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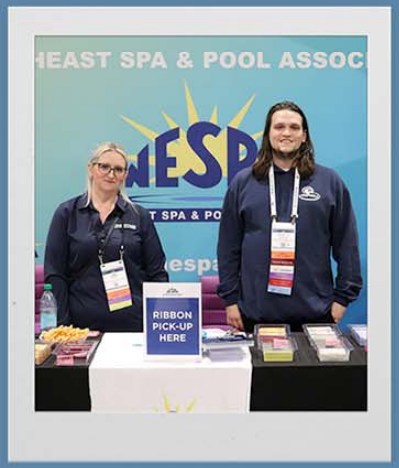

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De-mystifying Bonding and Grounding – How and Why

Dr. Bill Hamilton. P.E.

Hamilton & Associates

Pflugerville (Austin) TX

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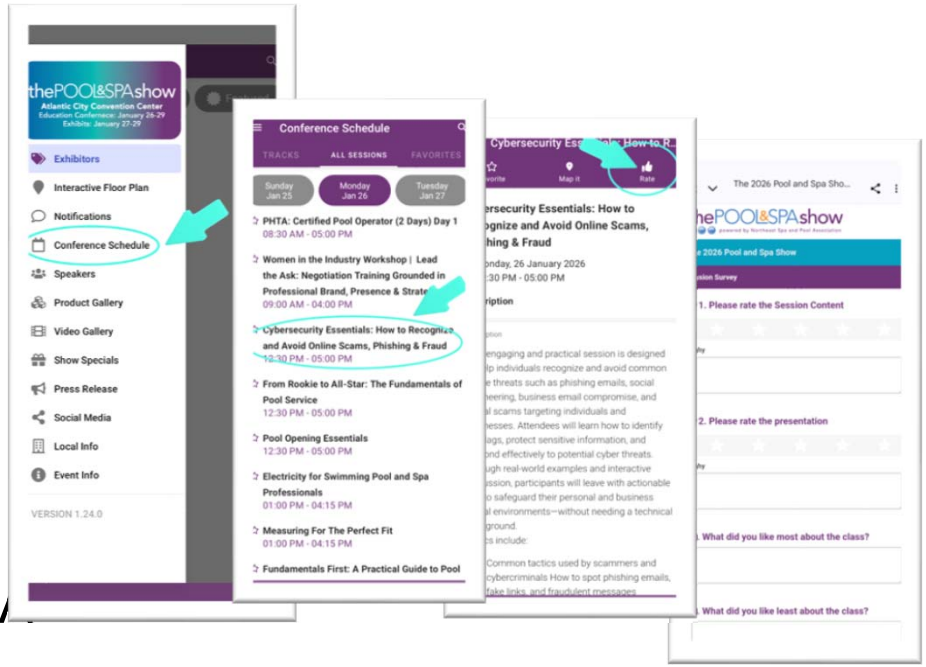

De-mystifying Bonding and Grounding – How and Why

Presented By

Hamilton & Associates

Engineering - Technical Services

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After completing this lesson, students should be able to:

- Understand some basic requirements of Article 680 in the 2011, 2014, 2017 and 2020 NEC regarding pools and spas
- Understand basic concepts of bonding and grounding
- Understand changes in the 2023 and 2026 Editions of the NEC regarding Bonding and Grounding

Why is this important to the pool and spa professional?

- Safety is paramount for everybody
- The why and how of pool electrical systems are not generally well-understood
- Poor and/or incorrect installation or maintenance of a pool installation by third parties can still expose the manufacturer, builder or maintainer to significant liability issues
- The issues don’t stop with owner acceptance of the initial installation of the product or the end of the maintenance or service call

Why is this important to the pool and spa professional?

HOUSTON CHRONICLE, November 8, 2013 (excerpts)

Two electricians charged in electrocution of man at Houston hotel pool.

Charged with criminally negligent homicide (felony – 2 yrs + $10,000 fine). One pleaded No Contest to slightly lesser charge. One pleaded Guilty to criminally negligent homicide. Both on probation and no longer have licenses.

An investigation by police, the city's Public Works and Engineering Department and the Texas Department of Licensing and Regulation also determined the wiring to the pool light **lacked a ground fault circuit interrupter** that would have immediately cut off the current in the event of a shock, officials said. The pool also **lacked proper bonding**, police said. Both are violations of the NEC.

Did not get a permit for the work with the City of Houston, police said.

Lawyers for the victim's family also filed several civil lawsuits seeking more than $2 million in 2013, which settled in 2015.

The Deadliest People Around the Pool

- Homeowner - generally clueless but thrifty
  - Tries to save a buck and gets it wrong. "WHAT CODE??"
- The property maintenance person
  - Generally just like the homeowner, but has an equally clueless boss with a budget. "I GOT AN OLD COPY YESTERDAY;" "They won't let me do it because it costs too much"
- The mass merchandiser's "expert"
  - Credentials and experience??? "HUH??"
- The pool tech who overdoes it
  - Most electrical work requires a license.
- The inexperienced electrician
  - May be good, but what do they know about pools??
- The "know it all" inspector
  - Did you look at it?? The Code "requires" ***WHAT***??

The NEC is a Safety Document Governing Construction of Electrical Installations on the Customer's Side of the Meter- "practical safeguarding"

The NEC is published by the National Fire Protection Association (NFPA) and is revised on a 3-year cycle

The NEC has no force of law unless it is adopted by an Authority Having Jurisdiction (AHJ). The AHJ is usually a government entity (state, city, county, etc.)

20 states including ME, NH, MA, MI, OH, KY and GA currently adopt the 2023 Edition

19 states including VT, RI, CT, NJ, DE, MD, VA, WV, NC, SC, AL, and FL adopt the 2020 Edition

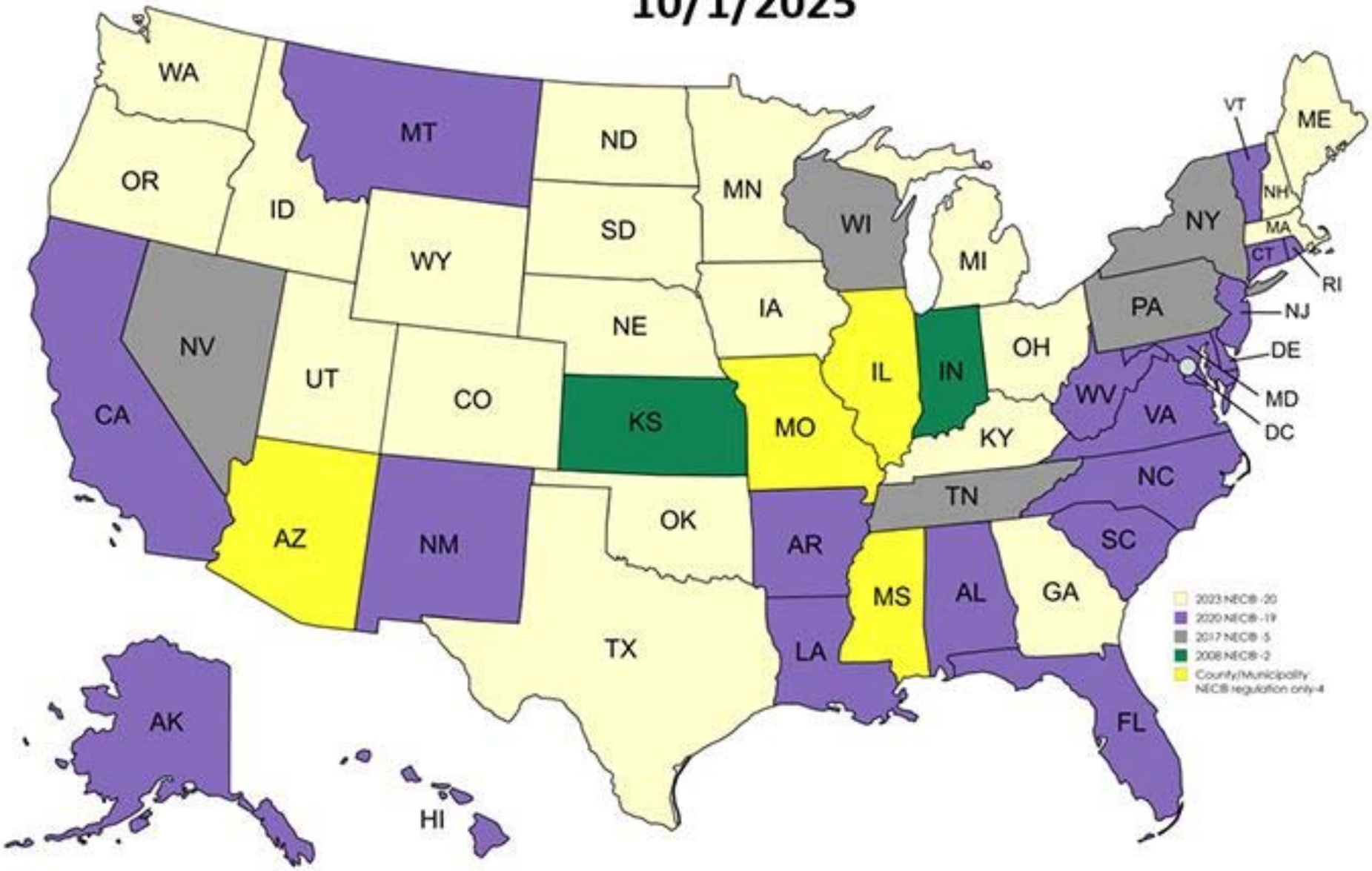
PA, NY, TN, WI, and NV currently adopt the 2017 Edition

IN and KS currently adopt the 2008 Edition

AZ, MO, IL and MS have local adoption only (no statewide adoption)

The 2011 New York City Electrical Code is based on the 2008 NEC Edition

NEC® In Effect 10/1/2025



NEC Article 680 Addresses Construction of Electrical Installations for Pools, Spas, Fountains, Pools and Tubs for Therapeutic Use, and Hydromassage Bathtubs

Because NEC Article 680 has changed considerably over time, in order to know what to expect on any existing pool, you need to understand what was required by a given edition of the Code – NOT ALL POOLS ARE THE SAME OR EVEN REMOTELY SIMILAR

Example – Older Pools

- Pre-1962 pools
  - No direct regulation-NEC 680 nonexistent!
- Pre-1965 pools
  - Open electrical connections in lights.
  - Bonding not directly addressed.
- Pre-1971 pools
  - Flush deck boxes at line voltage (120V).
- Pre-1975 pools
  - GFCI not mandatory under NEC **(Several states now require GFCIs on all public pools)**

National Electrical Code Recap

The NEC is revised on a 3-year cycle

Various editions of the NEC are adopted by authorities having jurisdiction.
REQUIREMENTS ARE DIFFERENT DEPENDING ON THE EDITION ADOPTED AND ANY LOCAL AMENDMENTS.

ALWAYS verify the proper edition of the NEC and any local amendments with the permitting/inspecting authority prior to doing work!

A Reminder …

Older Editions of the NEC Do **NOT** Require That Older Pools Be Routinely Upgraded To Current Standards

BUT…

Starting with the 2020 Edition, Reconstructed Pool Shells Must Be Bonded to Meet Current NEC Requirements, **AND** When Pool Pump Motors Are Replaced, They Must Be GFCI-Protected

Bonding vs. Grounding:

Two Different Jobs!

Bonding vs. Grounding

- They are designed to serve two entirely different functions. Grounding is not the same as bonding!
- Grounding - provides a metallic path for short circuit currents to earth ground for electrical equipment.

Grounding

- Pool system grounding
- Where do you ground the neutral wire?
- Proper grounding enhances safety – metallic path for short circuit current that allows circuit breakers to operate!

Grounding Required For:

- Underwater / In-pool lighting fixtures
  - Wet-niche, no-niche, dry-niche
    (except ungrounded low voltage 2-wire fixtures listed for the purpose)
- All electrical equipment within 5 feet of inside wall of specified body of water
- All water circulation system electrical equipment associated with the specified body of water

Grounding (Continued)

- All pool-associated motors (except low voltage motors not requiring grounding)
  - (pre-2017) Equipment grounding wire must be insulated or covered, including motors in interior of building
  - (2017) Wiring methods follow Chapter 3 wiring requirements except in corrosive areas where you follow 680.14 or other applicable section
- Metallic junction boxes
- Metallic transformer and power supply enclosures

Grounding (Continued)

- GFCI's
- Non-service panels supplying pool equipment
- Other items identified by the manufacturer as requiring grounding
- (2017) Regarding indoor wiring to outdoor spa or hot tub installations, there is no longer a requirement that a copper grounding conductor in a cable installed indoors be insulated or enclosed within the outer sheath of the cable and not smaller than 12 AWG; Chapter 3 wiring methods are allowed.

Rule #1 of Grounding

- The earth cannot and must not be used as a grounding conductor!
  - There must be a green equipment grounding wire all the way to the panel for the system to be safe
  - Use of multiple ground rods in place of a metallic grounding conductor is **unsafe and potentially deadly**, particularly around a pool
- Without a metallic grounding conductor, breakers may not trip in the presence of short circuits to exposed metal, and exposed metal parts may be at dangerous voltages

Rule #2 of Grounding

- On 120/240 and 120/208 Volt systems, the neutral (white) wire must be grounded.

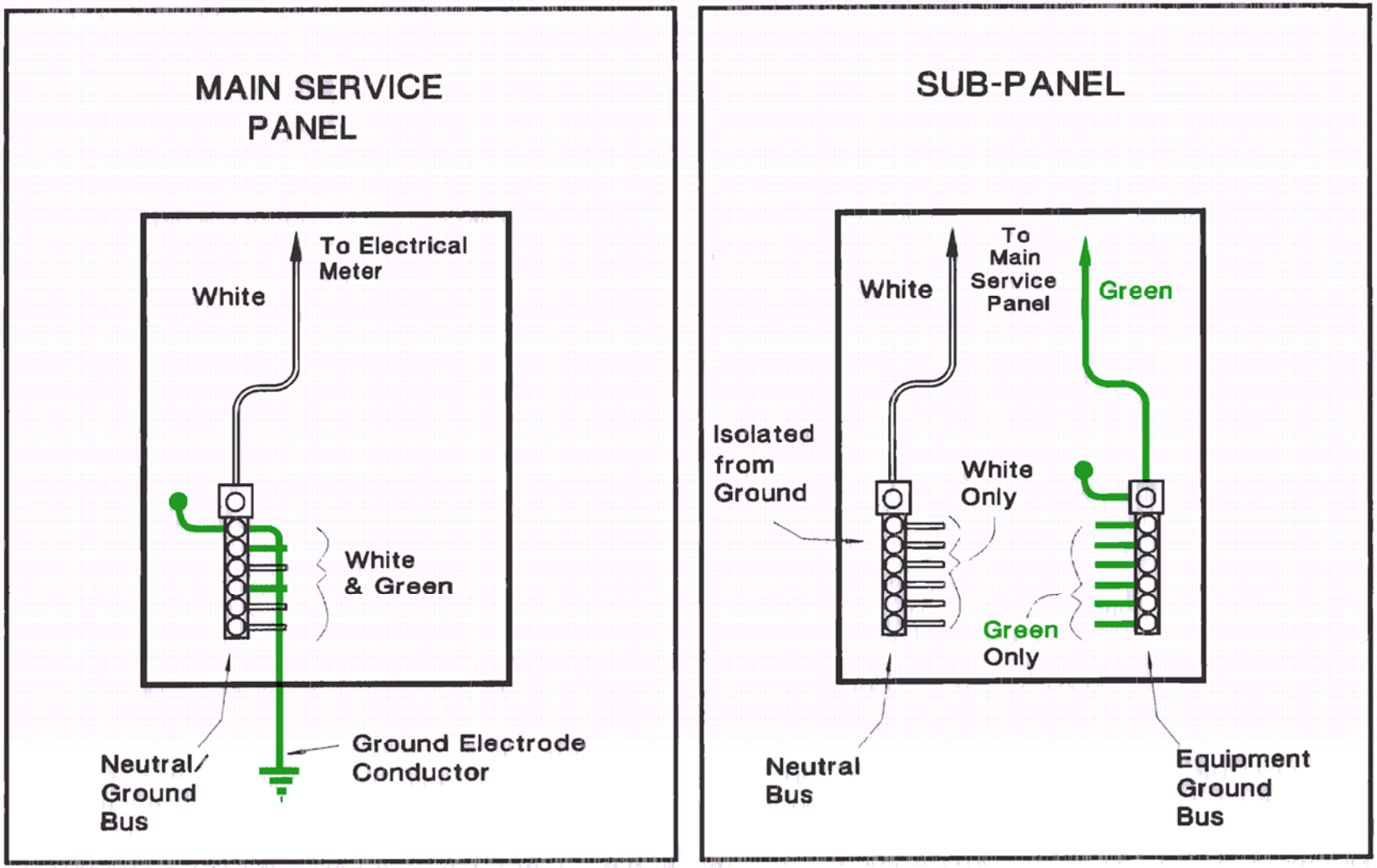
Where Do You Ground The Neutral Wire?

- Only at the service entrance - between the meter and the service disconnecting means.
- On the secondary side of grounded transformers (commercial systems).
- With a few exceptions, nowhere else!

Ground The Neutral (Cont'd)

- This means do not ground the neutral at any sub-panel unless it is in a separate building not connected to the main service by a ground wire!
- A properly installed sub-panel in a single building will have both a neutral bus, which is **not** bonded to the panel, plus a ground bus or lug which is!

Connection & Separation Of Ground & Neutral



How Proper Grounding Enhances Safety

- A properly installed grounding system can result in proper operation of circuit breakers and GFCIs!
- But BEWARE, a GFCI will **not** detect a ground fault when the fault is:
  - Ahead of it (between the GFCI and the panel)
  - On the low voltage side of a transformer or power supply (e.g., low voltage light)
  - And will not detect current on the green wire!

2023: Changes – 680

EQUIPMENT GROUNDING

- All requirements were consolidated and relocated to 680.7:
  - **All** flexible cords must contain a properly sized insulated copper EGC no smaller than #12, and they must terminate in a grounding-type plug with a fixed grounding contact member.
  - **All** feeders and branch circuits installed in a corrosive environment or wet location must have properly sized insulated copper EGC no smaller than #12.

2023: Changes – 680

2023 Edition Changes

MAJOR CHANGES TO GFCI REQUIREMENTS

- Receptacles and outlets not exceeding the Low Voltage Contact Limit (LVCL) supplied by listed transformers & power supplies meeting 680.23(A)(2) do not require ground-fault protection
- GFCIs are rated for a maximum 150 V to ground – systems with voltages to ground from over 150 up to 480 V requiring ground-fault protection must utilize Special Purpose Ground Fault Circuit Interrupters (SPGFCI)
  - Examples: 240 three phase delta, 480/277V in commercial installations and water parks

MAJOR CHANGES TO GFCI REQUIREMENTS

New UL Classes of SPGFCIs

- **A "normal" Class A GFCI is only rated for 150 Volts to ground – This creates a hazard for certain other systems which can exist (mostly on commercial installations):**
  - **3-phase wye systems above 120/208 V (e.g., 480/277)**
  - **3-phase 120/240 V 4-wire (open delta) systems**
    - **The "hot leg"/"high leg"/"freak leg"/"wild leg" (orange wire) voltage to ground is 208 V, while the voltage to ground of the other two conductors is 120V**
  - **3-phase corner grounded systems (voltage to ground is the phase-phase voltage)**

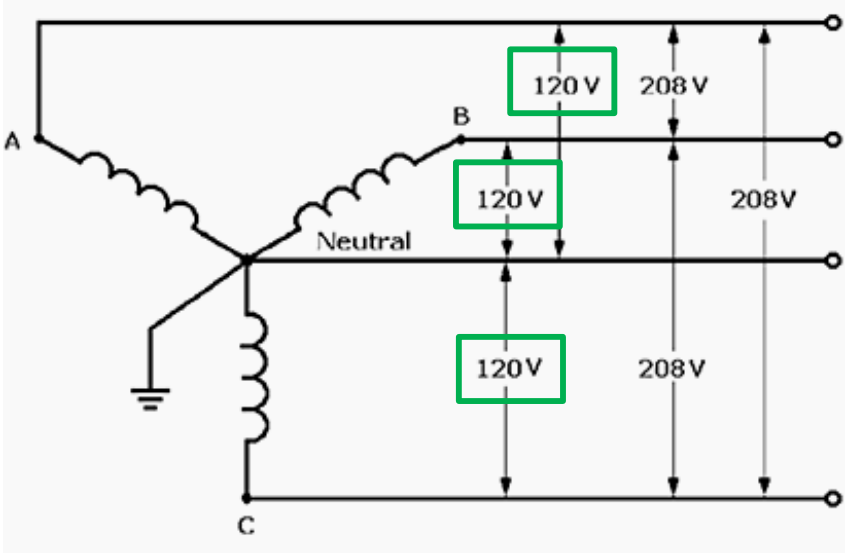
New UL Classes of SPGFCIs

- A new Special Purpose GFCI (SPGFCI) is rated for over 150 Volts to ground:
  - Class C, D, E SPGFCI
  - Class C can be used up to 480 V (300V or less to Ground)
  - Class D and E are generally for over 480 V (over 300V to Ground)
    - Class D requires an oversize ground wire
  - All trip at 15mA-20 mA

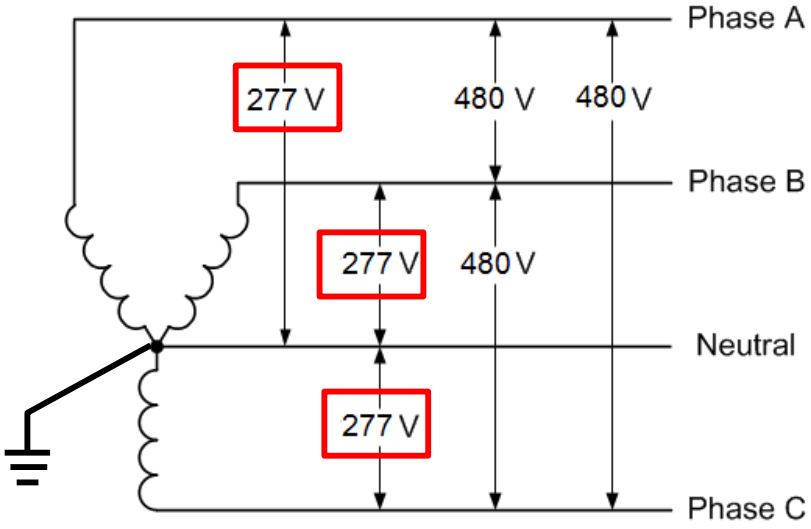
The 2023 NEC requires an SPGFCI where ground-fault protection is necessary on pools served by circuits with > 150V to ground - even with the higher trip current

New UL Classes of SPGFCIs

3-phase wye systems above 120/208 V (e.g., 480/277)



OK to connect a GFCI to this system



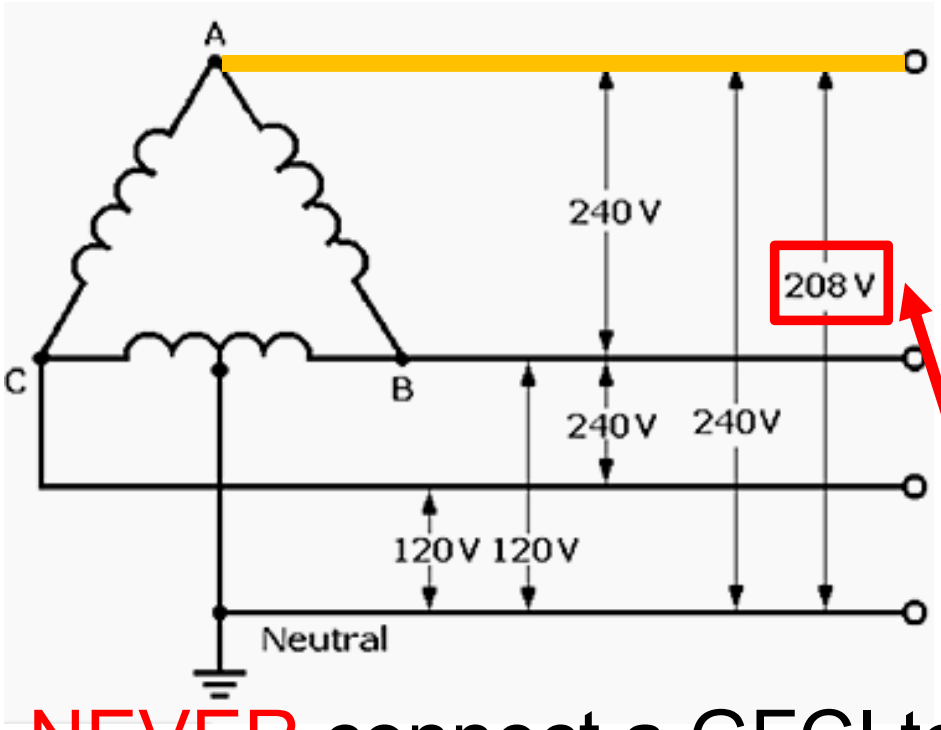
NEVER connect a GFCI to this system

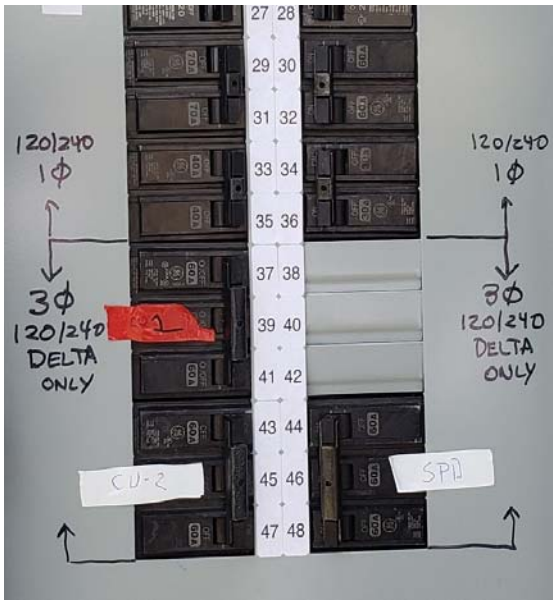
Class C SPGFCI works

New UL Classes of SPGFCIs

3-phase 120/240 V 4-wire (open delta) systems

The “hot leg”/”high leg”/”freak leg”/”wild leg” (orange conductor) voltage to ground is 208 V, while the voltage to ground of the other two conductors is 120V





NEVER connect a GFCI to the orange wire

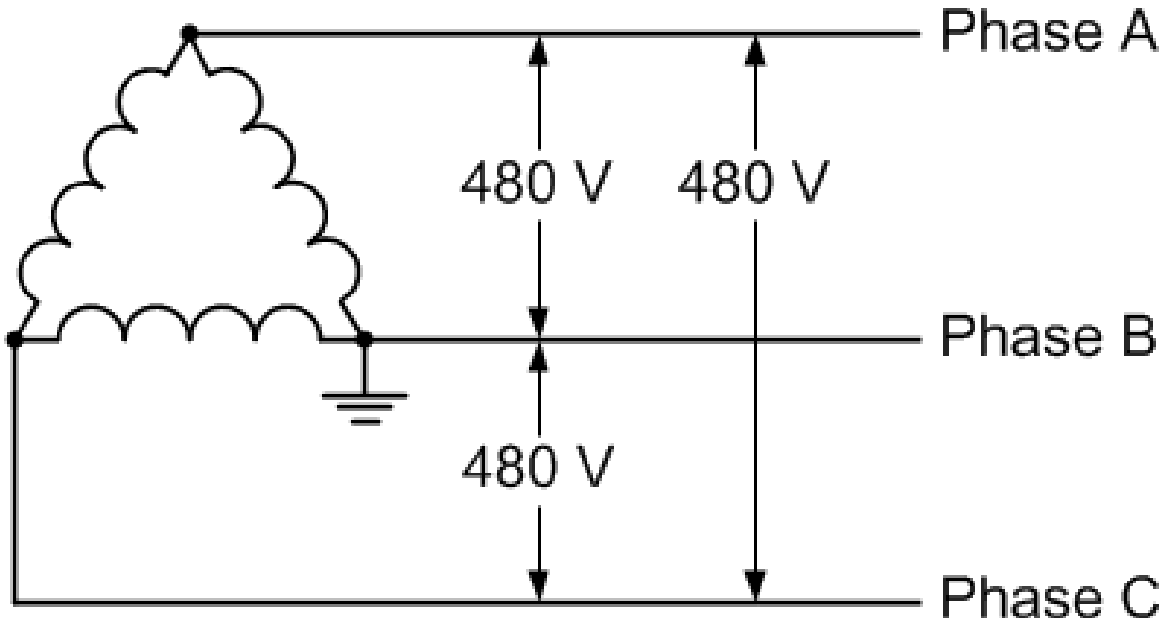
GFCI ONLY goes on 120/240 portion

Class C 3 phase SPGFCI can connect to orange

New UL Classes of SPGFCIs

3-phase corner grounded systems

voltage to ground is the phase-phase voltage



NEVER connect a GFCI to this system

Class D or E SPGFCI will work

2023 & 2026: TIA 70-26-1 680.21(C) GFCIs for Motors on Adjustable-Speed Drives (VFDs)

REMINDER - TIAs and how they work:

- TIA = Temporary Interim Amendment
- Can only address current edition and immediately prior edition (in this case, 2026 & 2023 ONLY – cannot address 2020 or earlier)
- Must be addressed by Code Panel 17 for next edition (2029)
- Some states do not recognize TIAs

2023 & 2026: TIA 70-26-1 680.21(C) GFCIs for Motors on Adjustable-Speed Drives (VFDs)

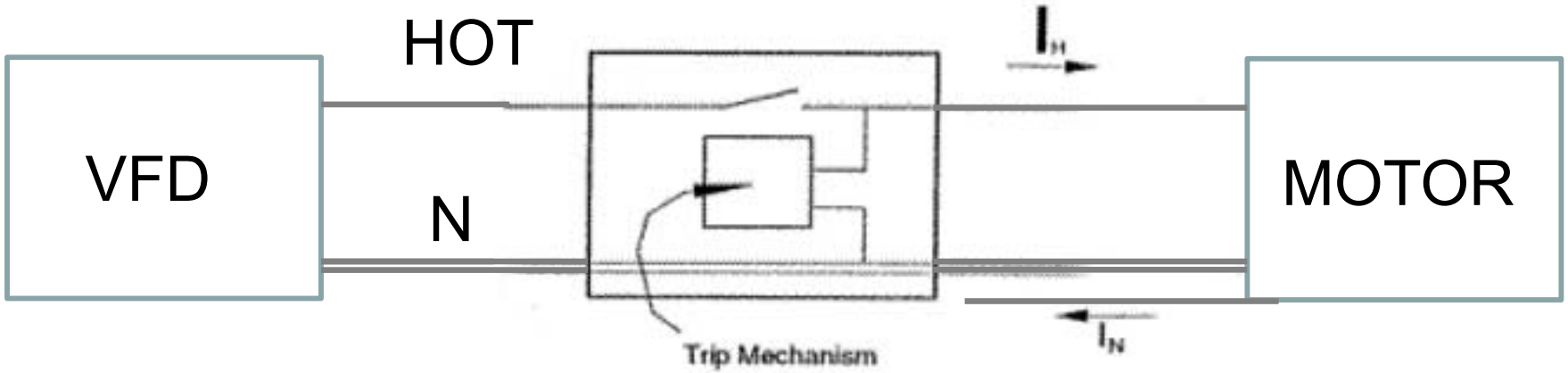
WHAT IT DOES

- 680.21(C) is amended to clarify that GFCI protection is NOT to be installed between the output terminals of a VFD and the input terminals of a motor
- Amends both the 2023 and the 2026 Editions
- Effective April 30, 2025
- This IS NOT the nuisance tripping issue;
  UL has a task force addressing this in UL 943

OTHER RELEVANT TIAs

- TIAs 20-23-20 and 70-26-3 add a new 430.132 (motors Article) that says the same thing

Why an Off-the-Shelf GFCI Installed Between the VFD and a Motor is Dangerous



The GFCI's Electronic Trip Mechanism uses incoming ac line power to operate its sensitive control electronics, which are designed for:

Constant 120V ac

Clean waveform – minimal harmonics

No voltage spikes

BUT, the VFD <u>provides</u>:

AC that varies from 0 to 120V – controls not always on

Dirty waveform – harmonics – affect control function

High voltage spikes – damage the electronics

Ground-Fault Circuit Interrupters (GFCIs) on the Output of a VFD

- **DO NOT connect a GFCI on the output of a variable speed drive (VFD) between the VFD and a variable speed motor (even if the inspector tells you to)**
  - **It won't work**
    - **The electronics get their power from the lines being monitored**
    - **They expect constant voltage – that's not what the VFD gives them**

AND……

Ground-Fault Circuit Interrupters (GFCIs) on the Output of a VFD

- **DO NOT connect a GFCI on the output of a variable speed drive (VFD) between the VFD and a variable speed motor (even if the inspector tells you to)**
  - **If it works, it won't last long**
    - **Operation of the VFD will likely fry the GFCI's electronics due to power quality effects including high voltage spikes**
    - **This can result in catastrophic failure with collateral damage, including a fire**

BOTTOM LINE – THIS CREATES SIGNIFICANT LIFE AND FIRE SAFETY HAZARDS

It is OK to Install Ground-Fault Circuit Interrupters (GFCIs) on the Input of a Motor with an Integral VFD

Bonding vs. Grounding

EQUIPOTENTIAL BONDING

POOL AND SPA EQUIPOTENTIAL BONDING IS NOT THE SAME AS THE BONDING OF PARTS ASSOCIATED WITH NEC ARTICLES 250, 314 AND OTHERS

Bonding vs. Grounding (Continued)

WHERE THE TERM “BONDING GRID” IS USED IN OLDER EDITIONS OF THE NEC REGARDING EQUIPOTENTIAL BONDING, IT **DOES NOT** MEAN A RECTANGULAR, SQUARE OR SIMILAR WELDED WIRE MESH UNLESS SUCH A CONFIGURATION IS SPECIFICALLY CALLED OUT IN THE CODE LANGUAGE FOR A PARTICULAR PURPOSE

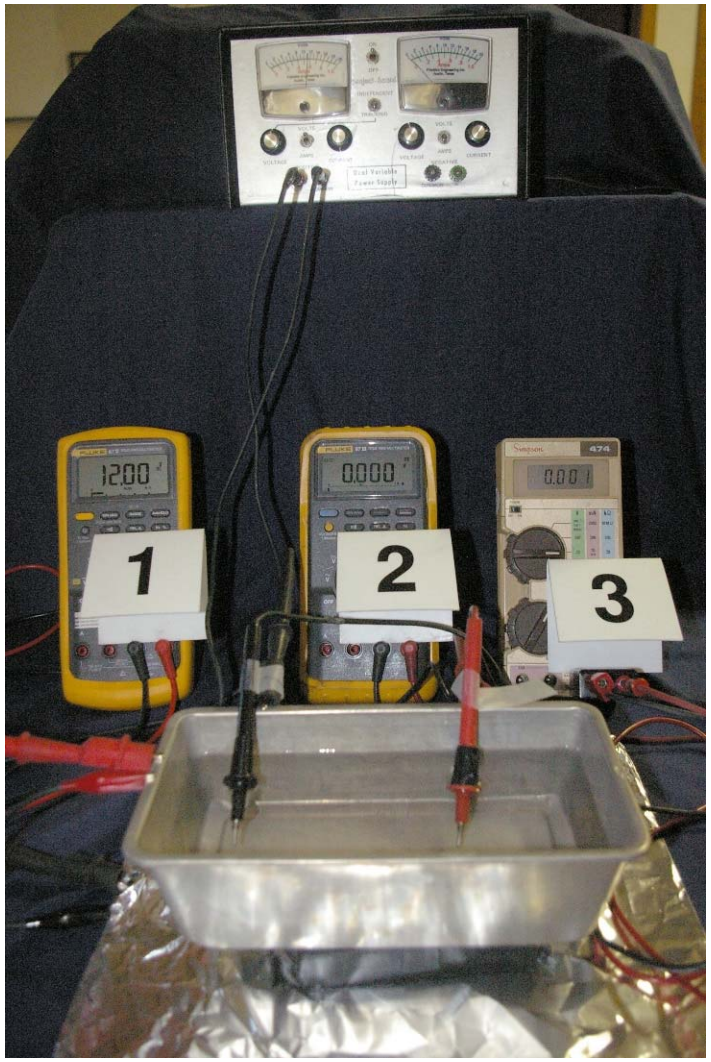
Bonding vs. Grounding (continued)

- Bonding - ties the deck and pool steel and all metallic objects near the pool together to reduce voltage gradients.
  Makes the pool and deck into an equipotential surface or "Faraday Cage" -A BIG "METAL" PAN - where voltages between all points in or out of the water are approximately equal! --> If done right, significant current can't flow in the water!

- Bonding is required even without any electrical equipment!

FARADAY CAGE

NO CURRENT IN THE WATER EVEN THOUGH STRUCTURE IS ENERGIZED



- Example of how a Faraday cage works in a pool environment.
- The metal pan is resistively isolated from the grounded foil to allow some current to flow while preventing a direct short circuit.
- 12 Volts is applied between the metal pan and the foil.
- Meter 1 measures between the pan and the foil.
- Meter 2 measures between 2 clips attached to the pan at two points.
- Meter 3 measures between the 2 probes in the water.
- There is no voltage in the water (Meter 3) or between any two points on the pan (Meter 2) even though the pan is energized at 12 volts with respect to grounded foil (Meter 1)

Equipotential Bonding

- Requirements
- Why and how - equipotential bonding grid
  - Formerly called the “common bonding grid”
- Specific Issues
  - Double-insulated pump motors
  - Encapsulated Rebar/Fiberglass Rebar
- Proper bonding enhances safety!

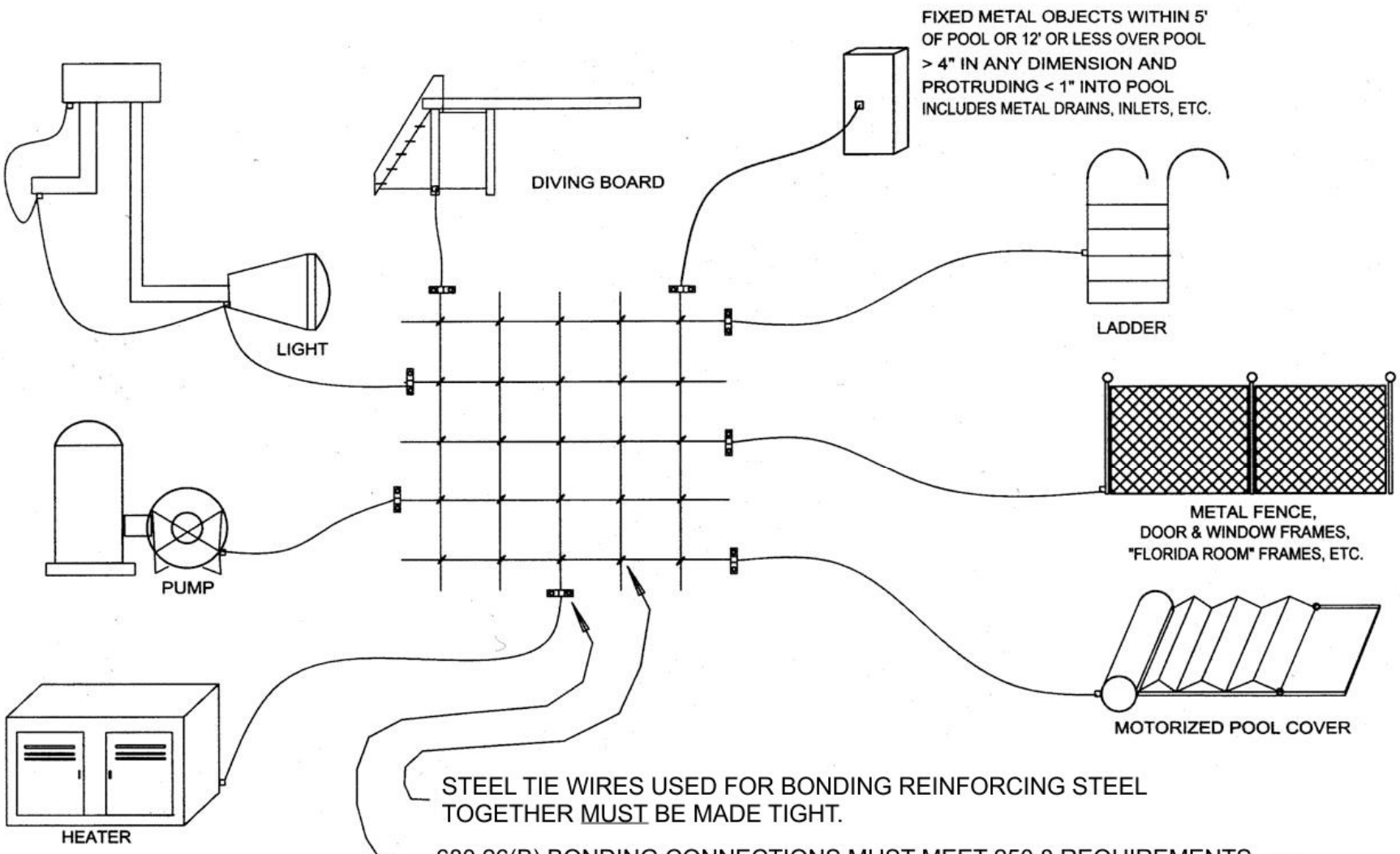
Equipotential Bonding System

- Bonding works because all items are electrically tied together with a good conductor in a single bonding system
  - Voltages are effectively equalized means little or no current flow
  - Does NOT eliminate voltage gradients; bonding is intended to reduce them to levels below electrical injury thresholds

Equipotential Bonding System (cont'd)

- Connections must be reliable over time
  - Suitable Clamps - labeled for use in concrete - stainless steel, copper, copper alloy (includes brass)
  - Cadwelding
  - (2017) Grounding and bonding terminals are required to be identified for use in wet and corrosive environments, and listed and labeled for direct burial use
    - labeled "DIRECT BURIAL" or "DB"
    - composed of copper, copper alloy (includes brass), or stainless steel
    - Cadwelding is still allowed

TYPICAL BONDING FOR CONCRETE (CONDUCTIVE) POOL, EXCLUDING PERIMETER SURFACES



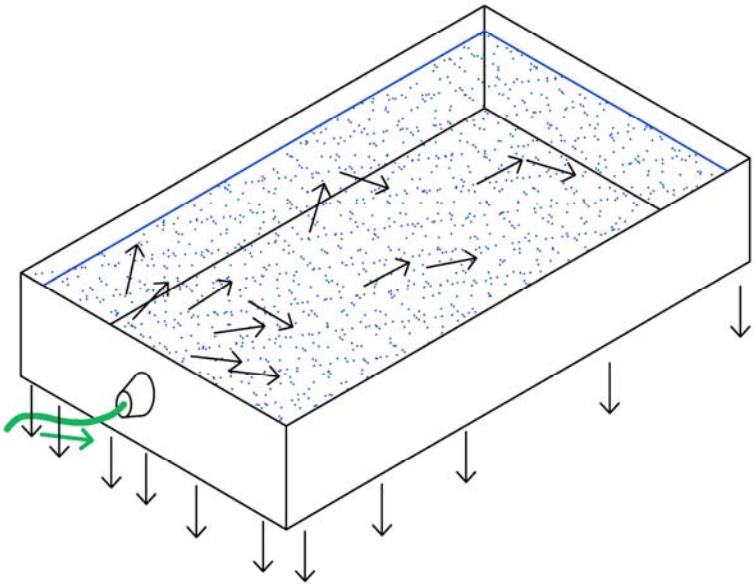
STEEL TIE WIRES USED FOR BONDING REINFORCING STEEL TOGETHER MUST BE MADE TIGHT.

680.26(B) BONDING CONNECTIONS MUST MEET 250.8 REQUIREMENTS. CLAMPS SHOULD BE BRASS, COPPER, COPPER ALLOY, OR STAINLESS STEEL AND MUST BE LABELED AS SUITABLE FOR THE PURPOSE. EXOTHERMIC WELDING ("CADWELD") IS ALLOWED. BRASS OR OTHER CORROSION-RESISTANT CONDUIT MAY BE USED IN COMMON BONDING GRID. #8 SOLID COPPER WIRE.

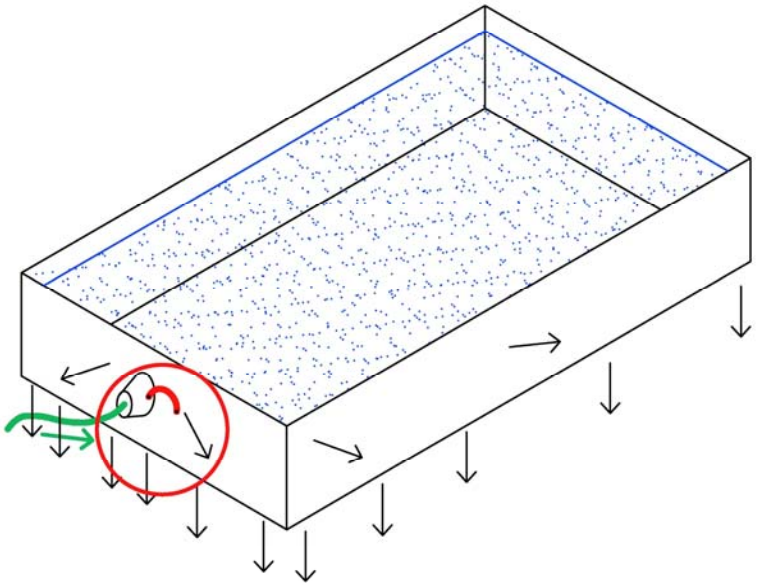
NOT BONDED vs. BONDED

THE POOL STEEL IS A GOOD CONDUCTOR

CURRENT FLOWING TO THE POOL THROUGH THE GREEN WIRE TO THE LIGHT--> VOLTAGE BETWEEN THE LIGHT SHELL AND GROUND



NOT BONDED--DIFFERENT VOLTAGES IN POOL BECAUSE OF RESISTANCE-->CURRENT FLOWS TO GROUND THROUGH THE WATER

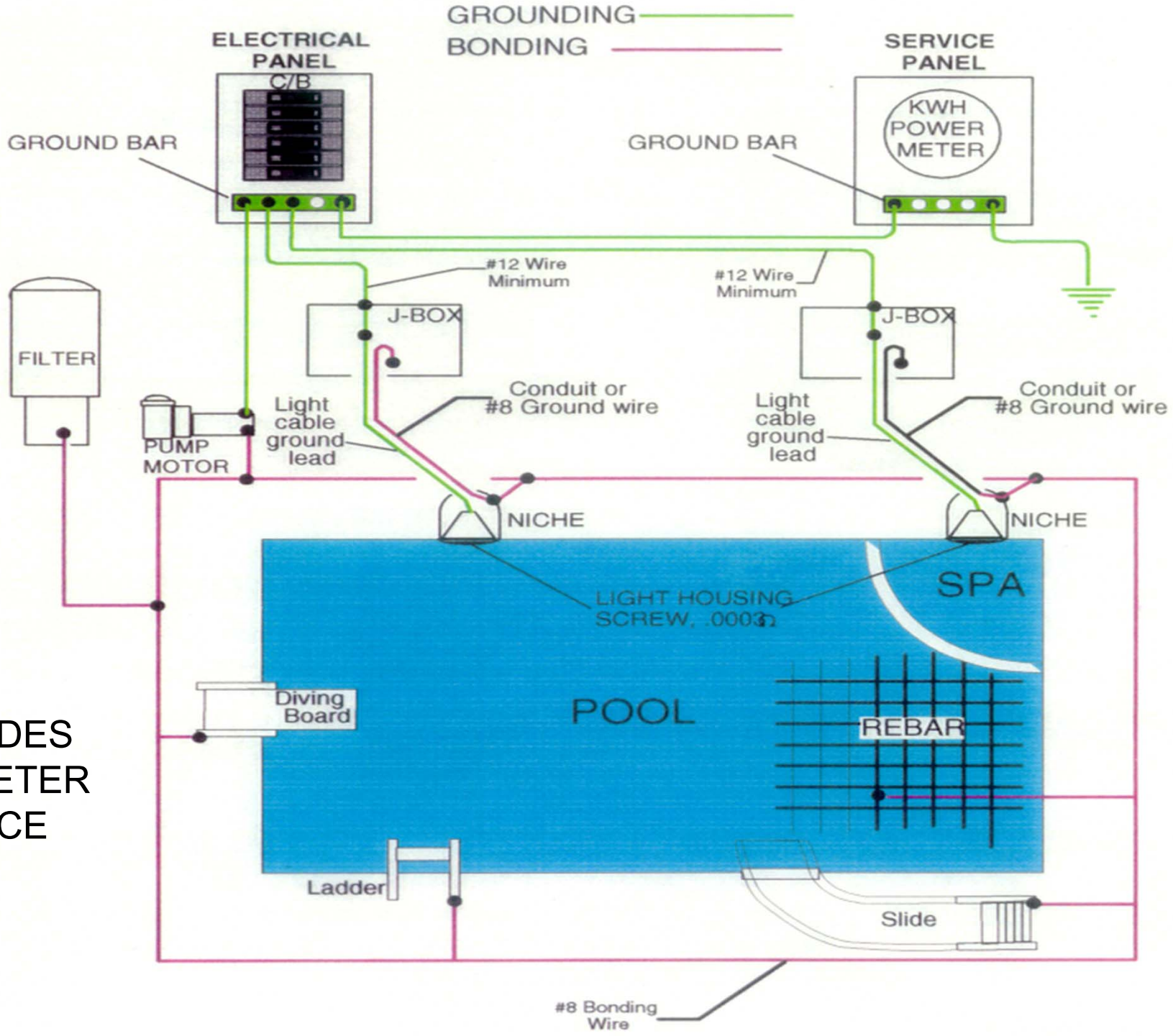


BONDED TO POOL STEEL--VOLTAGE SAME EVERYWHERE-NO VOLTAGE IN POOL-CURRENT TO GROUND THROUGH THE STRUCTURE-->NO CURRENT IN POOL

How Bonding & Grounding Can Interact Together

- The equipotential bonding system can interact with the grounding system because of common tie points.

POOL AND SPA BONDING AND GROUNDING SCHEMATIC



EXCLUDES PERIMETER SURFACE

How Bonding & Grounding Can Interact Together

- **Because of a properly built bonding system's low resistance, the pool may be the best ground electrode on the local power system!**
- **As a practical matter, this means……**

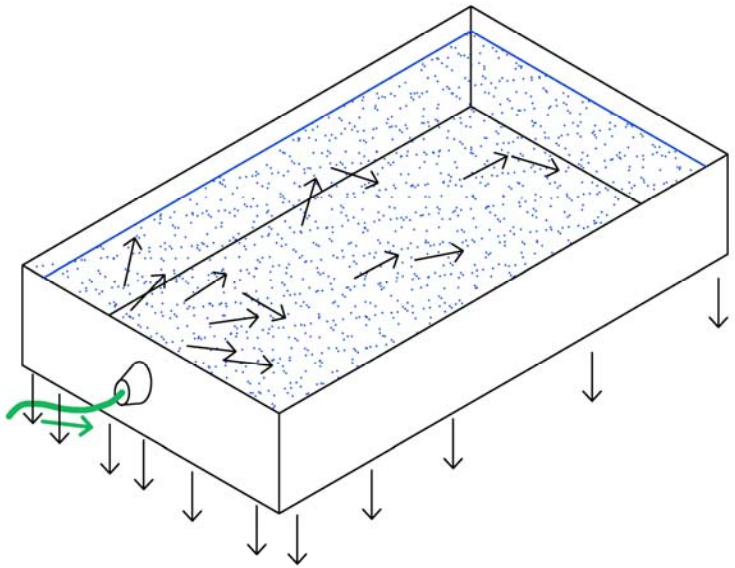
Proper Bonding Enhances Safety

- A properly installed equipotential bonding system can divert current to earth through the pool / deck structure and not through the water!
  - *Remember*-- It makes the pool a giant grounding electrode (outside) and a Faraday Cage where little or no significant amount of current can flow in water (inside). A real-world example - 1 Ohm (pool) vs. 26 Ohms (ground rod)!

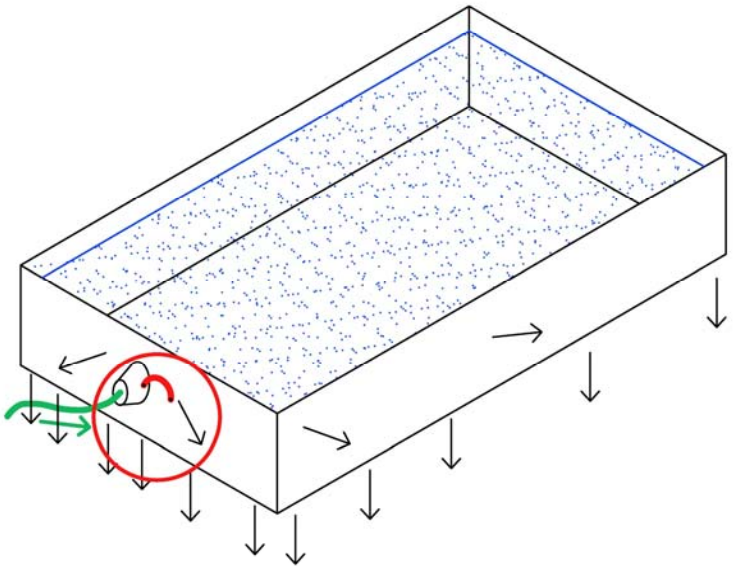
NOT BONDED vs. BONDED

CONDUCTIVE POOL CAN HAVE VERY LOW RESISTANCE COMPARED TO A GROUND ROD - BONDING HELPS KEEP CURRENT OUT OF THE POOL

THE POOL WITH CONDUCTIVE STRUCTURE BECOMES A SYSTEM GROUND ELECTRODE AND CURRENT FLOWS TO THE POOL THROUGH THE GREEN WIRES



NOT BONDED--CURRENT TO GROUND THROUGH THE WATER



BONDED TO POOL STEEL—LITTLE OR NO CURRENT IN POOL

Real-World Example:

- Houston, Texas, Concrete/Gunite pool - measured Summer 1999
  - 8’ service ground rod: 26 Ohms
  - 10’ Utility Pole Grounds: >40 Ohms
  - Resistance of Pool to Ground with only *partial* bonding in place: < 1 Ohm!
  - 1.5-7A running from the utility neutral wire to the pool! ***Shocking swimmers!!***

Bonding Mistakes

- The earth cannot and must not be used as a bonding conductor!
  - This is one of the most common mistakes made!
  - Use of multiple ground rods in place of a minimum #8 metallic bonding conductor is unsafe and potentially deadly, particularly around a pool
  - The relatively high earth (soil) resistance will not facilitate the formation of an equipotential surface
- An equipment grounding wire is not the same as a bond wire; grounding to the electrical system ground bus cannot be used in lieu of proper bonding, even when both are called for

Bonding Issues

- The pool structure includes the deck and coping!
- Fixed metal parts within 5’ of the pool MUST be bonded
- ALL METAL FITTINGS *WITHIN OR ATTACHED TO THE POOL STRUCTURE* GREATER THAN 4” IN ANY DIMENSION AND PENETRATING INTO THE STRUCTURE MORE THAN 1” **MUST** BE BONDED!
  - ***This means fence anchors, anchors for fixed lifts , and SOME cover anchors…***

Bonding Issues
Cover Anchors

(2020) Metallic pool cover anchors intended for insertion in a concrete or masonry deck surface, 25 mm (1 in.) or less in any dimension and 51 mm (2 in.) or less in length, and metallic pool cover anchors intended for insertion in a wood or composite deck surface, 51 mm (2 in.) or less in any flange dimension and 51 mm (2 in.) or less in length, do not require bonding.

Bonding lug on steel fence 4’ from pool inside edge

Pole-type Handicap Lift. This has to be bonded. The pocket comes with a bonding lug.

Double-Insulated Pump Motors

- MUST have a #8 AWG solid copper bonding wire run from pool to an accessible point in pump area
  - Allows for flexibility in pump replacement
- If the motor has a grounding screw, you must connect it to equipment grounding conductor of motor branch circuit at the motor
- If bonding system is NOT grounded, you must connect it to equipment grounding conductor of motor branch circuit at the motor

Bonding of Conductive Pool Shells

ONLY CONDUCTIVE POOL SHELLS ARE REQUIRED TO BE BONDED:

Conductive Pool Shell: ***Cast-in-place concrete, pneumatically applied or sprayed concrete, and concrete block with painted or plastered coatings are all considered conductive materials due to water permeability and porosity.*** *Vinyl liners and fiberglass composite shells are considered to be* ***nonconductive*** *materials.*

Unencapsulated steel rebar:

Use the pool's structural rebar with tie wires. Connect to the equipotential bonding system in at least 4 places.

Nonconductive Coated/Encapsulated Rebar and Fiberglass Rebar

- Very controversial and potentially dangerous
- CANNOT serve as a bonding to create the equipotential surface
- CANNOT be tied together electrically
- NOT required to be bonded (can't be)
- WILL NOT stop or reduce current flow in pool water (to earth ground) rather than around the pool water

Nonconductive Rebar

- Since the 2002 NEC, you MUST provide an **alternate means** to reduce voltage gradients in the pool
- 2002 NEC provided NO guidance as to how to do this. 2005 and later do provide guidance!!
- Section 680.26(B)(1)(b) defines what an **alternate means** is:

Nonconductive Rebar - Alternate Means

- The alternate means of bonding for a pool with encapsulated rebar is a **copper wire grid under or in a conductive pool shell**

- THIS IS **NOT** CHEAP!!!

Nonconductive Rebar - Alternate Means

- Minimum 8 AWG bare solid copper conductors, bonded to each other at all points of crossing -- uniformly spaced perpendicular grid pattern 12”x12” +/- 4”.
- Copper grid must conform to the contour of the pool.
- Below-grade grid must be secured within or under the pool, and it must follow the contours of the pool shell. When not part of the pool shell, it must be secured no more than 6” from the outer contour of the pool shell.
- Connections must be per 250.8 or other approved means
  - exothermic welding (cadwelding)
  - listed and labeled pressure connectors
  - listed and labeled clamps
  - other listed and labeled means
- MUST be connected to bonding system

Bonding To Rebar

- Make sure steel tie wires are tight!
- Use approved, listed and labeled clamp suitable for direct burial (DB).
- Make sure screws are tight!
- Cadweld is even better.
- No. 8 or larger solid copper bonding conductor
- Sealant such as *Scotchkote*™ (3M) can be useful to reduce long-term corrosion problems at screw terminals on embedded clamps.

Corrosion – Use Copper, Copper Alloy, Stainless Steel

Corrosion – Use Copper, Copper Alloy, Stainless Steel

This is a direct burial clamp which came with plated steel bolts. **This will not last.**

This is the same clamp with stainless steel bolts. **This will usually last a lot longer.**

Corrosion – Use Copper, Copper Alloy, Stainless Steel

This is a direct burial clamp with stainless steel bolts.

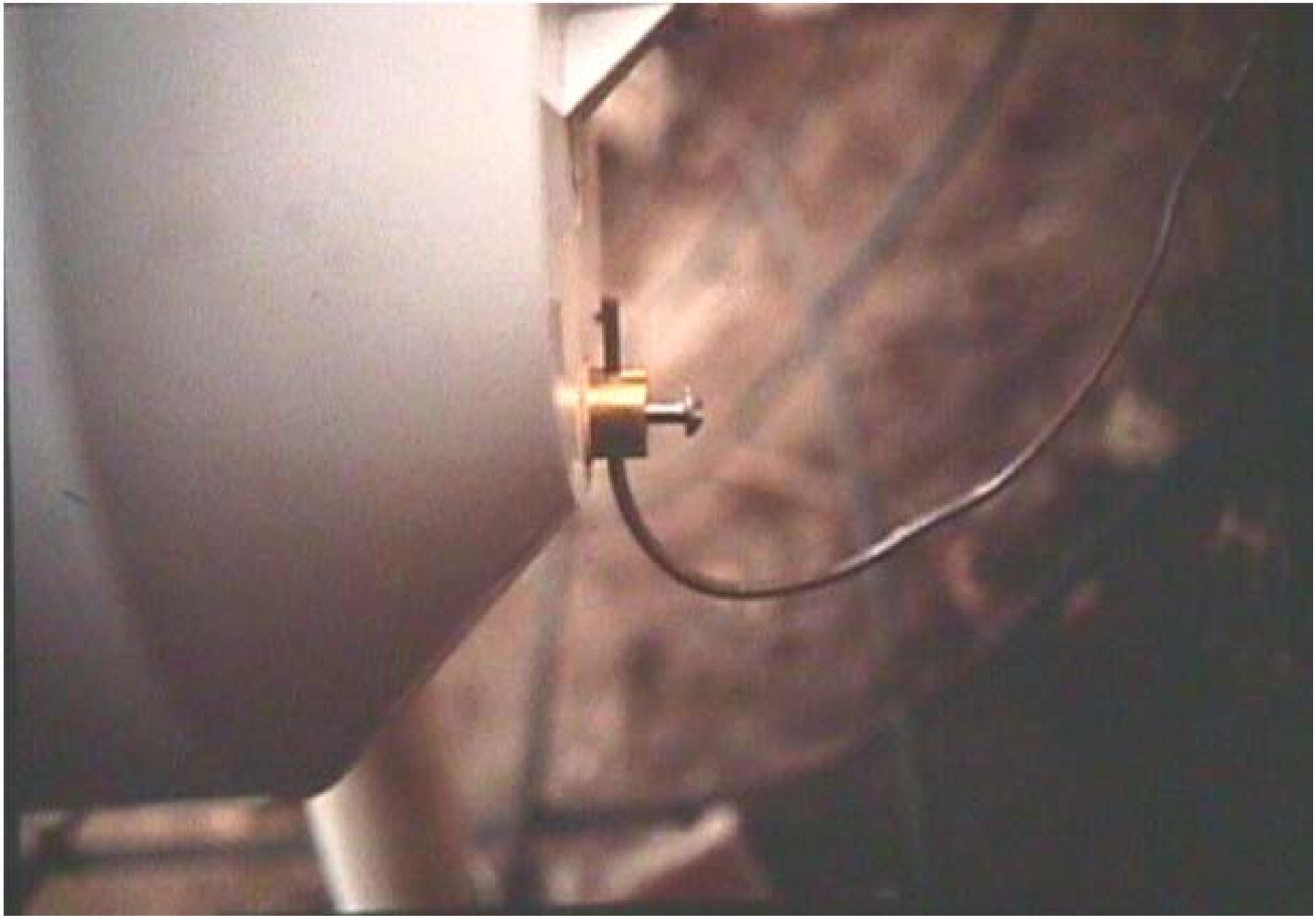
Notice it is LISTED AND LABELED for direct burial.

Corrosion – Cadwelding also allowed

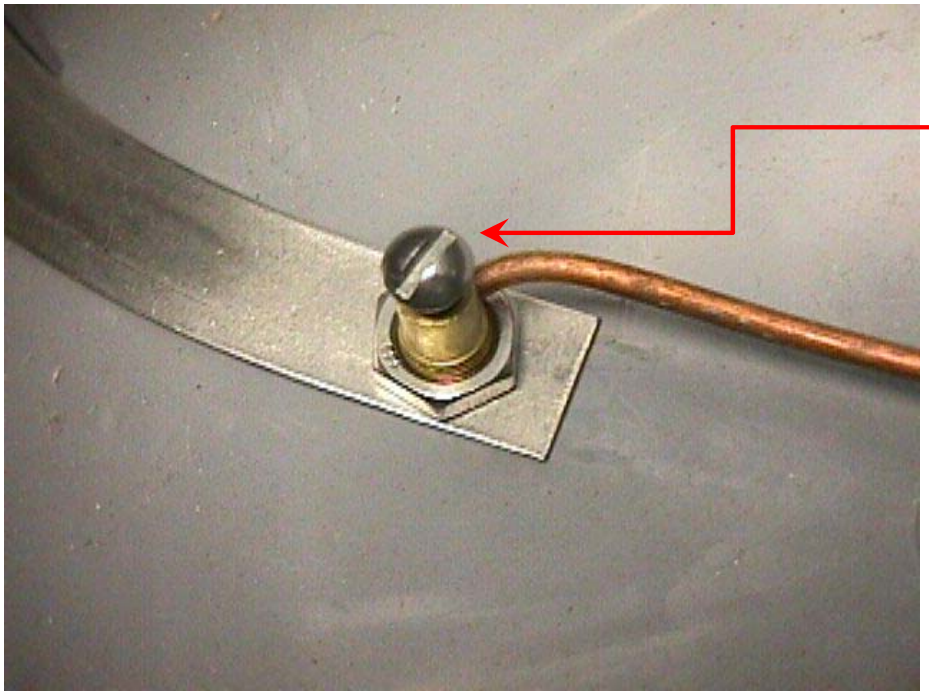
Cadwelding is an exothermic welding process which solidly welds metals together. It will also work on copper connections to steel rebars. **If done per instructions, this will also usually last a very long time.**

Bonding To Forming Shell (Light Niche)

- Make sure screws are tight!
- No. 8 or larger solid copper bonding conductor.
- Sealant such as *Scotchkote*™ (3M) can be useful to reduce long-term corrosion problems at screw terminals.



Internal Lug Connection
Plastic Niche



This connection

MUST be potted

Bonding the Perimeter Surface

The perimeter surface does not necessarily include the entire deck – it is a specific area around the pool or spa.

Perimeter surface extends ONLY 3’ horizontally beyond the inside walls of the pool – NO MORE.

Perimeter surface areas separated from the pool by a permanent wall or building at least 5’ in height are not required to be bonded

Perimeter surface includes **unpaved** surfaces as well as poured concrete and other types of paving.

Bonding the Perimeter Surface (THROUGH 2020 EDITION)

Bond the deck's structural reinforcing steel if available

Alternate Means - Where structural reinforcing steel is not available, at minimum a copper conductor or grid must be utilized as follows:

- At least 1 minimum #8 AWG bare solid copper conductor
- Conductor(s) must follow the contour of the perimeter surface
- Approved splices are permitted
- If only a single conductor is provided, it must be 18" to 24" horizontally from the inside wall of the pool
- Perimeter surface equipotential bonding conductor(s) must be secured within or under the perimeter surface 4" to 6" below the finished grade (subgrade).

Bonding the Perimeter Surface (THROUGH 2020 EDITION)

Perimeter bonding must be attached to the pool reinforcing steel or copper conductor grid at a **minimum of 4 points uniformly spaced around the perimeter of the pool if the pool shell is conductive**.

For non-conductive pool shells (vinyl liner, fiberglass, etc.), bonding at four points is not required (no place to make a connection).
NOTE: metallic copings and structural elements for vinyl liner pools must be bonded.

Bonding the Perimeter Surface (THROUGH 2020 EDITION)

- The use of a #8 AWG solid copper wire as the Alternate Means for perimeter bonding in 680.26(B)(2)(b) has been maintained in all Editions of the NEC since 2011. There is currently NO requirement up through the 2020 edition of the NEC to use only welded copper wire mesh, multiple conductors, etc. for perimeter bonding.
- (2020) Clarified that the use of a copper grid is also allowed (it has always been allowed)

Perimeter bonding ring

2023: Changes – 680

EQUIPOTENTIAL BONDING REQUIREMENTS

- Clarified that pools with or without associated electrical equipment must be bonded
- For bond to water, clarified that concrete pool shells are conductive bonded parts by referring back to 680.26(B)(1)-(B)(7)
- Clarified that metal parts of pool water circulation, treatment, heating, cooling, and dehumidification equipment must be bonded unless double-insulated, and (unless separated by a permanent barrier) all other electrical equipment within 5’ of the inside wall of the pool horizontally or 12’ vertically above max. water level or any observation stands, towers, platforms or diving structures, must be bonded. [this includes heat pump heaters, chillers, dehumidifiers, etc.]

2023: Changes – 680

PERIMETER BONDING REQUIREMENTS: TIA 23-9 (2023 Edition)

TIAs and how they work:

- TIA = Temporary Interim Amendment
- A TIA can only address current edition and immediately prior edition (currently 2026 & 2023 ONLY – cannot address 2020 or earlier)
- An adopted TIA must be addressed by Code Panel 17 for the next edition after adoption
- Some states do not recognize TIAs

2023: Changes – 680

PERIMETER BONDING REQUIREMENTS

REMINDER – THE PERIMETER SURFACE EXTENDS OUT ONLY 3’ FROM THE INSIDE EDGE OF THE POOL – NO FURTHER

New 2023 **perimeter bonding language** in 680.26(B)(2) reverted to the existing 2020 language due to an unresolved TIA and associated Standards Council action –

If your state <u>does not</u> recognize TIA’s, this is your Code language under the 2023 Edition:

2023: Changes – 680

PERIMETER BONDING REQUIREMENTS – THE OLD CODE LANGUAGE

If your state does not recognize TIA's, this is your Code language:

- The buried #8 copper ring is allowed for everything
- Burial depths for the copper rings and grids had been clarified in the 2023 text as produced by CMP-17:
  - Can be within or below a paved surface but no more than 6" below finished grade, or below an unpaved surface 4"-6" below finished grade
- This text was not included in the 2023 Edition due to the TIA, and the term "subgrade" remains in the Code language
- Be aware that the intent of the Panel was to clarify its original intent for the burial depth by changing "subgrade" to "finished grade," which is an accepted term in the construction industry.

"Finished grade" is the top of the finished surface, whether paved or not.

2023: Changes – 680

PERIMETER BONDING REQUIREMENTS (cont'd)

REMINDER – THE PERIMETER SURFACE EXTENDS OUT ONLY 3 FEET FROM THE INSIDE EDGE OF THE POOL – NO FURTHER

New 2023 **perimeter bonding language** in TIA 23-9 and associated Standards Council action effective 4/10/23 revamped 680.26(B)(2) and the Definition of a Pool –

If your state recognizes TIA's, this is your Code language under the 2023 Edition:

2023: Changes – 680

PERIMETER BONDING REQUIREMENTS – THE REVISED CODE LANGUAGE

- **If your state recognizes TIA's, this is your language:**

- **Redefines "Pool"** to EXCLUDE bodies of water used as part of industrial processes, lakes, lagoons, surf parks, and other natural or man-made bodies of water
- **Perimeter surface is now limited to 3' above and 2' below maximum water level, extending out 3' from the inside wall of the pool – all other areas are NOT perimeter surfaces**
- **Conductive paved perimeter surfaces** now require a **copper grid, structural steel welded wire reinforcement, or rebar grid**. This is **either embedded within the paved surface or, if pavers with no embedding possible, directly under the paving**. UL listing requirement time has passed – superseded in 2026 and has been extended to 2029.

2023: Changes – 680

PERIMETER BONDING REQUIREMENTS – THE REVISED CODE LANGUAGE (cont'd)

- **Unpaved portions of perimeter surfaces** can use a buried #8 copper conductor 4"-6" below finished grade and 18"-24" from the inside walls of the pool (as in earlier Editions)
- **Nonconductive perimeter surfaces do not require bonding**
  - Includes raised nonconductive surfaces separated from earth or raised on nonconductive supports
  - Includes any perimeter surface that is electrically separated from the pool structure and raised on nonconductive supports above an equipotentially bonded surface
- Minimum grid requirements for copper (12" square #8), steel welded wire reinforcement (ASTM 6x6-W2.0xW2.0) and rebar (12x12 #3) are defined
- Must follow the contour of the perimeter surface
- Only listed splices or exothermic welding
- **Must all be connected together and run back to the equipment pad as before**

2026: Changes – 680

EQUIPOTENTIAL BONDING REQUIREMENTS - GENERAL

- Adds “Metal Structures” to “Metal Fittings” in the title of 680.26(B)(5), to address items such as moveable bulkheads, clarifying that **conductive bulkheads must be bonded**. Exception 4 was added to provide relief for **conductive components attached to nonconductive bulkheads**. These are often constructed of nonconductive materials, with limited metal fittings and attachments such as handles or starting blocks. **When isolated from the pool structure and other conductive parts, these parts present minimal risk of electric shock and are not required to be bonded**.
- 680.23(b)(2) was revised to eliminate ambiguous language and clarify that the bonding jumper installed in a nonmetallic conduit from an underwater pool light must be connected at both ends.

2026: Changes – 680

CONDUCTIVE POOL SHELL BONDING REQUIREMENTS

- In 680.26(B)(1)(b), a **40% copper clad steel grid** is now allowed in addition to the copper grid currently required in the case of encapsulated (or other non-conducting) pool reinforcing steel or other material.

BONDING CONDUCTOR

- In 680.26(B)(2), the bonding conductor can be pool reinforcing steel, a #8 copper conductor, or a **40% copper clad steel #8 conductor.**

2026: Changes – 680

PERIMETER BONDING REQUIREMENTS

- **Perimeter bonding language** revamped 680.26(B)(2) and definitions in TIA 23-9 and associated Standards Council action effective 4/10/23 – **This has now been incorporated in the 2026 Edition with three important modifications (in red):**
- Perimeter surface is now limited to 3' above and **3' below** maximum water level, extending out 3' from the inside wall of the pool – all other areas are NOT perimeter surfaces
- **Conductive paved perimeter surfaces** now require a copper grid, **40% copper clad steel grid**, structural steel welded wire reinforcement, or rebar grid. This is either embedded within the paved surface or, if pavers with no embedding possible, directly under the paving. **Where not embedded, the copper grid, 40% copper clad steel grid, and structural steel welded wire reinforcement must be listed for corrosion resistance and mechanical performance after January 1, 2029.**

2026: Changes – 680

PERIMETER BONDING REQUIREMENTS (cont'd)

- **Unpaved portions of perimeter surfaces** can use a buried #8 copper or **40% copper clad steel** conductor 4"-6" below finished grade and 18"-24" from the inside walls (as in earlier Editions)
- **Nonconductive perimeter surfaces** do not require bonding
  - Includes raised nonconductive surfaces separated from earth or raised on nonconductive supports
  - Includes any perimeter surface that is electrically separated from the pool structure and raised on nonconductive supports above an equipotentially bonded surface
- Minimum grid requirements for copper and **40% copper-clad steel** (both 12" square #8), steel welded wire reinforcement (ASTM 6x6-W2.0xW2.0) and rebar (12x12 #3) are defined
- Must follow the contour of the perimeter surface
- Only listed splices or exothermic welding
- **Must all be connected together and run back to the equipment pad as before**

Bond to Water - 680.26(C)

- Intentional bonding connection to the water
- **ONLY required when NONE of the bonded parts is in direct connection with the pool water**
- **Minimum 9 sq. inches in contact with the water (e.g., 3” x 3” plate) AT ALL TIMES**
- MUST be corrosion-resistant
- MUST be located where it is not exposed to physical damage or dislodgement during usual pool activities
- MUST be connected to the equipotential bonding

Bond to Water - 680.26(C) (cont'd)

Bond to water can consist of any or all parts required to be bonded under 680.26(B) that are in direct contact with the water

- Conductive pool shell (i.e., concrete etc.)
- Metal fittings > 4" in any dimension and penetrating >1" into the pool (required to be bonded)
- Metallic underwater light fixtures in contact with the water
- Usually not pumps or heaters because bonded metal parts are not in contact with the water

Bond to Water - 680.26(C) (cont'd)

A bonded conductive pool shell (i.e., concrete etc.) in direct contact with the water is considered to be sufficient as a bond to water. A bonded permanent metal ladder, rail or a metallic pool light in direct contact with the pool water will also suffice. The testing performed in support of a bond to water was conducted only on pools with non-conductive shells.

IF THE INSPECTOR MAKES YOU ADD A WATER BOND TO A CONCRETE POOL OR SPA, THEY ARE MISTAKEN – THE CONCRETE STRUCTURE IS THE WATER BOND.

Bond to Water - 680.26(C) (cont'd)

NESC Handbook 2017:

A conductive element that is part of the pool bonding system must be in direct contact with the pool water. Where bonded items such as ladders, rails, or underwater luminaires are in direct contact with the pool water and provide the required surface area, it is not necessary to provide another conductive element. A conductive pool shell in contact with the water also satisfies this requirement. However, where the pool does not include any of these items, it is necessary to install a conductive element. Devices have been specifically listed as a means to provide this contact with the pool water.

A SEPARATE BOND TO WATER IS NOT REQUIRED FOR A CONCRETE POOL

Portable Spas and Hot Tubs

- The 2011 NEC requirement in 680.42(B) for perimeter bonding for listed self-contained spas and hot tubs (portable spas and hot tubs) installed outdoors at or above ground level or on a raised deck (either conducting or nonconducting) was rescinded by Tentative Interim Amendment (TIA) 11-1, effective 3/21/11:
  - TIA 11-1 was incorporated into 680.42(B) of the 2014 NEC and all later Editions.
  - There has been no documented evidence presented to the Panel demonstrating that not installing perimeter bonding in this situation presents a hazard of serious physical injury or death.

Portable Spas and Hot Tubs(cont'd)

Perimeter bonding requirements in 680.42(B) for portable spas and hot tubs installed outdoors (in conformance with TIA 11-1). Eliminates the perimeter bonding requirements so long as the spa or hot tub is:

- Listed as a self-contained spa for aboveground use
- Not identified as only for indoor use
- Installed on or above grade in accordance wit the manufacturer's instructions
- Located such that the top rim is at least 28 in. above all perimeter surfaces within 30 in. horizontally from the spa or hot tub. This requirement does not apply to non-conductive steps.

Adds an informational note referring to UL 1563 – 2010 Standard for Electric Spas, Equipment Assemblies, and Associated Equipment regarding listing requirements

Portable Spas and Hot Tubs(cont'd)

680.43 Exception 2 eliminates the perimeter bonding requirements for portable indoor spas and hot tubs so long as the spa or hot tub is:

- Listed as a self-contained spa or hot tub
- Installed above a finished floor

(2017) 680.22(B)(7) – Low Voltage Gas-Fired Luminaires, Decorative Fireplaces, Fire Pits and Similar Equipment

- Equipment must be bonded per 680.26(B)

- Metallic gas piping must be bonded per 250.104(B) [other metal piping, including gas piping] and 680.26(B)(7) [fixed metal parts]

(2017) 680.22(B)(7) – Low Voltage Gas-Fired Luminaires, Decorative Fireplaces, Fire Pits and Similar Equipment (cont'd)

- Bonding requirements for gas piping per 250.104(B) [NEC 2020 text]

(B) Other Metal Piping. If installed in or attached to a building or structure, a metal piping system(s), including gas piping, that is likely to become energized shall be bonded to any of the following:

(1) Equipment grounding conductor for the circuit that is likely to energize the piping system
(2) Service equipment enclosure
(3) Grounded conductor at the service
(4) Grounding electrode conductor, if of sufficient size
(5) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper is of sufficient size

The bonding conductor(s) or jumper(s) shall be sized in accordance with 250.122, and equipment grounding conductors shall be sized in accordance with Table 250.122 using the rating of the circuit that is likely to energize the piping system(s). The points of attachment of the bonding jumper(s) shall be accessible.

Informational Note No. 1: Bonding all piping and metal air ducts within the premises will provide additional safety

Informational Note No. 2: Additional information for gas piping systems can be found in Section 7.13 of NFPA 54-2018, *National Fuel Gas Code*, and NFPA 780-2017, *Standard for the Installation of Lightning Protection Systems.*

(2017) Part VIII – Electrically Powered Pool Lifts – Sections 680.80-680.85

- Bonding Requirements:
  - Must be connected to the bonding system in accordance with 680.26(B)(5) and (B)(7):
    - Metal fittings > 4”(100 mm) in any dimension or penetrate into the pool structure >1” (25mm)
    - EXCEPT fixed metal parts separated by a barrier, > 5’ (1.5 m) from the inside wall of the pool, or >12’ (3.7 m) above the surface of the water, or above any observation stands, towers, platforms, or diving surfaces

Immersion Pools

- (2020) Immersion pool requirements added to Parts III (Portable and Storable) and IV (Permanently Installed).
- Applies to installations used for ceremonial or ritual immersion of persons, which is designed to have its contents drained or discharged (e.g., baptistries and mikvahs).
- General: An immersion pool is a spa or pool, but it has unique characteristics which must be addressed.

Immersion Pools

- (2020) 680.35 Storable and portable immersion pools
- Requirements reflect considerable variety in product configurations
  - Cord connection for self-contained units must utilize cord 6’-15’ long and must be protected by a GFCI (may be integral GFCI within 12” of plug)
  - Cord-connected storable and portable pumps not built-in must be identified for swimming pool and spa use, and must be (680.31):
    - Double insulated with grounding conductor connected to internal parts and grounding-type plug
    - Integral GFCI in the plug or within 12” of the plug
  - Storable and portable heaters not built-in must be identified for swimming pool and spa use, and must meet the following additional requirements:
    - Rated 120 V 20 A or less, or 240 V 30 A or less, single phase
    - If plug-and-cord connected, cord must be 6’-15’ long and at rated for at least “hard usage”
    - Heaters supplied by branch circuits 150 V or less to ground must be protected by a Class A GFCI
    - If integral GFCI, must be in the plug or within 12” of the plug

Immersion Pools

- Storable and portable immersion pools (cont'd)
  - No audio equipment installed in or on pool
  - All audio equipment located within 6' from the inside wall of the pool and operating at >LVCL must be grounded and GFCI-protected
  - At least 10' (straight line measurement) between nearest point on top rim and luminaires, lighting outlets, and ceiling-suspended paddle fans
  - Located at least 5' (horizontal measurement) from switches >LVCL not part of the pool
  - All receptacles rated 250 V 50 A or less within 20' of the inside walls and supplying power to heaters or other electrical equipment serving the pool must meet the requirements of 680.32 and 680.34:

    Protected by GFCI

    Not located within 6' of the inside walls of the pool

    Distance is shortest path a cord connected to receptacle would follow without piercing a floor, wall, ceiling, or other effective permanent barrier

Immersion Pools

- Storable and portable immersion pools (cont'd)

Immersion Pools

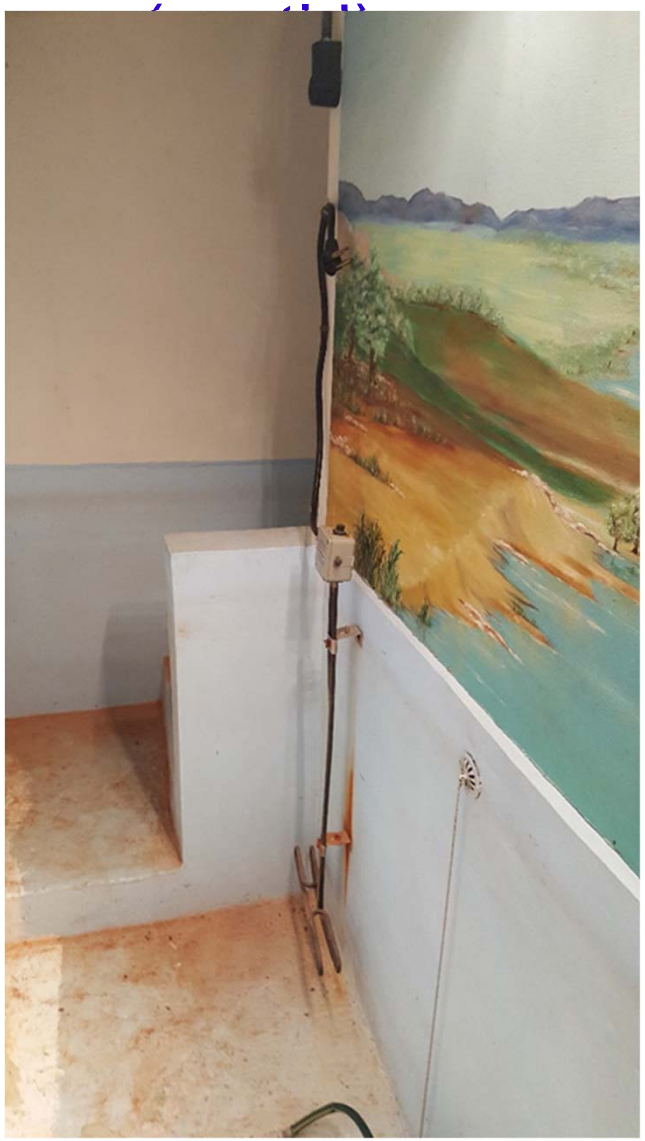
- Permanently Installed Immersion Pools
- Must meet requirements of Parts I, II and IV and use the Chapter 3 wiring methods
- Considered a spa or hot tub with regard to Part IV requirements
  - Any cord connection on a permanently installed portable packaged immersion pool must utilize cord 6'-15' long and must be protected by a GFCI (may be integral GFCI within 12" of plug)
  - Cord-connected storable and portable pumps not built-in or permanently attached, rated 120 V and 20 A or less must be identified for swimming pool and spa use, and must be:
    - Double insulated with grounding conductor connected to internal parts and grounding-type plug
    - Integral GFCI in the plug or within 12" of the plug
- All references to heaters include immersion heaters, circulation heaters and combination pump-heater units

Immersion Pools

- Permanently Installed Immersion Pools
  - Permanently installed heaters must be identified for swimming pool and spa use, and must meet the following additional requirements:
    - Includes built-in or permanently attached heaters
    - Rated 120 V or 250 V, single phase
    - Heaters supplied by branch circuits 150 V or less to ground must be protected by a Class A GFCI
    - Permanently installed immersion heaters rated 120 V 20 A or less, or 240 V 30 A or less, single phase may be plug-and-cord connected, cord must be (1) 6'-15' long, (2) must be grounded and must contain an integral means for grounding all non-current-carrying parts of the heater, and (3) must be GFCI protected. If integral GFCI, must be in the plug or within 12" of the plug
  - Storable and portable heaters not built-in must be identified for swimming pool and spa use, and must meet the following additional requirements:
    - Includes any heaters not built-in or permanently attached
    - If plug-and-cord connected, cord must be 6'-15' long and at rated for at least "hard usage"
    - Heaters supplied by branch circuits 150 V or less to ground must be protected by a Class A GFCI
    - If integral GFCI, must be in the plug or within 12" of the plug
  - No audio equipment installed in or on pool
  - All audio equipment located within 6' from the inside wall of the pool and operating at >LVCL must be grounded and GFCI-protected

Immersion Pools

- Permanently Installed Immersion Pools (cont'd)



Splash Pads

- (2020) Splash pads added to requirements for fountains:

- Defined as a fountain with a pool depth 25 mm (1 in.) or less, intended for recreational use by pedestrians. This definition does not include showers intended for hygienic rinsing prior to use of a pool, spa, or other water feature.

- Treat a splash pad as a fountain.

680.74 Bonding for Hydromassage Bathtubs (2017 and later)

- Extensively revised text in 2017 Edition clarifies the intent of the requirement for bonding in the area around hydromassage bathtubs.
- What MUST be bonded:
  - All metal fittings within or attached to the tub structure that are in contact with the circulating water
  - Metal parts of electrical equipment associated with the tub water circulating system, including pump and blower motors
  - Metal-sheathed cables, metal raceways and metal piping that are within 5' (1.5 m) of the inside walls of the tub and not separated from the tub by a permanent barrier
  - All exposed metal surfaces that are within 5' (1.5 m) of the inside walls of the tub and not separated from the tub area by a permanent barrier
  - Non-current-carrying metal parts of electrical devices and controls that are not associated with the hydromassage tubs and that are located within 1.5 m (5 ft) from such units
- What does NOT have to be bonded:
  - Small conductive surfaces not likely to become energized, such as air and water jets, supply valve assemblies, and drain fittings not connected to metallic piping, and towel bars, mirror frames, and similar nonelectrical equipment not connected to metal framing
  - Double-insulated motors and blowers

680.74 Bonding for Hydromassage Bathtubs (2017 and later - cont'd)

- How and what to bond:
  - Bond all metal parts required to be bonded
  - Solid copper bonding jumper, insulated, covered, or bare, not smaller than #8 AWG is required
  - Bond ONLY in the area of the hydromassage bathtub
  - Bonding jumper is NOT required to be extended or attached to any remote panelboard, service equipment, or any electrode
  - In ALL installations a bonding jumper long enough to terminate on a replacement non-double-insulated pump or blower motor must be provided
  - Bonding jumper must be terminated to the equipment grounding conductor of the branch circuit of the motor when a double-insulated circulating pump or blower motor is used. Otherwise, terminate it on the motor.

Wet Niche Light Fixtures and Bonding

- Electrical bonding between the light and niche occurs at the attachment screw. **This is the only reliable connection between the light and niche and is tested by UL!**
- While an electrical connection between the hooks on the light fixture and the niche can exist for a while after installation, **it is not reliable!**

Wet Niche Light Fixtures and Bonding (Cont'd)

- **Installing after-market repair parts such as float-in rings without bonding lugs or connections and plastic light fixture clamping devices can destroy the electrical safety bonding connection between the light fixture and the bonded niche!**
- **Destroying this bonding connection is virtually guaranteed when using such "innovative" fasteners as wallboard screws to replace the proper part.**
- **Similarly, unless the light is cross-listed and specifically labeled for use in another manufacturer's niche, do not mix. Under these conditions, the electrical safety bonding connection between the light fixture and the bonded niche has not been shown to be reliable!**

Remember...

Proper bonding is ABSOLUTELY CRITICAL for keeping stray currents out of the water

AND

bonding should be tested annually!

2023 NFPA 70B

CHANGED FROM PECOMMENDED PRACTICE TO STANDARD FOR EQUIPMENT MAINTENANCE

- In effect end of 2023
- Adds public pools, fountains and similar installations (Ch. 34).
- Includes bonding, grounding, GFCIs, motors, etc.
- Requires conformance to manufacturer's instructions and industry consensus standards for maintenance.
- Requires preparation, implementation and documentation of an overall Electrical Maintenance Program (EMP) that "directs activity appropriate to the safety and operational risk," and includes consideration of current condition as well as the operational safety and risk (Ch. 4).
- Includes testing as well as visual inspection.
- Incorporates maintenance intervals for specific types of equipment

A Reminder (again) …

Older Editions of the NEC Do **NOT** Require That Older Pools Be Routinely Upgraded To Current Standards

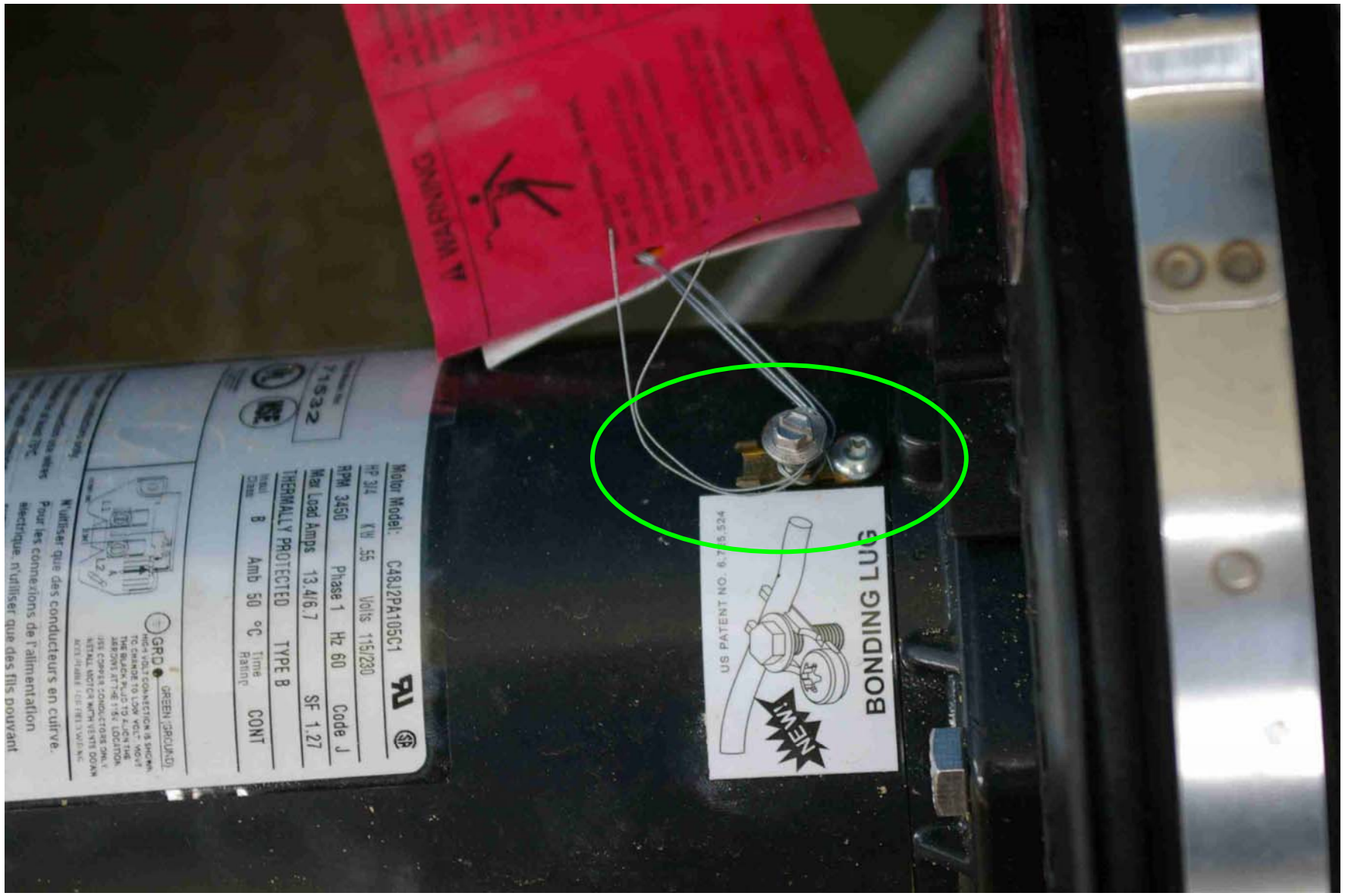
BUT…

Starting with the 2020 Edition, Reconstructed Pool Shells Must Be Bonded to Meet Current NEC Requirements, AND When Pool Pump Motors Are Replaced, They Must Be GFCI-Protected

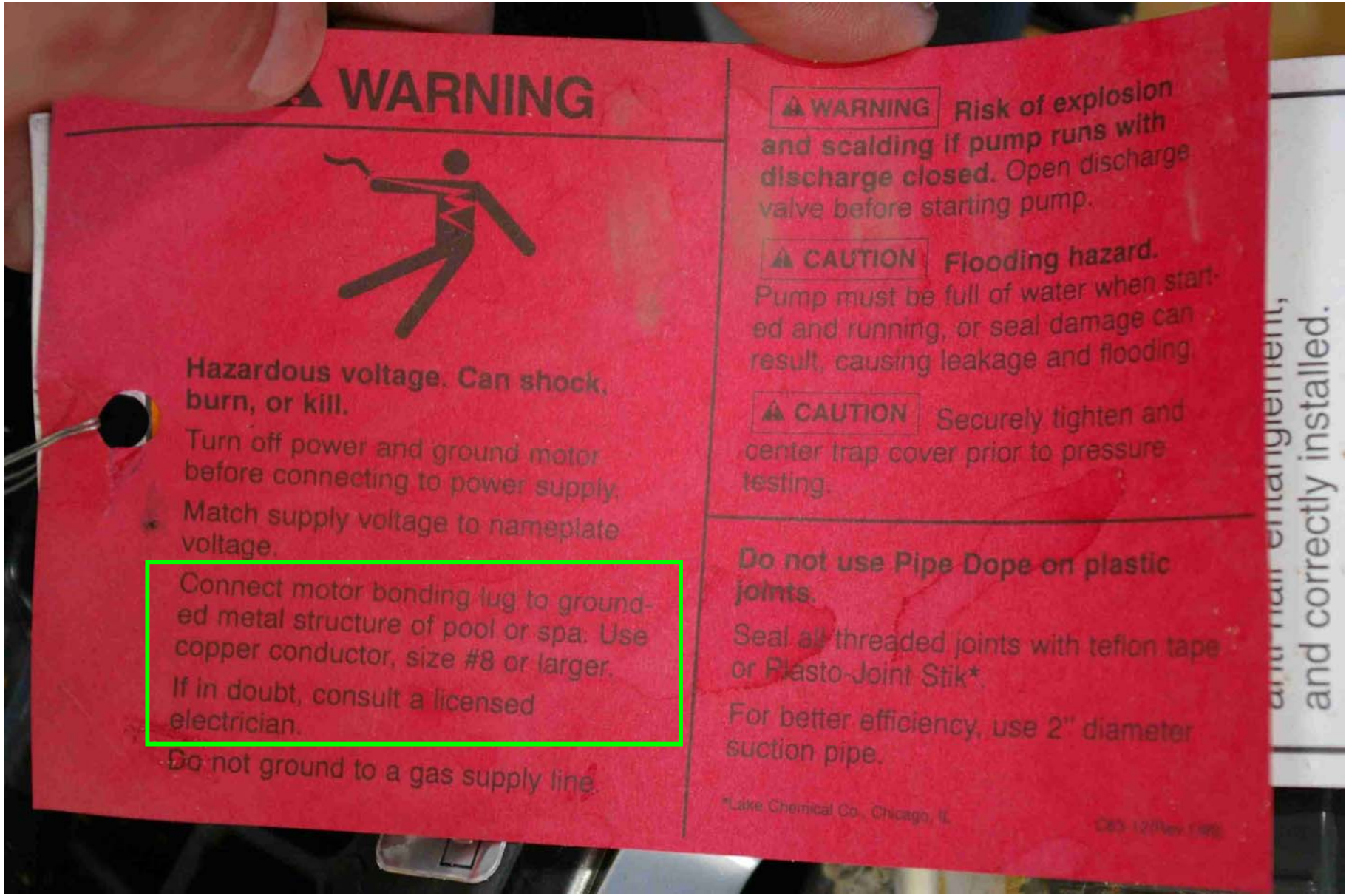
Booby Traps

Grounding and Bonding

Pump is not bonded



Neither is this one...



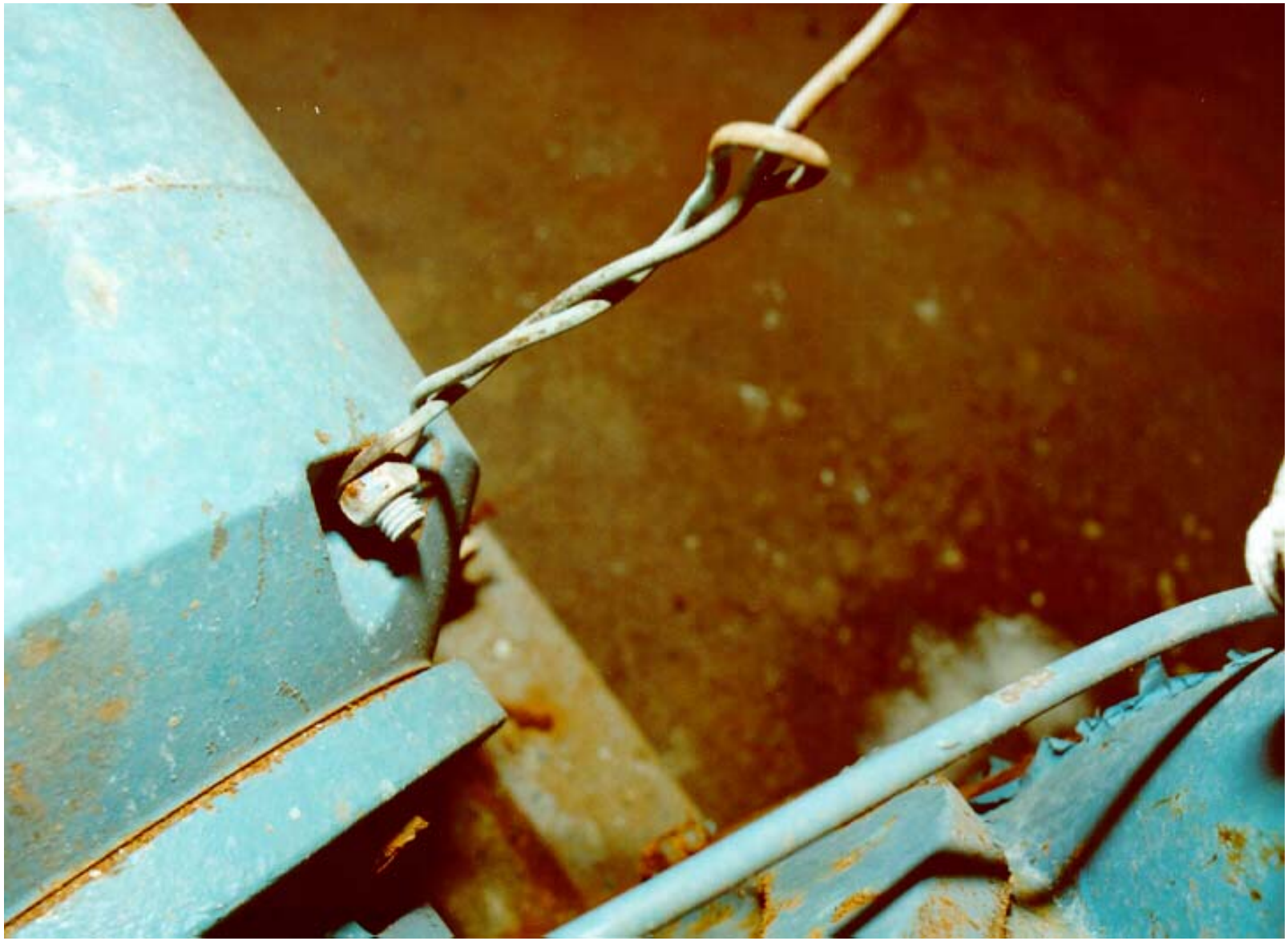
But then, who reads the directions anyway??

These two pumps aren't bonded, either.

Neither are these two.

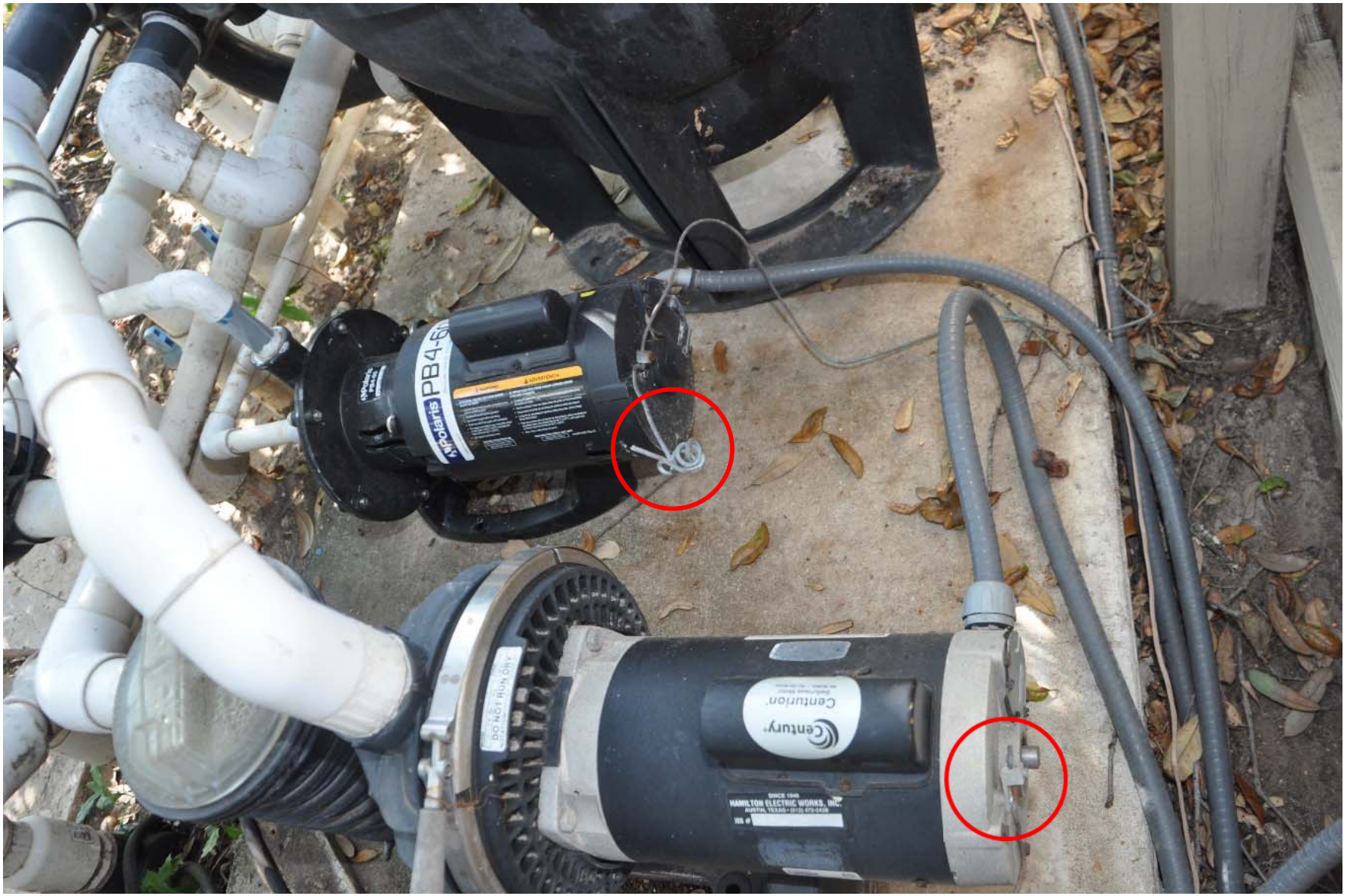
Are you beginning to get the idea that maybe this is COMMON??

Do you want to work on these?

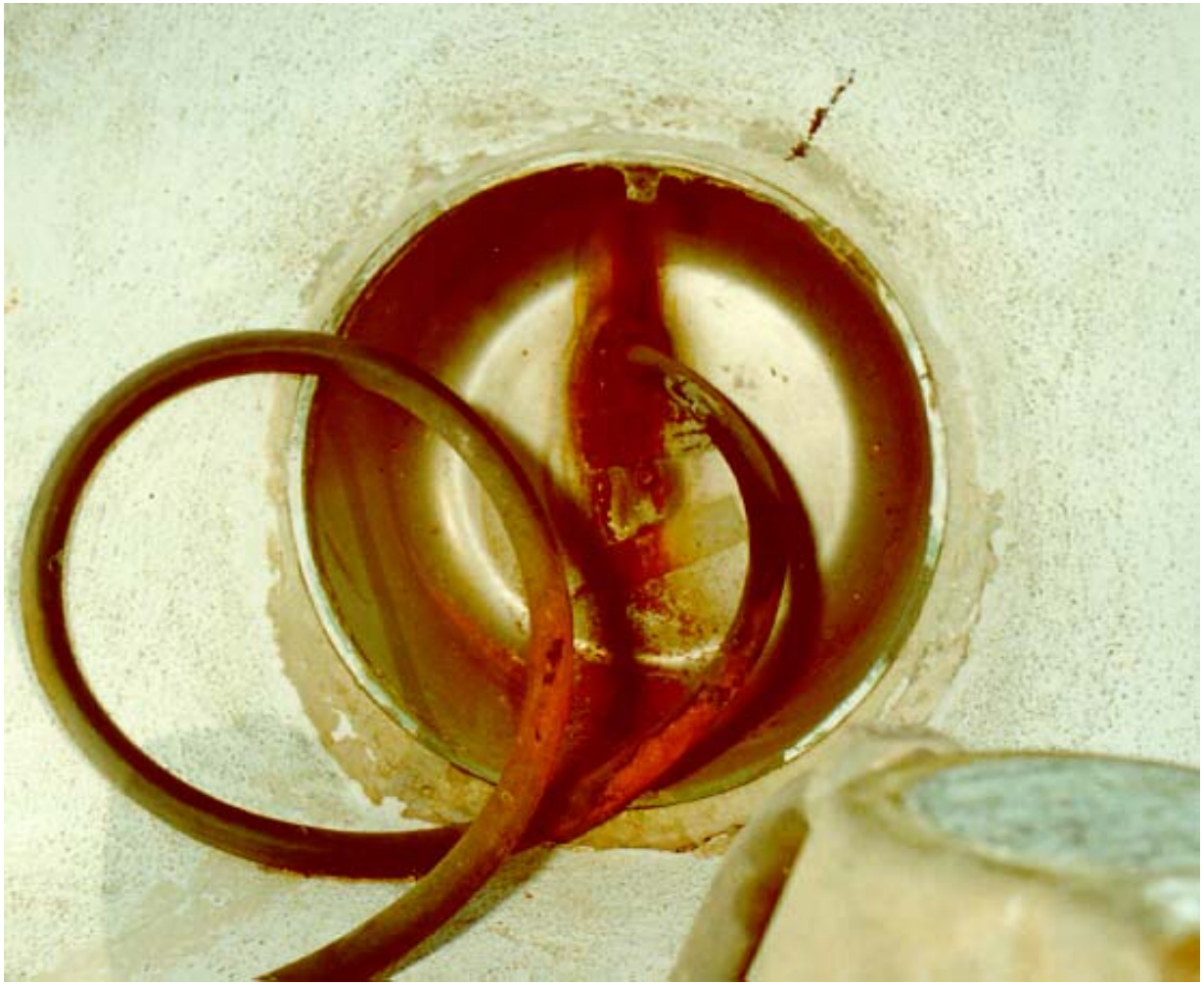


Improper, unreliable bond - needs lug

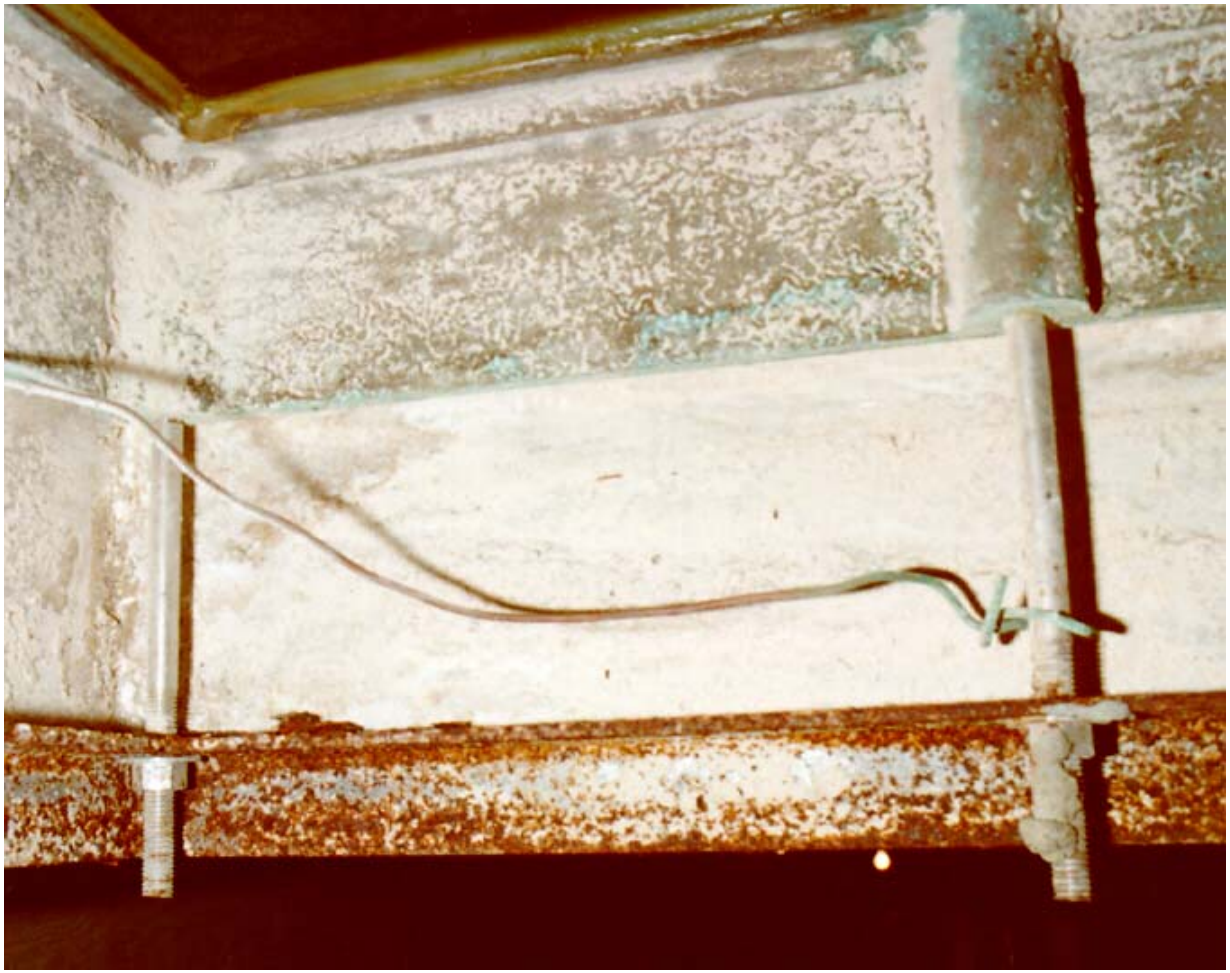
This is NOT a good connection!



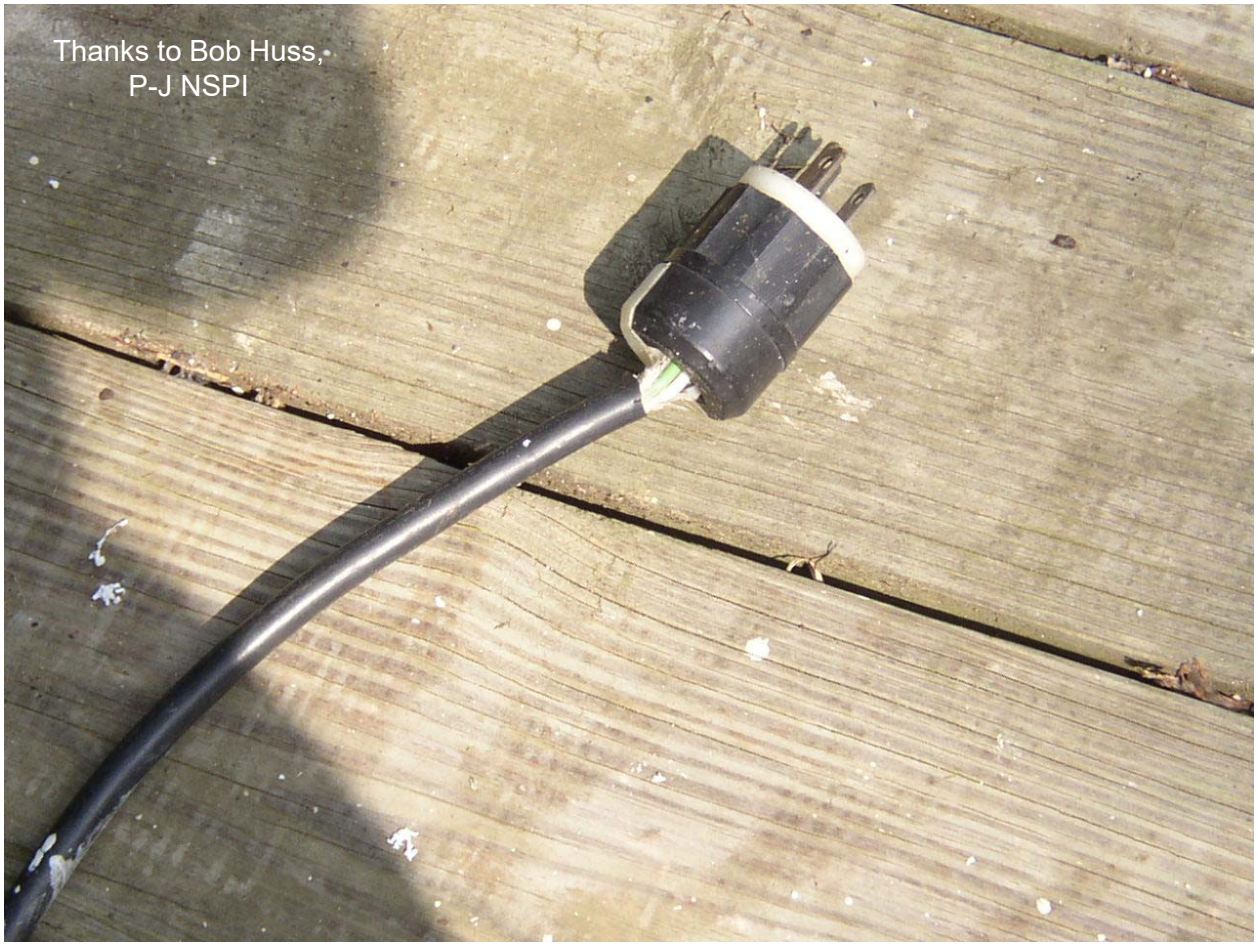
Bond wire cut between pumps



This niche is not connected by metal conduit to the j-box and is not bonded



This is a pool window in contact with the water, with somebody's idea of a bonding connection



The ultimate pool light switch! Even with the frayed wires fixed this is UNSAFE - plug is not allowed, ground is NOT continuous. Here's how this cord gets to the light…..

Threaded under the concrete……

……And into a piece of flexible plastic pipe. And, of course, no #8 green wire! Notice the misused bonding nipple and strap on the water pipe.

THIS IS ALL EXTREMELY DANGEROUS!

Improper dry niche light installation
flexible cord & plug not allowed
This is not an effective ground and is not bonded!

Bonding Conductor for Pool is Loose and Unattached to Equipment

Splice in ground electrode conductor

This is an unreliable ground!

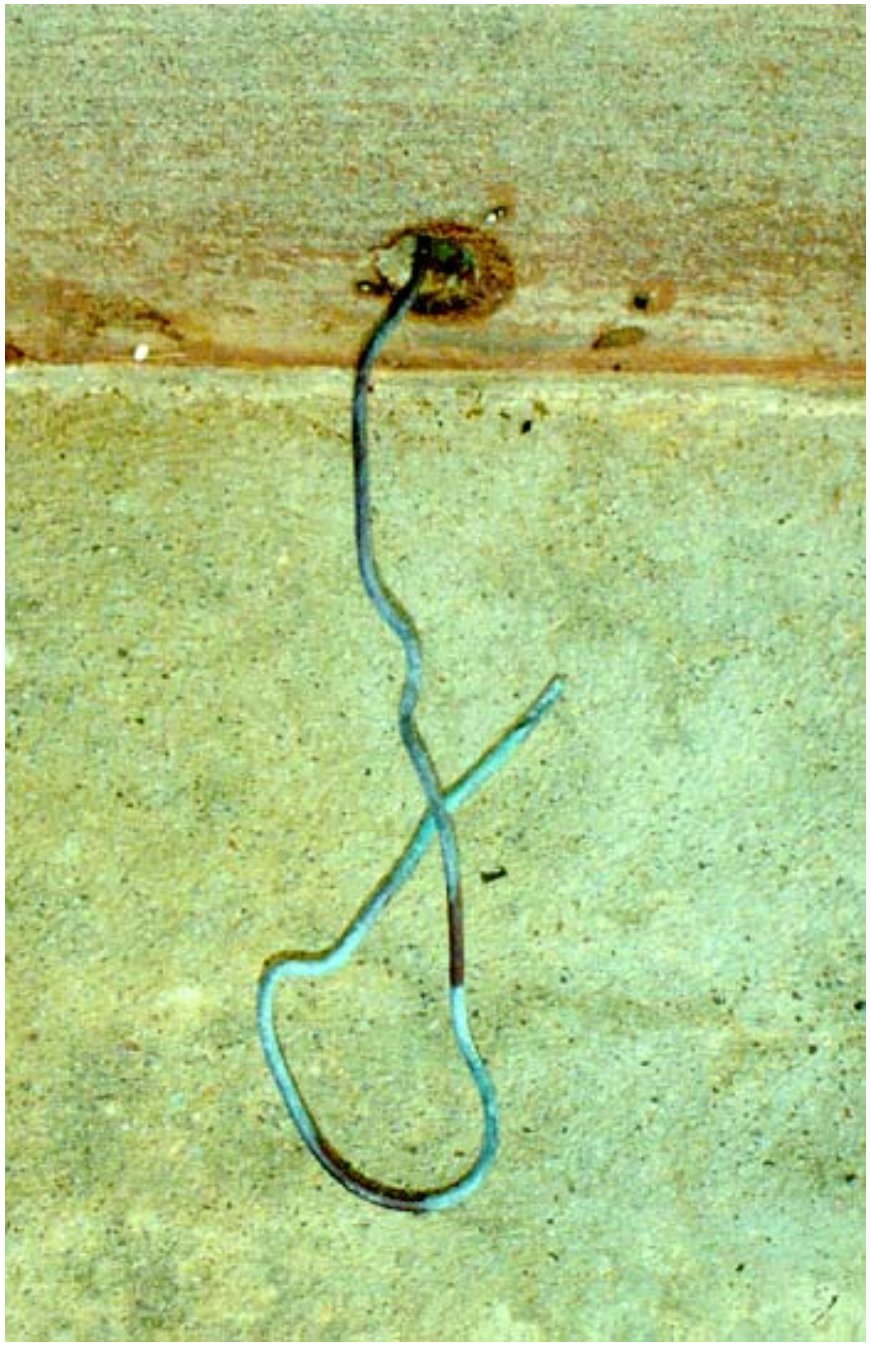
Corroded main service ground electrode connection in commercial equipment room

This is an unreliable ground!

What’s wrong with this bond???

Improper bond to lifeguard stand

Putting a baseplate on
doesn’t make it a good bond



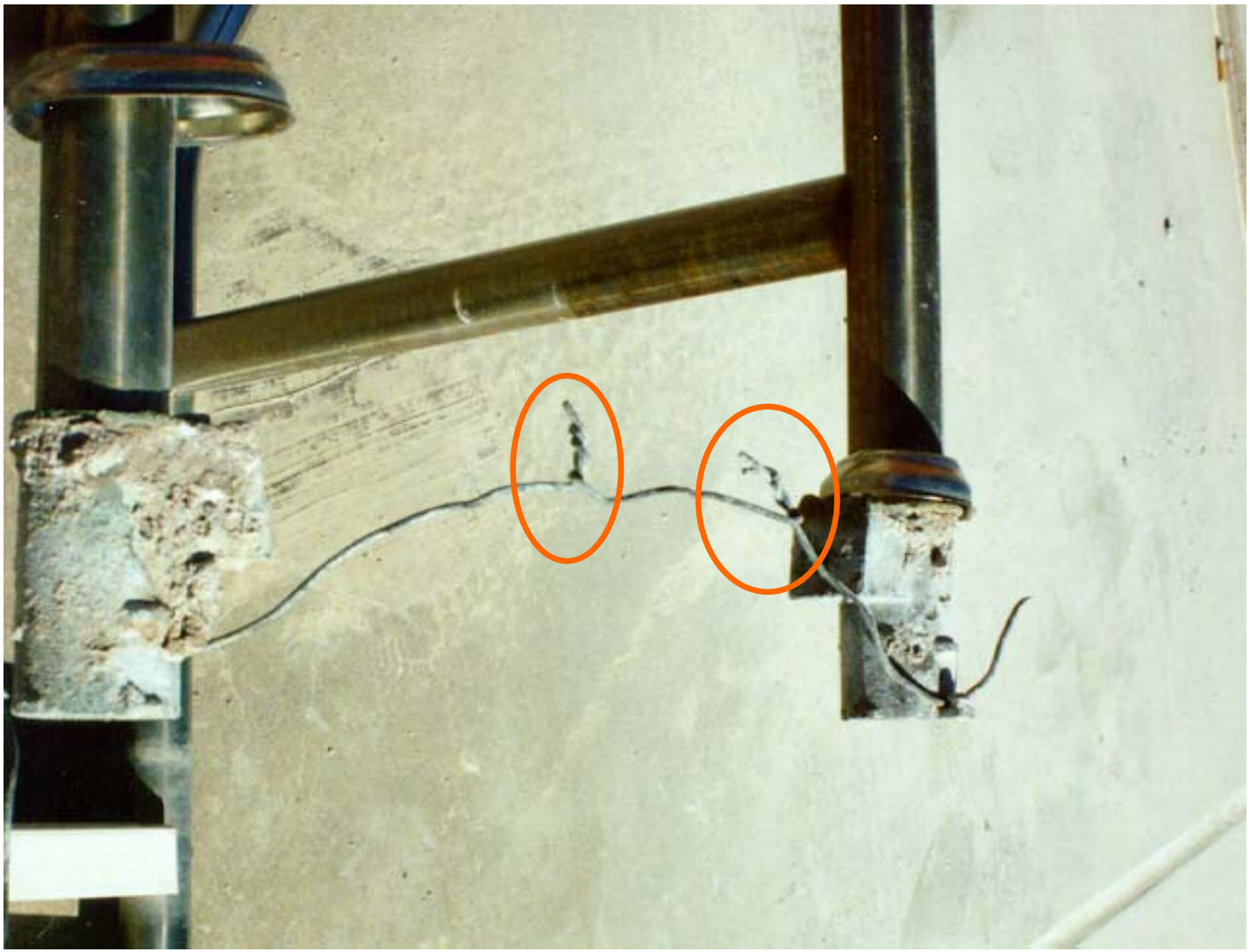
Disconnected bond wire

Improper, dangerous bond to filler pipe

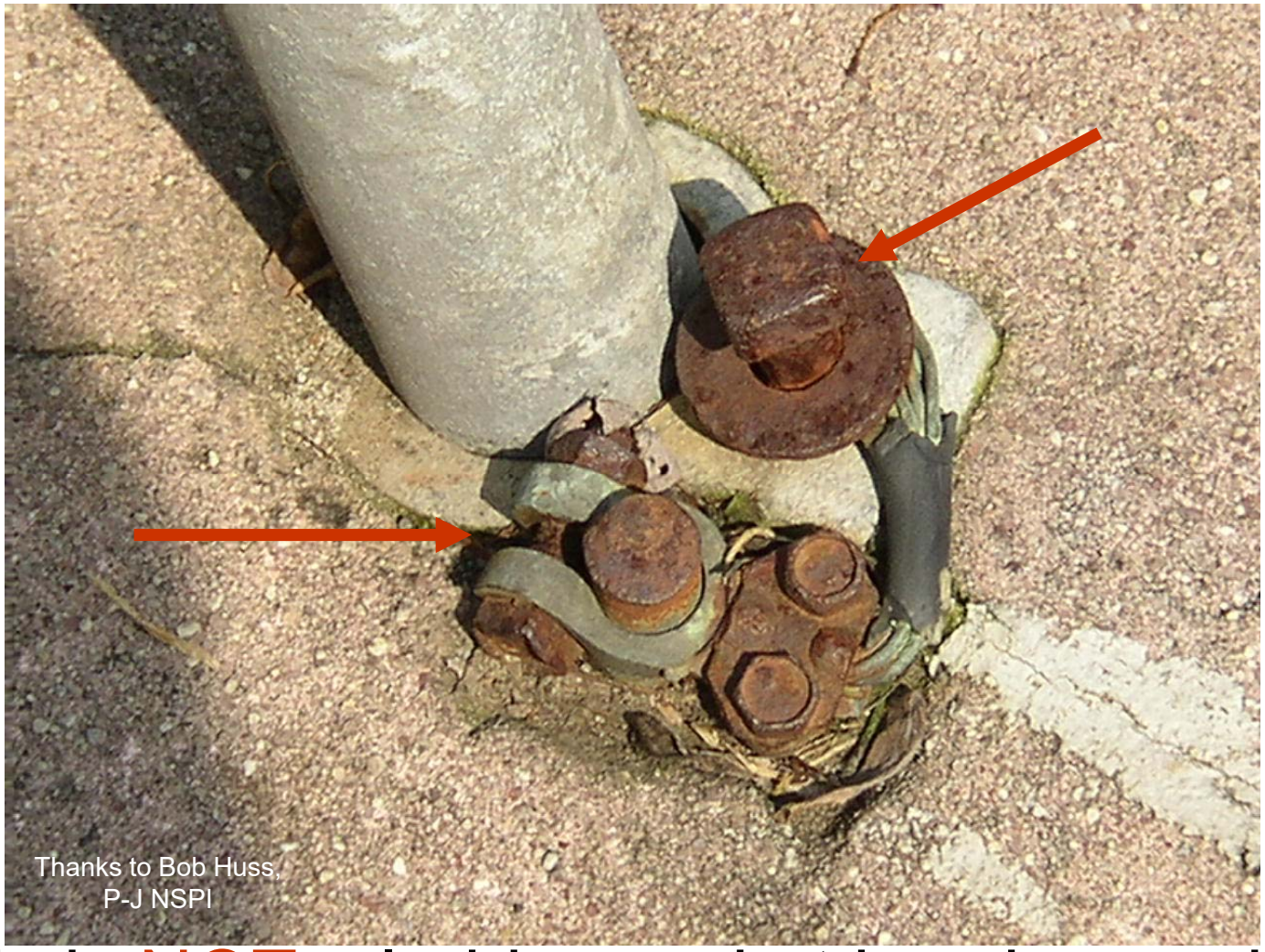
Improper bond to water pipe

J-box “Poster Child”

Check connections at ladder pockets



One of the best reasons to inspect *during* construction…THIS IS A “BOND” WIRE!!



This is NOT a ladder pocket bond, even if the bolt were tight! DO NOT USE A GROUND ROD IN PLACE OF A BOND. DO NOT USE A BATTERY CLAMP!

Here's the other pocket. Well, at least the guy was consistent…..

THIS IS UNSAFE!

Add-on plaster rings can eliminate bonds at the niche when the attachment is bad or if they don't contact the metal niche, PARTICULARLY IF THE NICHE HAS BEEN PLASTERED OVER!

If You Find *ANY* of These Hazards, They *MUST* be Repaired or Replaced

Safety Improvements For Older Pools & Spas - Bonding

- Repair and replacement of bond wires
  - Can get expensive
  - Surgical approach
    - **Use joints in concrete**
    - **Saw cut concrete deck where required**
    - **Lift coping tiles and reset**
    - **Cadwelding is usually cost-effective and preferable**

Grounding and Bonding Are Safety Systems - Purpose:

- Grounding System

  Shunts unwanted energy to earth ground.

  Makes breakers & GFCIs work correctly.

- Bonding Systems

  Maintain pool equipment and structure at equal potential (voltage) to reduce shock hazards

THEY ARE NOT THE SAME!

Remember...

Proper bonding and grounding are ABSOLUTELY CRITICAL for keeping stray currents out of the water

AND

bonding and grounding should be tested annually!

Upgrade To Meet Code

- Major modifications may require entire building to be upgraded.

- **When in doubt, check with the local inspector; a permit and inspection may be required! A licensed electrician may be required to do the repairs!**

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If You Find A Safety Problem

- **Easy** - Repair On The Spot.
- **Major** - Notify The Pool Owner In Writing.
- **Life-threatening & Extensive** - Shut Down and Lock Out The Pool. Notify The Owner In Writing.

Remember - Always Err On The Side Of Safety!!!!

If You See A Problem:

Tell The Pool Owner In Writing, AND Let Them Know How It Can Be Repaired.

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