Electric Shock Drowning
-- A Silent Killer

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District 10 Electric Shock Drowning
Awareness Initiative for 2016
Minnesota, Wisconsin, Michigan UP

Questions and comments are welcome
Electric Shock Drowning

ESD is getting a lot of attention in both television and print media

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

Lost to ESD

Marcus Colburn, age 21, died on Father’s Day, June 21, 2015 as a result of ESD
Electric Shock Drowning

Lost to ESD

March 27, 2016

Electric shock in pool kills man, injures 5 kids

A father is dead and his daughter is 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.

Electric Shock Drowning

Lost to ESD

April 16, 2016

Carmen Elizabeth Johnson

15-year-old girl drowns at Smith Lake

Coroner: Electrocutation may have caused Priceville cheerleader's drowning, along with a 2nd injury.

Family members had earlier reported feeling tingling sensations in the water.

Electric Shock Drowning

ESD "Near Miss"

June 20, 2016

It is believed that the actual number of ESD fatalities is much higher than reported or documented — very possibly hundreds more.

Paralysis due to small electric currents passing through the body is not typically identifiable post-mortem as the cause of a drowning.

Electric Shock Drowning

ESD Incidents

76 Known Incidents

44 "Near miss" Incidents

as of 06-20-16
Water + Electricity = A Dangerous Mix

Shore Power

Boat Lifts

Fountains
Electric Shock Drowning

Aerators

“Weed Eaters”

Cultural Firewall in the Brain
Water + Electricity
Indoors
Be Safe!

Outdoors

???

The use of electric power at lakes and rivers, and in ponds, has increased exponentially in the past few decades. This has introduced a new danger into our daily lives.

And yet, few are 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."
FACT: ESD is a serious concern in ALL situations where electric circuits and equipment operate in, on, over, or near a body of water, large or small.

Electric Shock Drowning (ESD) is a unique form of drowning caused by the presence of AC electrical currents in freshwater lakes, rivers, pools, ponds, etc. These in-water currents can flow through the bodies of individuals immersed in the electrically charged water.

The current, where sufficiently intense, can partially or completely paralyze the body’s skeletal muscles, inhibiting the ability to swim or even move one’s limbs. The outcome in many such cases is the drowning death of an otherwise healthy individual.

Typical ESD Scenario
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 situation worse seeking a ‘safe haven’ by moving toward the source, rather than away, from it.
Electric Shock Drowning

"The Electric Shock Drowning of Samantha Chipley"

Article by Attorney B. Clark Batten II

Electric Shock Drowning

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 ESD statistics because they are caused by the exact same conditions that cause an ESD injury or fatality.

Medical research has shown that an AC current of 6 milliamperes through the body can begin to affect muscle control.

The ESDPA recognizes 10 milliamperes of AC current through the human body as the threshold for a possible ESD incident.

A 60 watt, 120 volt incandescent light bulb draws 500 milliamperes of current — 50 times more than the 10 mA that can paralyze an individual in the water.

ESD is a Fresh Water Phenomenon

<table>
<thead>
<tr>
<th>In-Water Through-Current</th>
<th>Leakage Body Current</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salt Water</td>
<td>6 Amps</td>
<td>1.1 mA</td>
</tr>
<tr>
<td>Fresh Water</td>
<td>0.3 Amps</td>
<td>23.8 mA</td>
</tr>
</tbody>
</table>

1/20th the leakage current — 20 times the body current.

What about pets and other critters?
Animals are not immune to the effects of these in-water currents

ESD has claimed family pets that have entered electrically charged waters

and

Individuals have fallen victim to ESD when they enter the water attempting to rescue their pet

A Terrible ESD Tragedy in 2012

Friday Aug 31, 2012

Track coach [woman], two men [one a relative], one dog [family pet] electrocuted in Idaho irrigation canal

Another family member attempting a rescue was shocked but survived

Police say: “The electrified canal could have killed more”

They [canal experts] say it is virtually impossible to know if water is electrified by sight or sound

Idaho Power shut off the power in the area so rescuers could recover the bodies

Why all the concern about ESD?

- 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 materials, wiring methods and equipment on docks and boats
Electric Shock Drowning

- Lack of electrical inspections [initial and recurring]
- Lack of monitoring for dangerous conditions
- Postponing of repairs due to cost
- Less caution exercised by the general public

Electric Shock Drowning

In-water shock hazards (i.e. electrical currents in the water)
- may already exist
- can occur suddenly
- can continue indefinitely without any notice, indication or warning
wherever AC powered equipment or wiring is located in, on, over, or near the water

Electric Shock Drowning

- Marinas
- Private docks
- Recreational vehicle parks
- Decorative ponds and pools
- Swimming and wading pools
- Swimming beaches
- Other

Electric Shock Drowning

The ESD condition in marinas can be caused by faulty equipment or wiring in or on ...
- The marina/dock electrical system
- Electrically operated boat lifts
- Your own boat
- Neighboring boats

Electric Shock Drowning

Similar conditions can exist or occur at private docks where electric equipment and wiring are installed and faults exist
- The dock electrical system
- Boat lifts, lights, receptacles, etc.
- Neighboring dock or docks electrics
- Your own boat (shore-powered)
- Neighboring boats (shore-powered)

Causes of In-Water Shock Hazards
Two conditions must be met to establish 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.

2nd – There has to be a failure of the safety bonding/grounding system, i.e. the equipment bonding/grounding path/conductor.

High level fault currents will flow back through the safety ground conductor – if present – and trip the circuit breaker.

Low level fault currents will flow back through the safety ground conductor but will NOT trip the circuit breaker.

An ESD condition in the water is caused, in part, by an electrical fault current that is too small to trip the circuit breaker.

This then is an ‘undetected’ fault [unless GFCI or ELCI protection is installed]

An undetected fault can continue for long periods of time, even indefinitely.
Electric Shock Drowning

Causes include (but are not limited to):

- Incorrect installation of equipment or wiring
- Improper use of equipment or wiring
- Malfunction or failure of equipment, wiring, plugs, connectors, etc.
- Wiring errors (commission or omission)
- Failed or nonexistent safety ground path (conductor)

When a fault exists and the safety ground is missing or ineffective, the only fault current path is through water

Dangerous levels of alternating current could now be flowing in the water
A person finding themselves in such waters will likely experience a dangerous AC current passing through their body.

If this current through the body is high enough—10 or more milliamps—paralysis or worse is likely.

The result will be the inability to remain afloat, followed by drowning.

On-board generators and inverters, as a general case, do not create an ESD hazard when the boat is operating on the water and is not connected to a shore-based grounded electrical supply or other off-boat systems or equipment.

Direct Current (DC) is generally not a concern, although it can be a fire or burn hazard under certain conditions.

The primary electrical systems aboard boats are typically 12 or 24 volts DC. It takes from 2 to 5 times as much DC to cause the same bodily effect as the equivalent AC.

The heart is far more susceptible to disruption or injury by AC than by DC.

There are exceptions—such as a boat sharing AC electrical power with another boat while rafting or beached.
Detection of In-Water Currents

In-water electrical currents are similar to carbon monoxide. They are invisible, silent, and odorless. One cannot see, hear, or smell them.

There are electrical tests that can be performed on a regular basis to minimize (but not eliminate) the risk of in-water shock where electrics are installed. These tests require specialized testing equipment and training.

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

Not Compliant NFPA - 308 3.21.1
One of the ‘HOT’ conductors
• Can you find the 2 faults here which killed a mother and daughter on Lake Cumberland in May of 2002?
• This plug was wired by the husband/father.

Electric Shock Drowning

Electrical safety goals must include
- Enforceable safety standards
- Quality and skilled workmanship
- Inspection by competent authority
- Recurring inspection
- Continuous monitoring
- Routine testing and maintenance
- EDUCATION OF THE PUBLIC

Electric Shock Drowning

Electric Shock Drowning Prevention Association

Awareness
Prevention

Education
Mitigation
Proactive education includes:

- Warning signs
- Informational brochures
- Safety guidelines
- Training Sessions
- Presentations
- Other outreach

"WARNING - POTENTIAL SHOCK HAZARD - ELECTRICAL CURRENTS MAY BE PRESENT IN THE WATER."
Proactive mitigation is essential for
- those in the water unintentionally
- the uninformed
- the misinformed
- the disbelieving
- those careless regarding their well-being and the well-being of others
- trespassers

Marina Power
Shore Cord
NFPA 70 — NEC
ABYC E-11
NFPA 303
NFPA 302
Shore Cord
Stricter requirements have been or are being enacted in some states:
- West Virginia
- Tennessee
- Kentucky
- Missouri
- Arkansas

Ground fault (GFCI) protection required for shore power service to boats with adoption of the 2011 National Electrical Code.
**Electric Shock Drowning**

**On-Boat ELCI (30 mA Trip)**

Required on boats built after 12-31-2012

**In-Line ELCI (30 mA Trip)**

**EPO Switch for Marinas and Docks?**

“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

**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 near-water equipment

**Battery Powered Boat Lift w/ Solar Charger**
Electric Shock Drowning

Battery Powered Dock Lights w/ Solar Chargers

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
3. 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/wiring is installed.

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

Increasing Risk of ESD Accident when approaching closer than 150 ft

Known condition / Change always a possibility

Very Low Risk

Very High Risk

10 feet

Electrical equipment or wiring

Electric Shock Drowning Prevention Association

Conditions are always subject to change
Electric Shock Drowning

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 mile 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

It might be considered "low risk" to enter the water (for inspection, maintenance and repair purposes) where ALL nearby shore power is switched off, and locked off, at the power source.

This would include securing ALL nearby on-board generators and inverters.

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:
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!

“That’s a great idea to have an emergency pushbutton at all docks with electricity, better yet, NO a/c power on any boat dock!”
“I would NEVER put ac power on my boat dock and I don’t have a pool light in my pool.”
Mike Holt, Electrical trainer, Consultant, Author, Publisher
Private communication - 05-30-2016

Please take a brochure
Take some for friends and neighbors

Responding to an ESD incident
Electric Shock Drowning

ESD Incidents

Questions?

Thank You!

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ELECTRIC SHOCK DROWNING PREVENTION ASSOCIATION
www.electricshockdrowning.org/

Boat Owners Association of The United States
Electric Shock Drowning Resource Center
www.boatus.com/seaworthy/ESD.asp