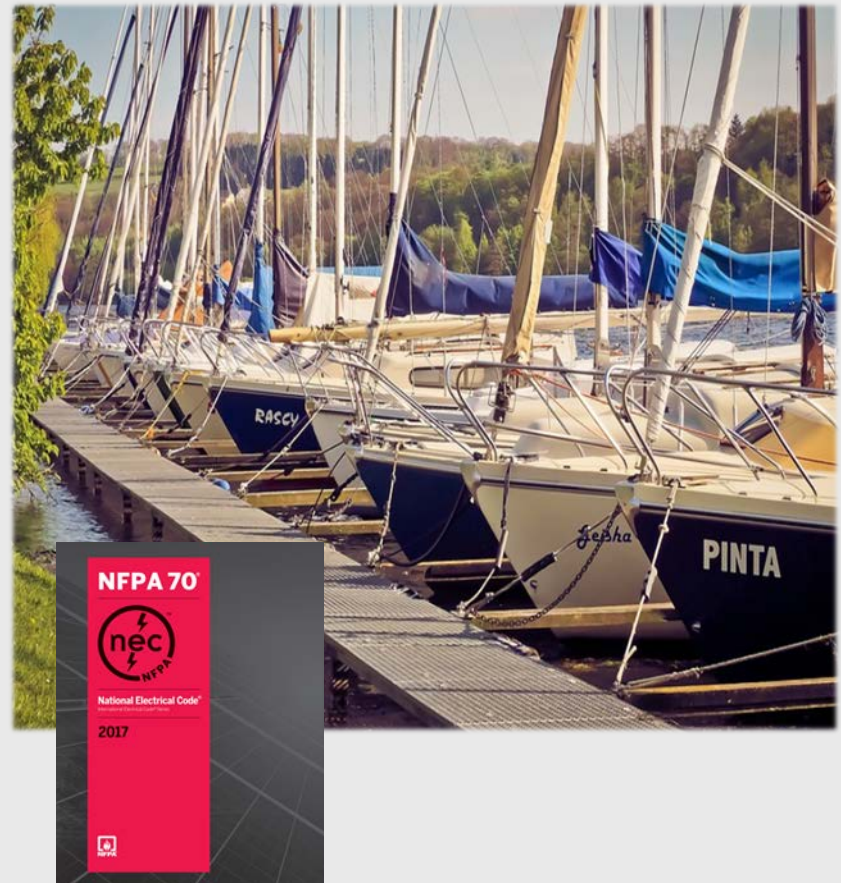
555.3 Ground-Fault Protection.

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



Section 555.3

- The ground-fault protection (GFP) required for OCPD for marinas, boatyards, and commercial and noncommercial docking facilities cannot exceed 30 mA (rather than 100 mA)
- GFP protection is required in all (feeder or branch circuit) supply overcurrent protective devices, not necessarily in the main OCPD



Proposed TIA

TIA Log No.: 1348

Reference: 555.2 and 555.3

Comment Closing Date: December 21, 2017

Submitter: Alan Manche, Schneider Electric



1. *Add new definitions to 555.2 to read as follows:*

Docking Facility. A covered or open, fixed or floating structure that provides access to the water and to which boats are secured.

Marina. A facility, generally on the waterfront, that stores and services boats in berths, on moorings, and in dry storage or stack storage.

2. *Revise 555.3 to read as follows:*

555.3 Ground-Fault Protection. For other than floating buildings covered by 553.4, ground-fault protection for docking facilities shall be provided in accordance with (A) and (B).

(A) Feeder and Branch Circuit Conductors. ~~The overcurrent protective devices that supply the Feeder and branch circuit conductors that are installed on marina, boatyards, and commercial and noncommercial docking facilities shall have be provided with~~ ground-fault protection set to open at currents ~~not~~ exceeding 30 mA. Coordination with downstream ground-fault protection shall be permitted at the feeder overcurrent protective device.

Exception: Transformer secondary conductors of a separately derived system that do not exceed 3 m (10 ft) and are installed in a raceway shall be permitted to be installed without ground-fault protection. This exception shall also apply to the supply terminals of the equipment supplied by the transformer secondary conductors.

(B) Receptacles Providing Shore Power. In lieu of the requirement of 210.8, receptacles installed in accordance with 555.19(A) shall be permitted to have ground-fault protection set to open at currents not exceeding 30 mA.

How did we get here?



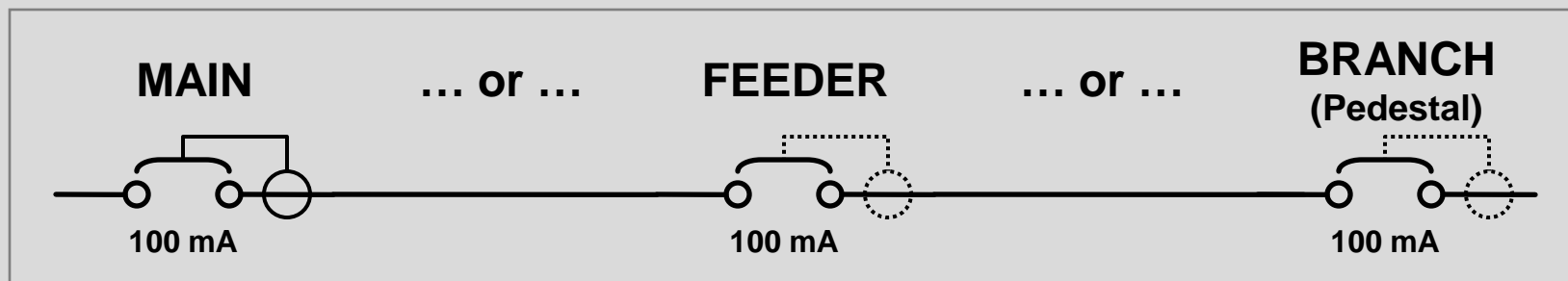
555.3 Ground-Fault Protection.

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.



How did we get here?

Ground-fault protection not exceeding 100 mA required



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.

What happened in the 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.



ject

c P. Hartwell,
Inc.

this section.

sal returns this portion of the
ding and removes the new
so it would be ineffectual at
rocution, or more to the
no documentation to support
s been included.





The panel has proposed an NFPA Research Foundation Code Fund Project to review the American Boat and Yacht Council (ABYC) study on the subject, titled “Research on the Mitigation of Residual Current/Voltage Detection in Marinas, Boatyards to a Level Below Muscular Tentanization Level”. CMP-19 hopes that results from such a study will provide necessary stimulus for development of life saving technologies. In the meantime, CMP-19 has concluded that elimination of the present requirement would be regressive at this time and lead to no required protection at all.

CMP-19 recognizes the critical nature and immediacy of the safety issue and, if this above-mentioned code fund project is approved, intends to address the findings of the project when any recommendations become available.

CMP-19.... Tabled the proposals for 555.3 and requested more information through the research foundation for the 2017 NEC.



The Report

Assessment of Hazardous Voltage/Current in Marinas, Boatyards and Floating Buildings

Final Report

Prepared by:

John Aley
ABYC Foundation Inc.
615 Third Street, Suite 10
Annapolis, Maryland 21403
Bill Daley, P.E. and Ryan Kelly
CED Technologies, Inc.
2444 Holly Ave.
Annapolis, Maryland 21403

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SEARCH

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BRYMARCH PARK
JETTIE, U.S.A. 02169-7471
info@ced.com
<https://ced.com>

device that
ceding a fault
moment stray current

it has become energized. 30 mA represents
prevent a majority of ESD incidents while
unnecessary tripping.

through the swimmer.
s when the
act with the
e by grabbing a
energized. 30
vel that ABYC
ESD incidents
to minimize

2017 NEC First Draft Meeting



Public Input No. 3152-NFPA 70-2014 [Section No. 555.3]

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 provided the ground fault protection of each individual branch or feeder circuit does not exceed 30 mA.

Statement of Problem and Substantiation for Public Input

The purpose of the revised text is to define the ground fault protection level when the option to protect individual branch or feeder circuits is chosen in 555.3.

A new report (Assessment of Hazardous Voltage/Current in Marinas, Boatyards and Floating Buildings) commissioned by The Fire Protection Research Foundation and conducted by The ABYC Foundation, Inc. states in it's overview:

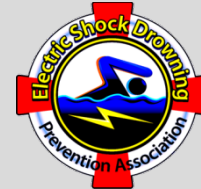
"ABYC Standards recommend a device that interrupts the source of power feeding a fault within 100 ms from the moment stray current exceeds 30 mA. While 30 mA through the body is more than enough to kill a swimmer it is not sufficient to assume that all of the 30 mA leaking into the water will actually go through the swimmer. Rather, U. S. Coast Guard studies have shown that due to hemispherical 'spreading' of the electric field, only a portion of the leakage current will go thru the swimmer. The main exception to this occurs when the swimmer comes into direct contact with the voltage source itself, for example by grabbing a metallic ladder that has become energized. 30 mA represents an acceptable level that ABYC expects to prevent a majority of ESD incidents while remaining practical enough to minimize unnecessary tripping."

It should also be noted that ABYC standards, since December 31, 2012, have required 30 mA Equipment Leakage Circuit Interrupters on the boat. While boats are not subject to NFPA 70 requirements, boats are connected to circuits that are. Choosing the 30 mA individual branch circuit or feeder option in 555.3 promotes a consistent level of protection from shore to the boat, while at the same time providing many protected circuits so that a fault only shuts down a limited area of the marina.

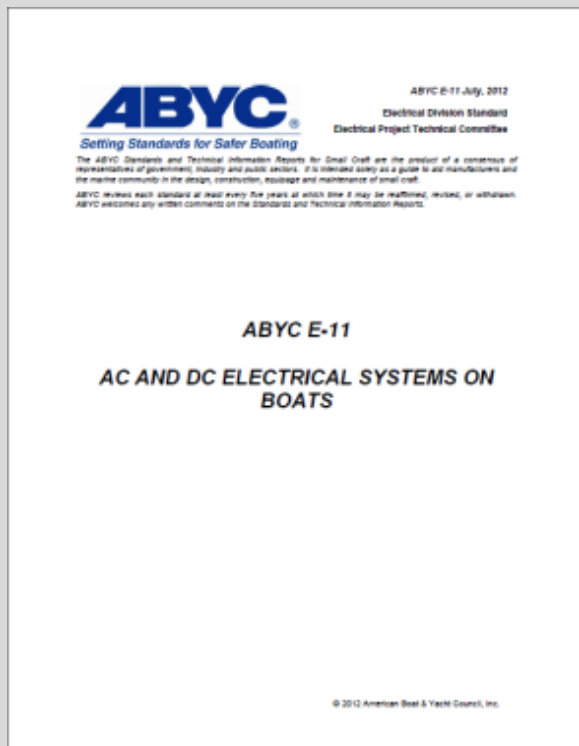
Note 1: ESD means Electric Shock Drowning.



example by grabbing a metallic ladder that has become energized. 30 mA represents an acceptable level that ABYC expects to prevent a majority of ESD incidents while remaining practical enough to minimize unnecessary tripping.



On-Board ELCI (30 mA Trip)



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

2017 NEC Second Draft Meeting



First Revision No. 5436-NFPA 70-2015 [Section No. 555.3]

555.3 Ground-Fault Protection.

The ~~main~~ overcurrent protective devices that feeds supply the marina, boat yards, and noncommercial docking facilities shall have ground-fault ~~ground-fault~~ protection not exceeding 100 30 mA. Ground-fault protection of each individual branch or feeder circuit shall be permitted as a suitable alternative.

Submitter Information Verification

Submitter Full Name: CMP 19

Organization: [Not Specified]

Street Address:

City:

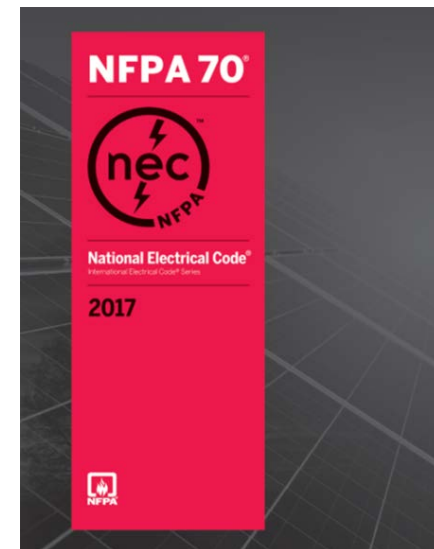
State:

Zip:

Submittal Date: Tue Jan 20 13:09:02 EST 2015

Committee Statement

Committee Statement: The 30 mA ground fault limit is consistent with that recommended in the Fire Protection Research Foundation report "Assessment of Hazardous Voltage/Current in Marinas, Boatyards and Floating Buildings"



ABYC Position Statement on FPRF Report



613 Third Street, Suite 10 Annapolis, MD 21403 410-990-4460

ABYC's conclusions and intent were as follows:

The study recommends the use of ground fault protection at the pedestal.

This protection is recommended to mirror the ABYC E-11 Equipment Leakage Circuit Interrupter specifications. Those specifications are a 30 milliampere trip level with no more than a 100 millisecond trip time.

ABYC was reluctant to discuss the effectiveness or any change to the existing 100 milliampere requirement for the main feeder of a marina until a similar study could be completed on the marina environment itself.

ABYC has declined to pursue any investigation on this topic due to the lack of expertise on the land-based portion of marina properties and their associated utilities.

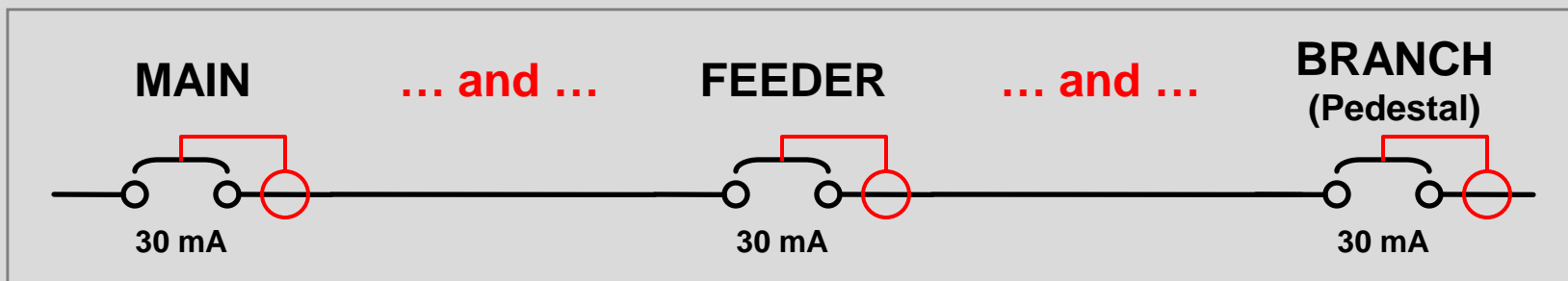
Respectfully,

John Adey
President, ABYC



2017 NEC Second Draft Meeting

Ground-fault protection not exceeding 30 mA required at all circuit breakers



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. ~~Ground-fault protection of each individual branch or feeder circuit shall be permitted as a suitable alternative.~~

Where are we headed for the 2020 NEC?

ft meeting in January.

rticles 553 and 555

ice/feeder and 30 mA

|

tion for “Other Than Shore



Reaction to the 2017 NEC



Electric Shock Drowning



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 protection from 100 mA¹ to 30 mA and applies that requirement to all overcurrent protective devices (OCPDs) installed in any facility or installation covered by Article 555.

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 protection not exceeding 30 mA. ^a

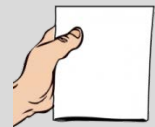
^a2017 National Electrical Code, ARTICLE 555 — Marinas, Boatyards, and Commercial and Noncommercial Docking Facilities

The 2014 code rule requires that the ground-fault protection not exceeding 100 mA be applied at the main service feeding the marina, but permits 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 in the article, one finds 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*.²

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.

¹milliamperes

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



National Electrical Code



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 revised Section 555.3 stated in its intent is consistent with that recommend in the Fire Code of Hazardous Voltage/Current in Marinas, and report is available to the public and gauge.² The final sentence of that report on main feeder protection, citing the need level may be determined.

Under Section 555.3, several organizations have issued 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 change to the code." The department agrees with his recommendation. Assistance in interpreting the code is available. The NFPA offers its members one-on-one help resources available from private code consultants, and factors 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 interpret the code according to the intent of the National Fire Protection Association to enforce an erroneous interpretation requiring 30

2016_NEC-P19_FD_ballotfinal.pdf, p. 81
resources/research-foundation/research-foundation-
inmarinasboatyardsandfloatingbuildings.pdf?la=en
pa-technical-questions

device. We will continue to educate and

have any questions or concerns.

Department of Labor and Workforce Development
Mechanical Inspection

Chairman, Port of Juneau
City of Sitka
Harbormasters and Port Administrators

National Electrical Code



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 70th 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 60th 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

a specific request to L&I that the
the feeders does not go far enough,
at the feeders and 30mA at the
thru June 2018 according WAC 296-

gued with L&I since this issue first
March 2017. We took immediate
won a one-year extension of the

meeting at Elliott Bay Marina on
100mA of stray current plus the
first, focusing specifically on the
protection requires a standard below
and, 100mA of stray current on
a standard that is not sustainably
ther reinforce this point.

, who attended both meetings with
to see what is actually happening on
ly compiled his findings in a report,
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Association of the Society of
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Boat Builders and Repairers

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Vehicle (RV) industry and
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L&I.

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National Electrical Code



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

ained by looping a flexible current
. Care was taken to exclude the

in the St. Croix River were typical
200 ampere feeders serving four
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ers measured below 30 mA. (The
mperes. The next lowest feeder
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te of hazardous voltage gradients
age gradients in the water with a

Shafer and Rifkin point out that
hazardous voltage gradients are
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Washington conducted similar
are included with this document

December 15, 2017

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December 15, 2017

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2017 NEC are

ber 15, 2017

National Electrical Code



National Electrical Code



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.				

National Electrical Code



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

National Electrical Code



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

*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]



WARNING!



Potential Shock Hazard

Electrical currents may be present in the water.



WARNING!



Potential Shock Hazard

Electrical currents may be present in the water. These electrical currents can be harmful or lethal.

www.electricshockdrowning.org

Electric Shock Drowning



A sign could have made a difference



Electric Shock Drowning Prevention Association



**Education
Awareness
Mitigation**

Founded on July 15th 2011



Education and Awareness includes

- Warning signs
- Informational brochures
- Safety guidelines
- Emergency response protocols
- Marina staff training
- Marina customer education
- Education of the general public
- Education of the Electrical Community

Electric Shock Drowning



**ELECTRIC SHOCK
DROWNING
A SILENT KILLER**

**What You
MUST Know**
to Protect
Your Family



www.ElectricShockDrowning.org

Electric Shock Drowning



Electric Shock Drowning



You are a safe, skillful boater.

You keep your vessel and its support equipment in 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 it is tied up to 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, 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.

What is electric shock drowning?

March 22, 2016

Electric Shock Drowning



03/25/2009

Harbor Cove Marina, Duluth, MN

Electric Shock Drowning



**NO
SWIMMING
OFF OF
BOATS
OR
DOCKS**

**Minnetonka Power Squadron
Island Facility, Lake Minnetonka**

Electric Shock Drowning



Sister Bay Marina, WI



Significant Coverage by Boating and Marina Publications





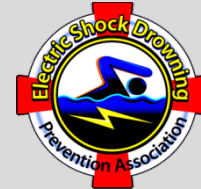
Increasing Coverage by Media



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



UK Daily Mail, May 21, 2016



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

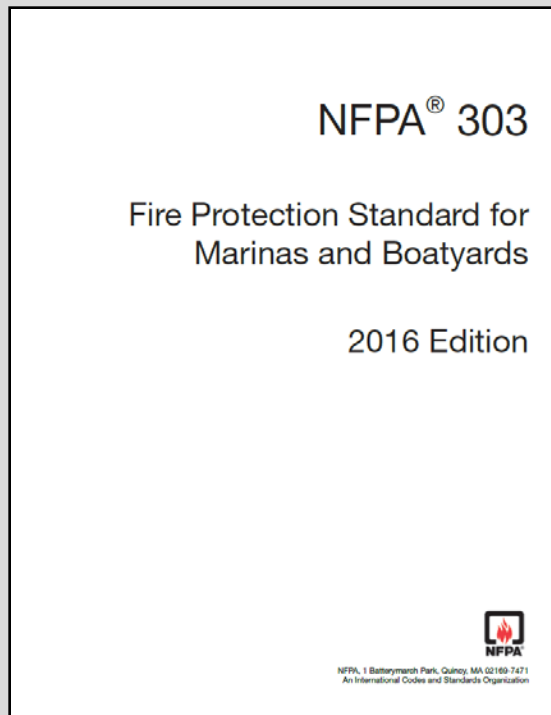


Electrical safety goals should include

- ✓ 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

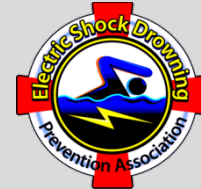


- West Virginia
- Tennessee
- Kentucky
- Missouri
- Arkansas



SHOCK ALERT





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



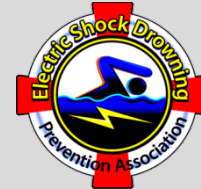
'Safe' is defined in Noah Webster's 1828 Dictionary as

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



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



Electric Shock Drowning



EPO Switch for Marinas and Docks?



Electric Shock Drowning



"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



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.

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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 Cardinal Rule:

#1

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 !



More Information



Electric Shock Drowning



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ELECTRIC SHOCK DROWNING PREVENTION ASSOCIATION

www.electricshockdrowning.org

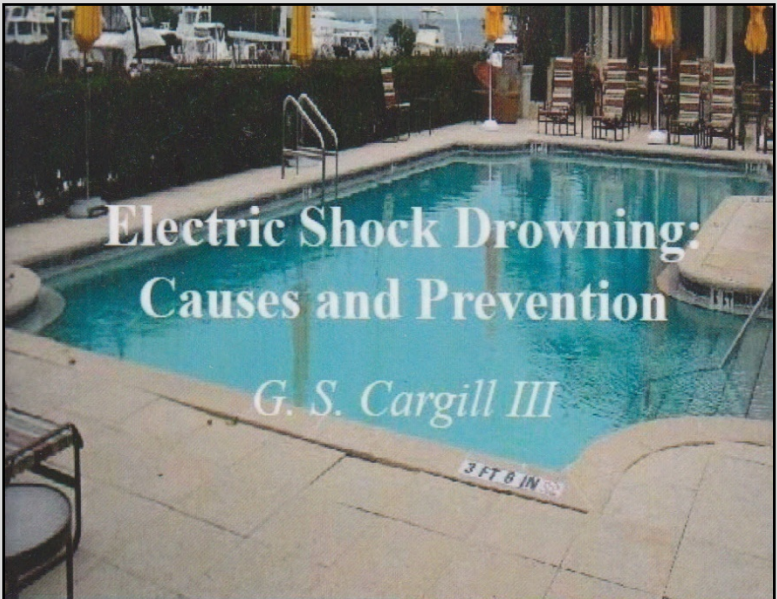


Electric Shock Drowning Resource Center

www.boatus.com/seaworthy/ESD.asp



Electric Shock Drowning



ANY
QUESTIONS
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