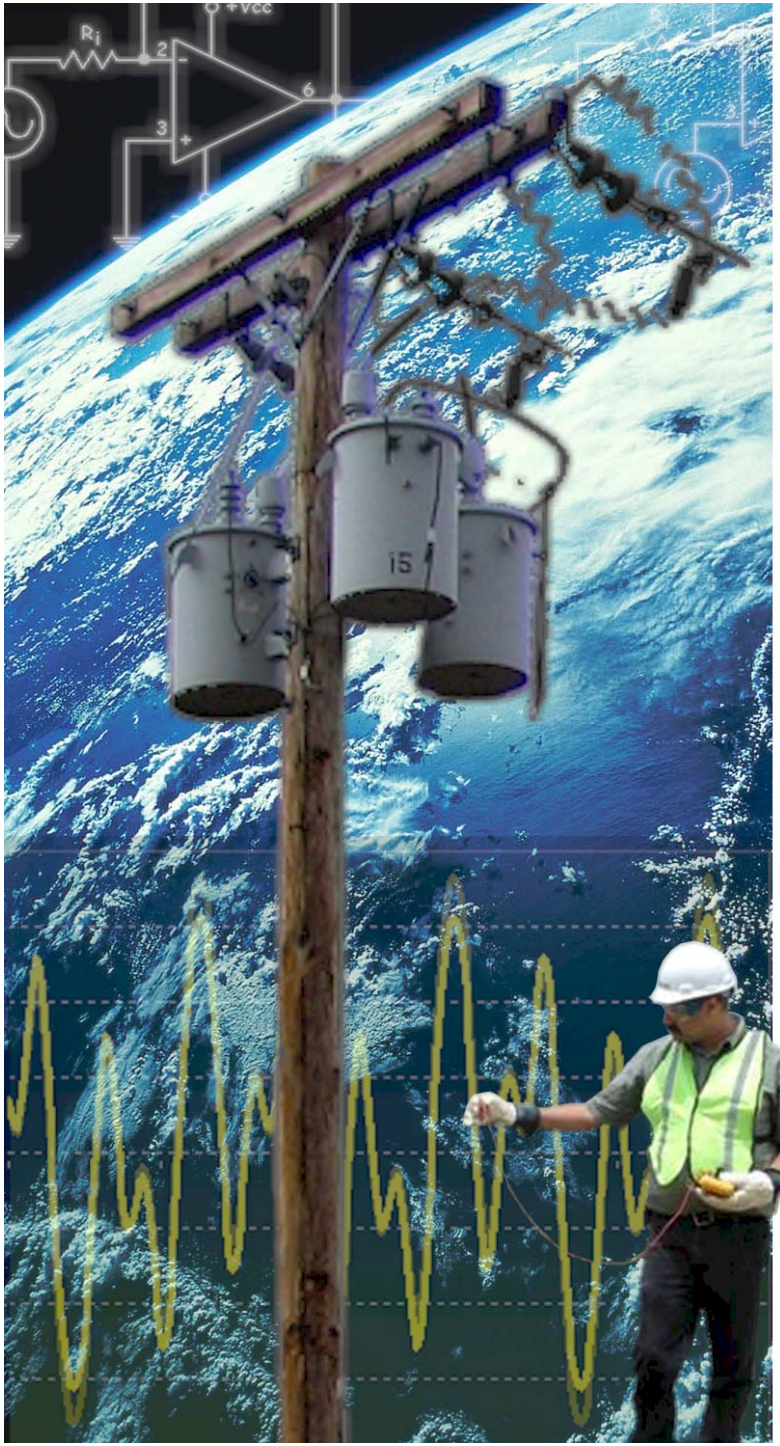


Project Update

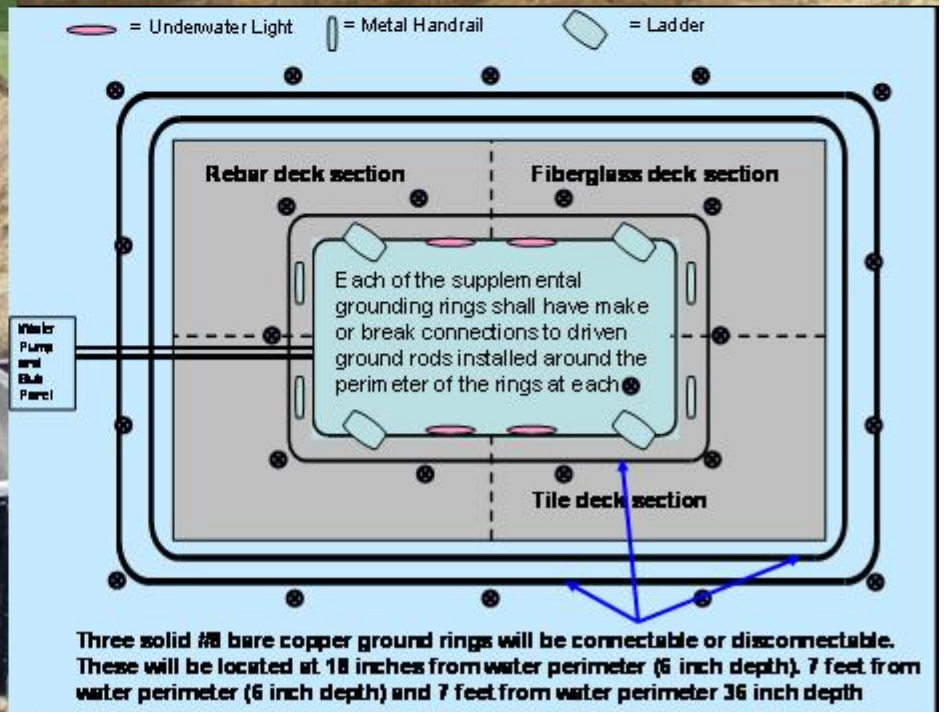
Evaluation of Grounding and Bonding Around Swimming Pools and Spas – May to September 2009

Discussion Topics

- Review of the Objectives and Pool Construction Plan (nice photos!)
- Review of Test Plan
  - NEV test plan
  - Fault test plan
  - Input from Team to refine test plans
- Photos and preliminary results from this weeks testing
- Follow-on test schedule

Swimming Pool Testing to Be Conducted at the EPRI Lenox, MA Outdoor Test Facility

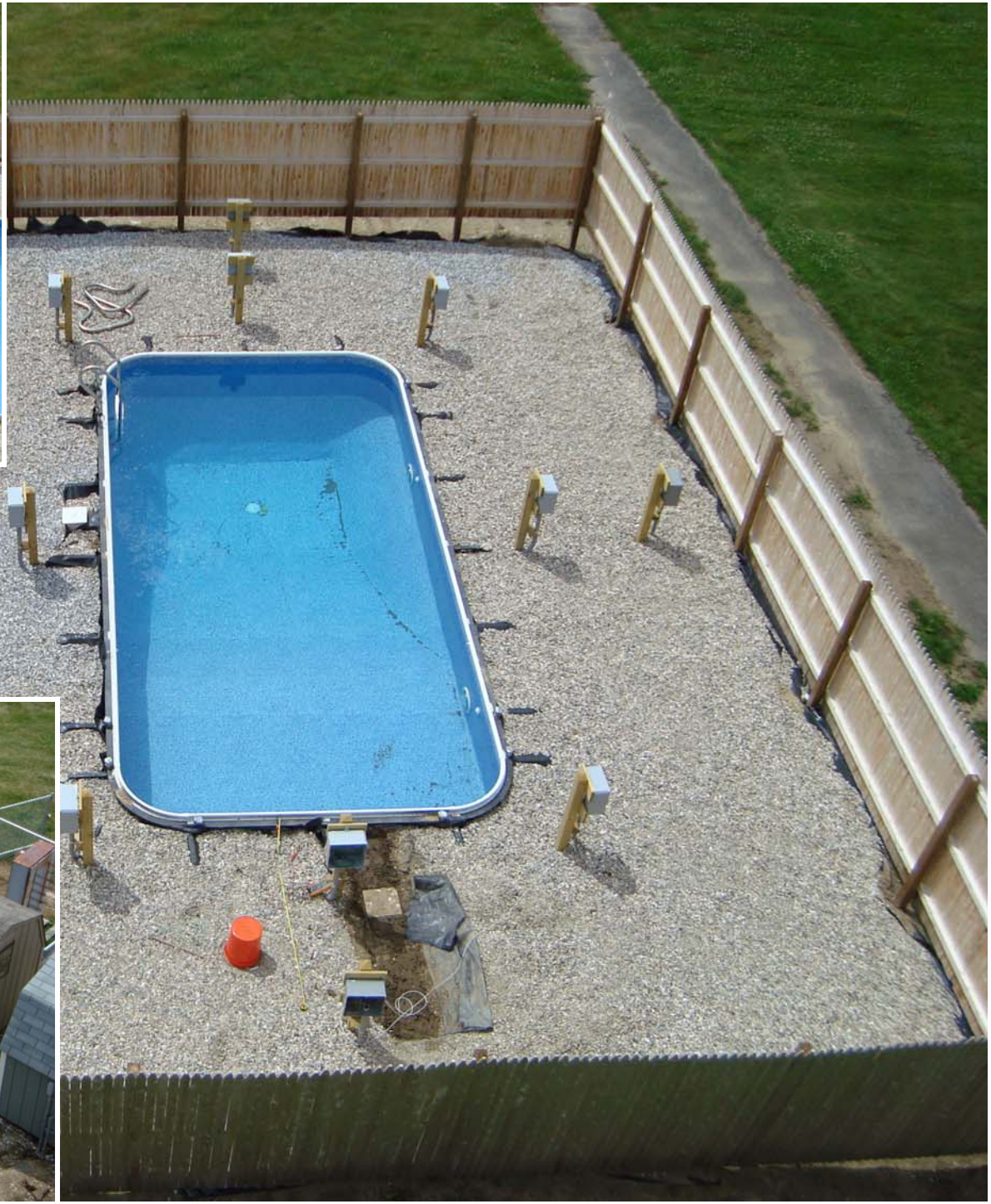
To support the project objectives, we have constructed a controllable test area at the Lenox, MA facility
Can vary: Distribution Configurations, Neutral impedances, grounding configurations, NEV sources....

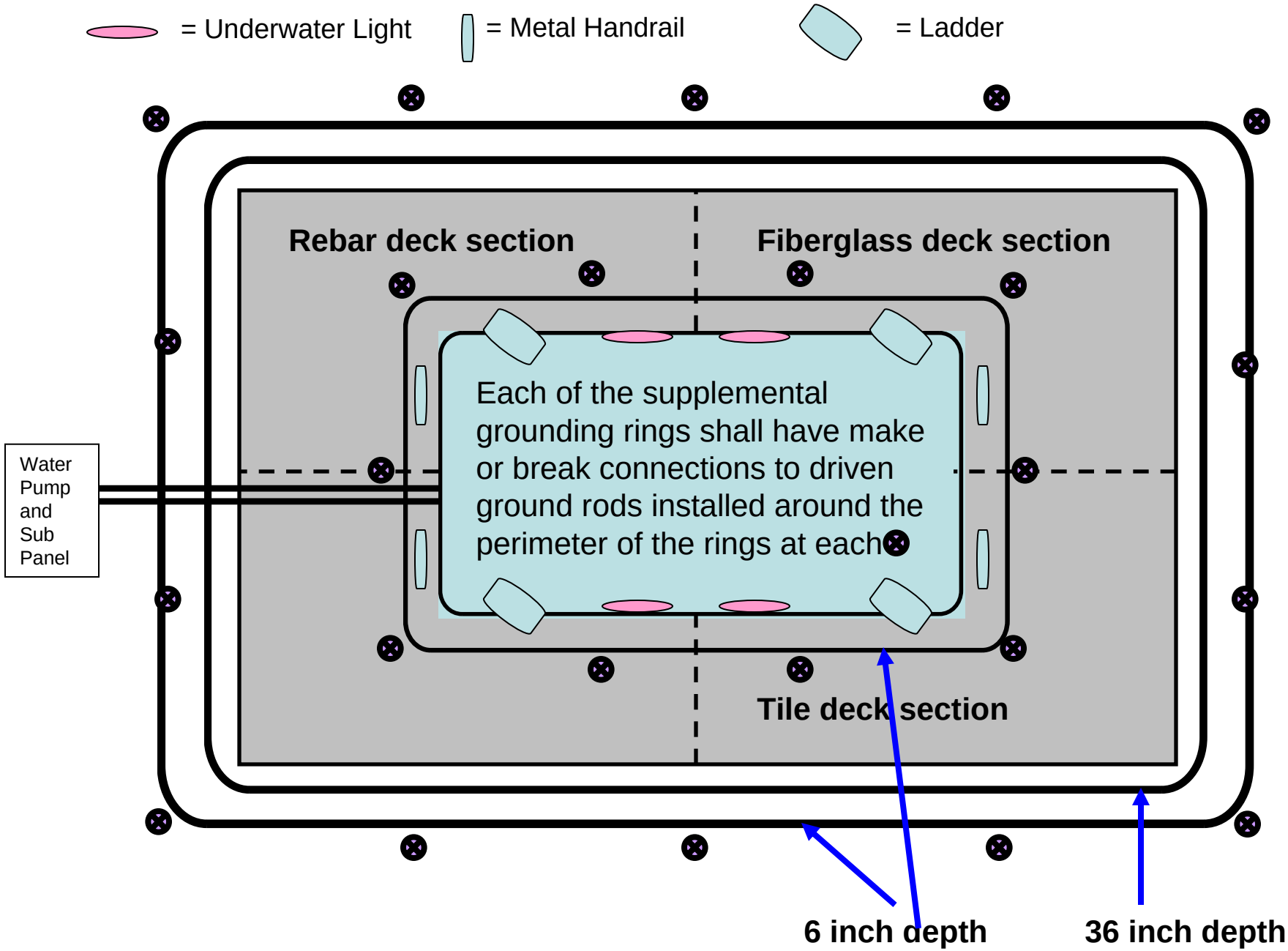


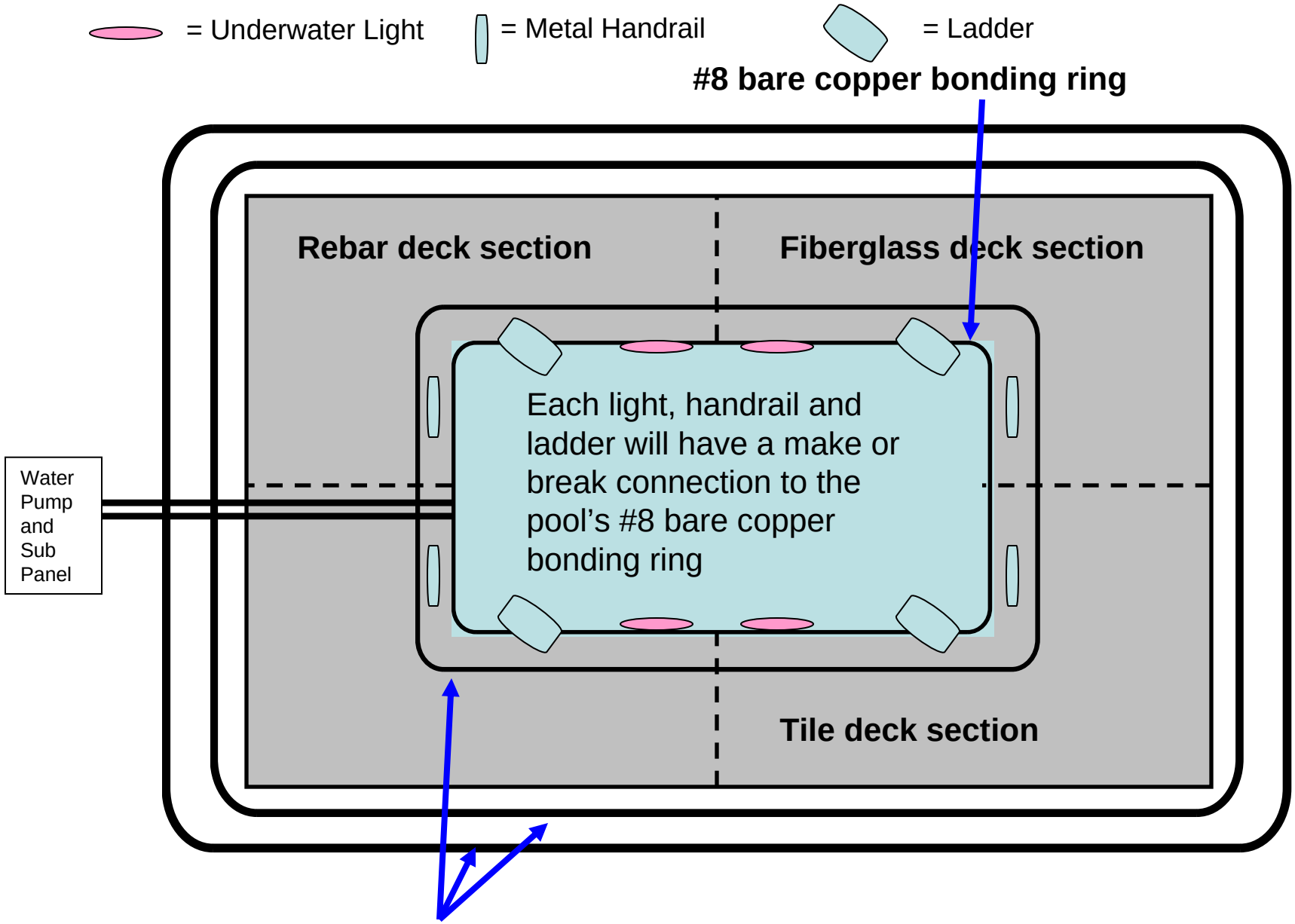

20 Simulated Residences and Variable NEV Source
from Overhead and Underground Distribution

Over 300 photos were taken during pool construction. These are available to the team either on CD or via the EPRI FTP site

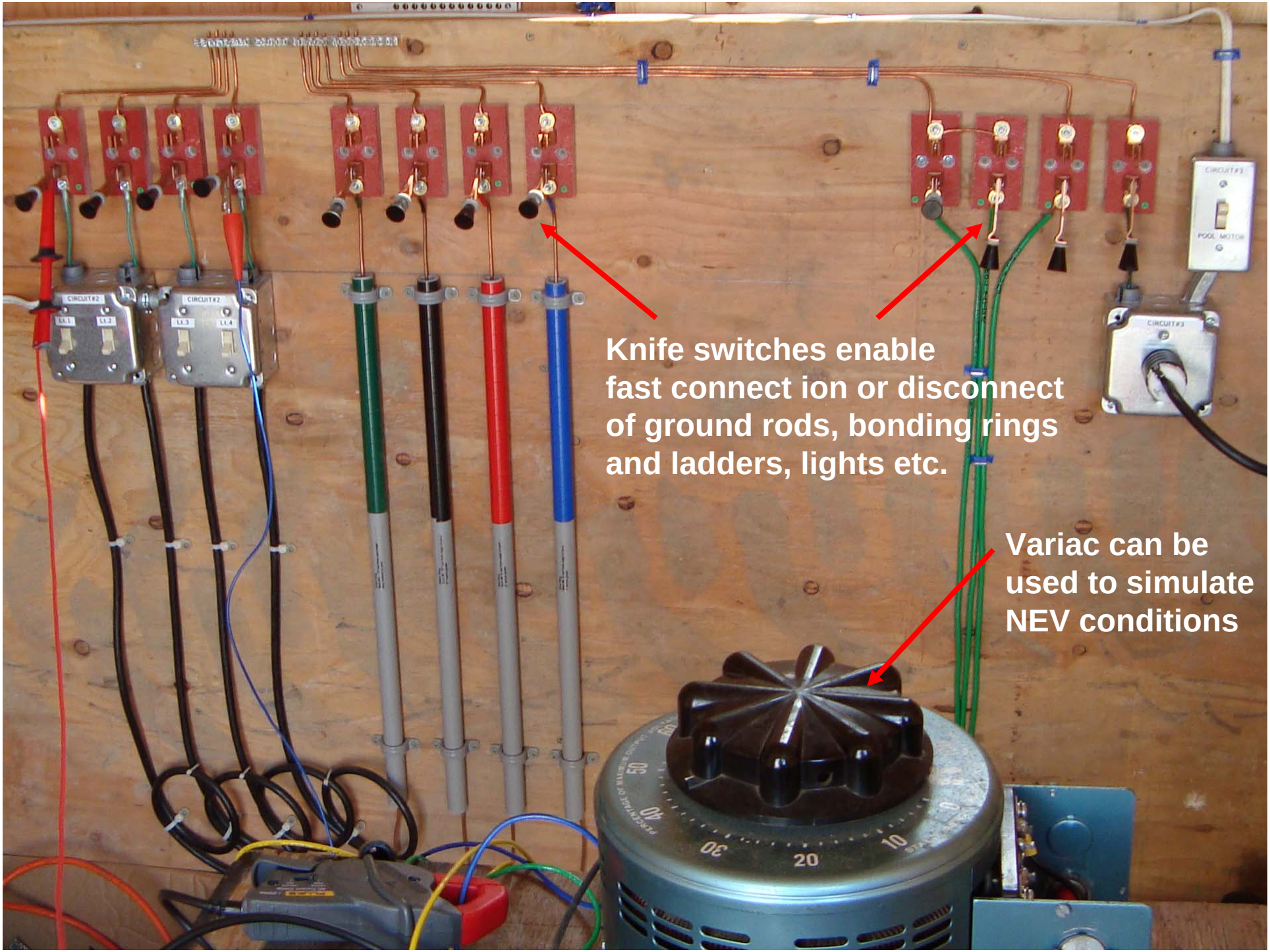
Wet Area will have #8 bare solid copper bonding ring around shell. Each ladder, light, and handrail will be connectable at a corner service box




= Underwater Light
= Metal Handrail
= Ladder
Rebar deck section
Fiberglass deck section
Each of the supplemental grounding rings shall have make or break connections to driven ground rods installed around the perimeter of the rings at each
Water Pump and Sub Panel
Tile deck section
6 inch depth
36 inch depth

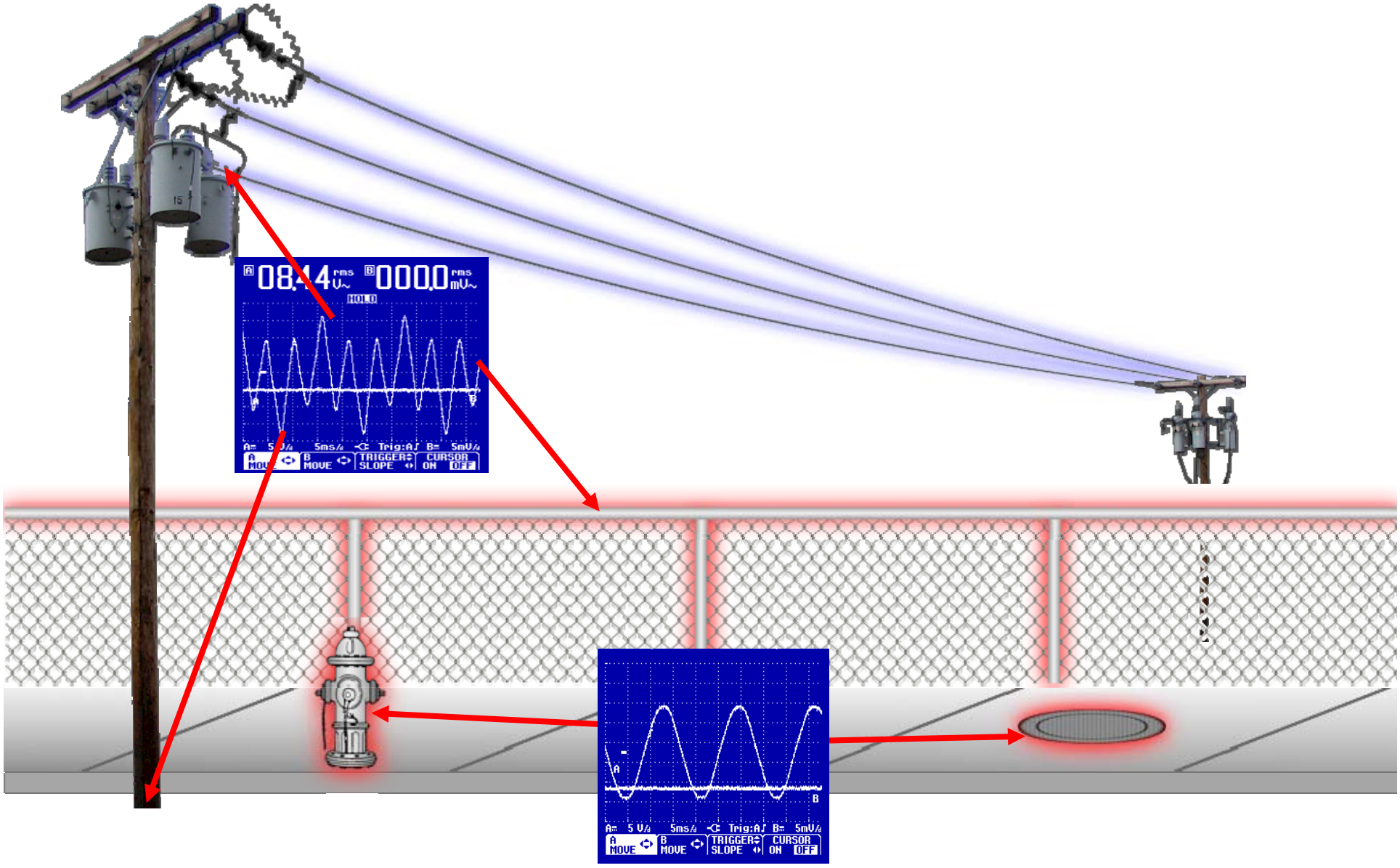


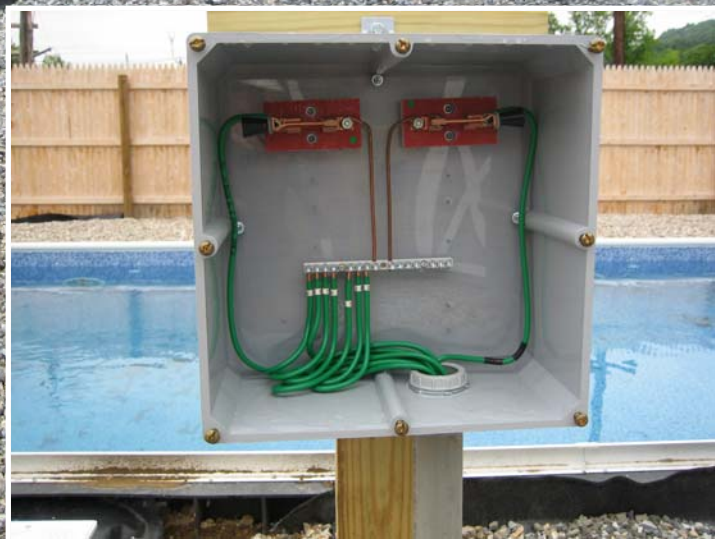
Three solid #8 bare copper ground rings will be connectable or disconnectable. These will be located at 18 inches from water perimeter (6 inch depth). 7 feet from water perimeter (6 inch depth) and 7 feet from water perimeter 36 inch depth


Knife switches enable fast connect ion or disconnect of ground rods, bonding rings and ladders, lights etc.
Variac can be used to simulate NEV conditions


ON
OFF
New Water

Can Energize Pool Water with Faults, NEV from Pole Down Grounds or Induced Sources

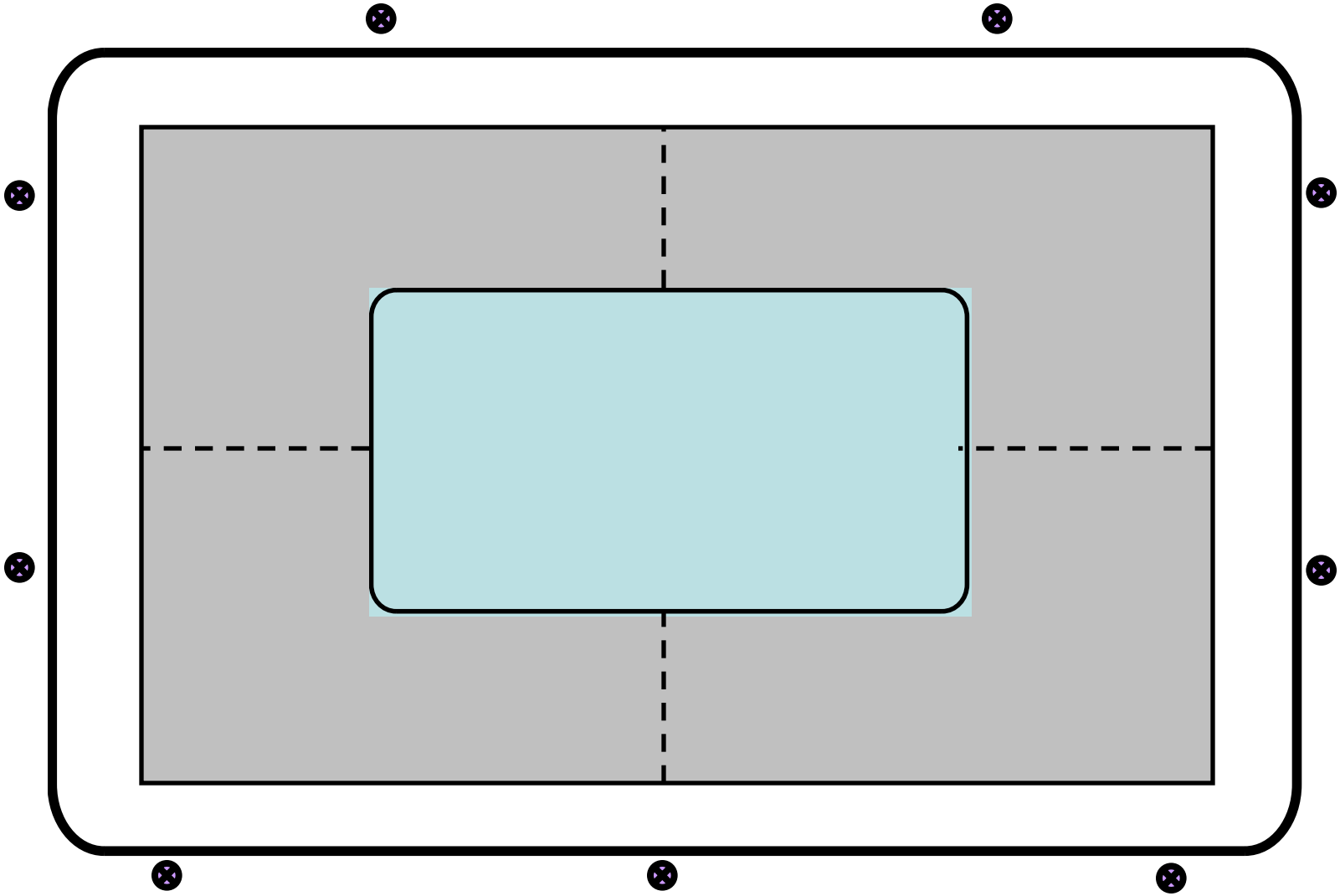




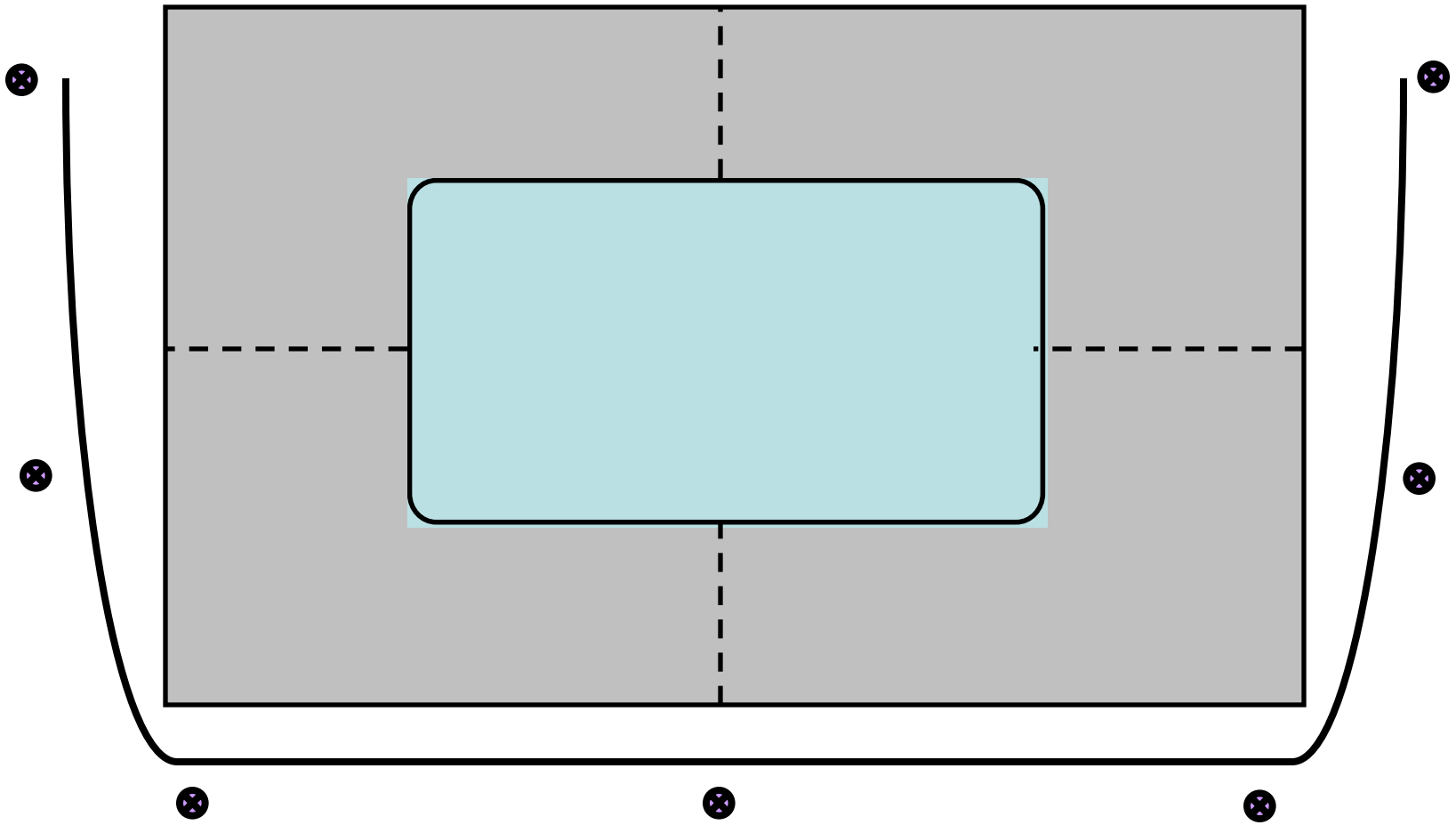
Discussion Topics

- Effect of inner ring vs outer ring
- Effect of ring combinations
- Effect of vertical vs angled ground rods
- Effect of multiple ground rods
- Effect of horseshoe vs full ring
- Effect of depth of ground ring
- Effect of load resistor
- Follow on test schedule

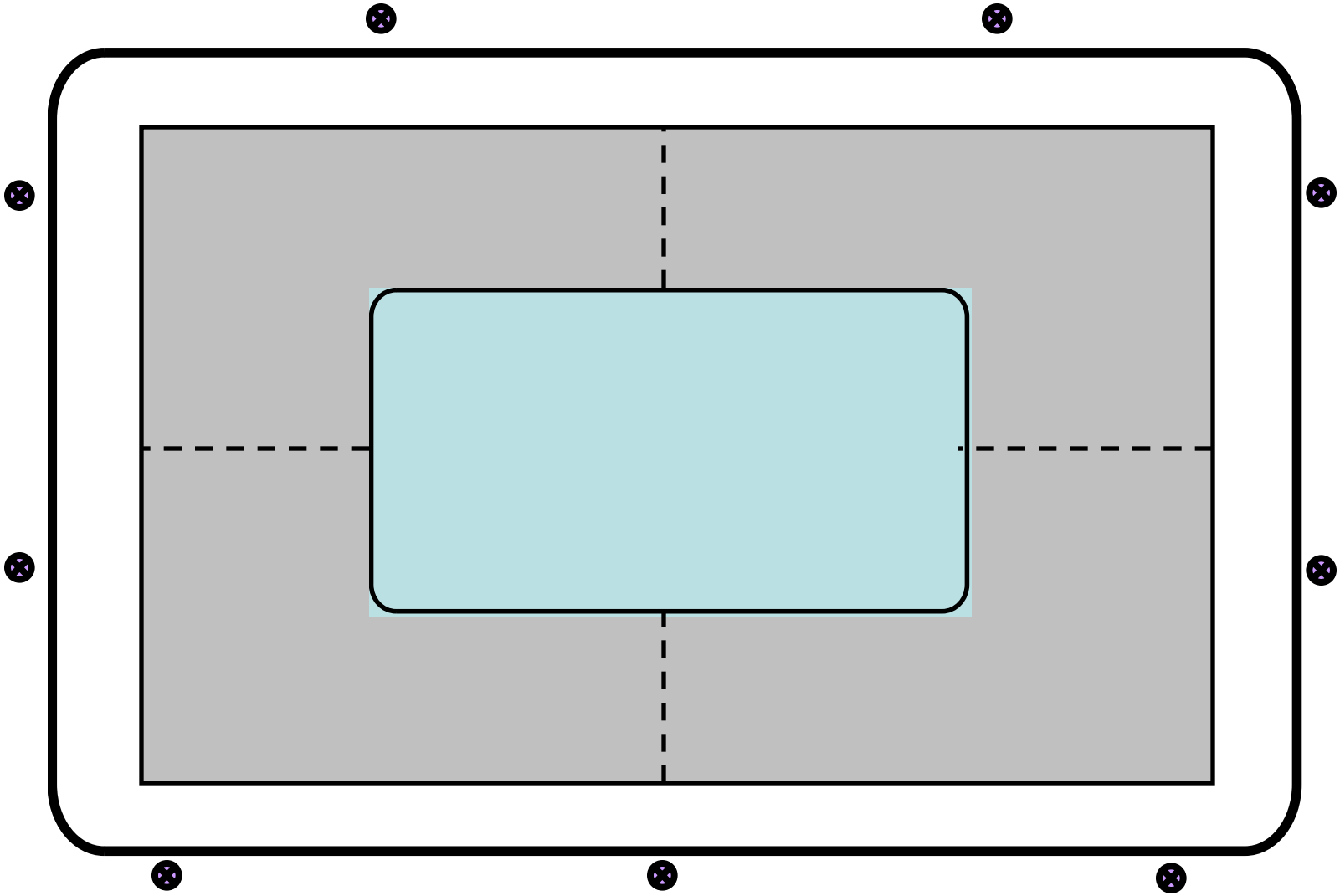
Outer Ground Ring Reduces Voltage Around Pool Area by 50% to 60% and each ground rod adds another 1% to a max of 70%



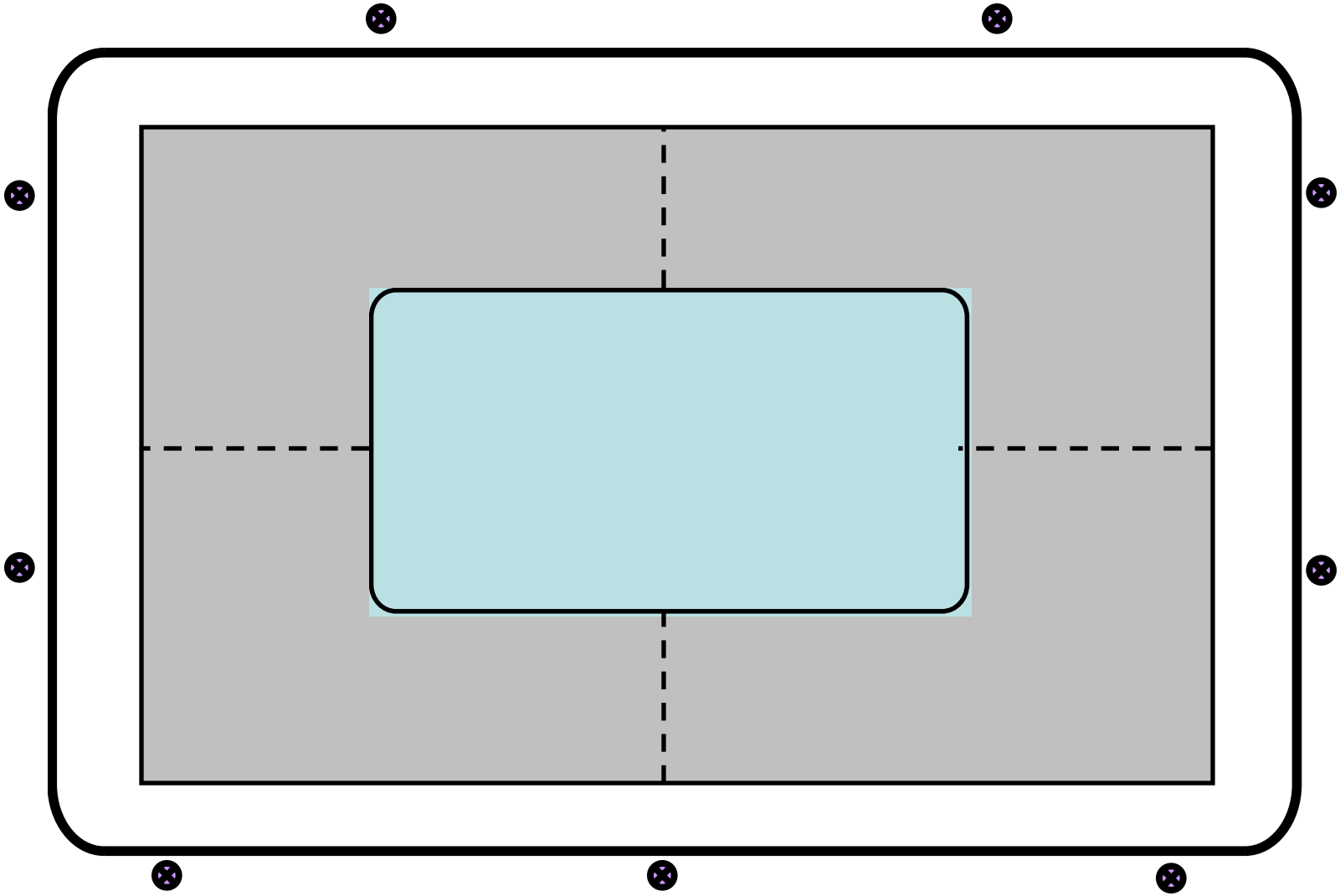
A horseshoe configuration works well for NEV (approx 5% less effective than a full ring!). But does not help on the side where the horseshoe does not come around. Note that 8 foot ground rods spaced less than 16ft apart have minimal effectiveness!



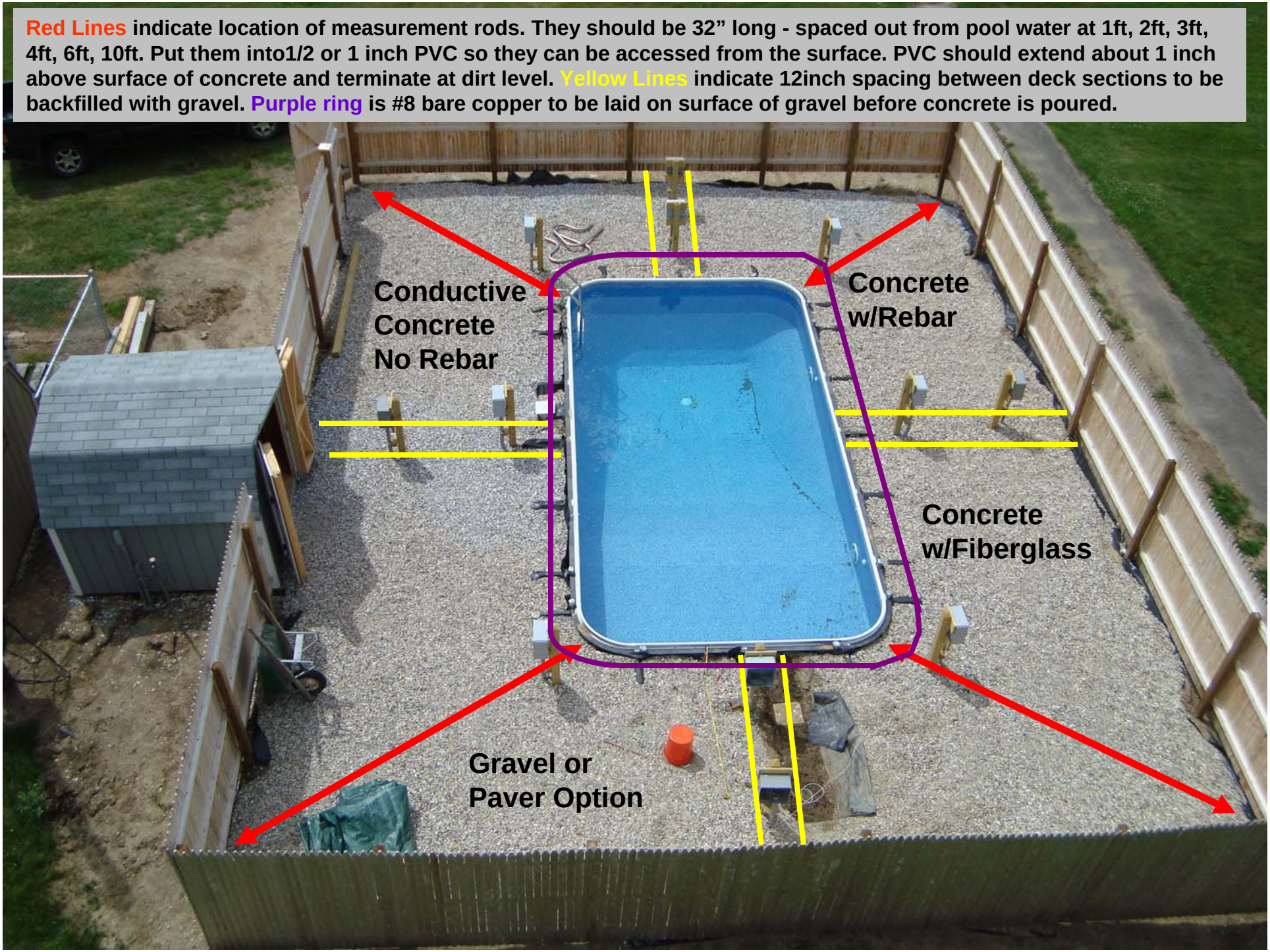
Two outer ground rings buried 8 ft from pool edge at 6 inches (depth) and 3 feet (depth) adds another 6% to 16% Improvement compared to just one ring (deeper rod is better)



Ground rods driven straight down (vertically) are slightly more effective than ground rods driven at an angle toward the pool surface



Red Lines indicate location of measurement rods. They should be 32” long - spaced out from pool water at 1ft, 2ft, 3ft, 4ft, 6ft, 10ft. Put them into1/2 or 1 inch PVC so they can be accessed from the surface. PVC should extend about 1 inch above surface of concrete and terminate at dirt level. **Yellow Lines** indicate 12inch spacing between deck sections to be backfilled with gravel. **Purple ring** is #8 bare copper to be laid on surface of gravel before concrete is poured.



Fault Test Plans

Evaluation of Grounding and Bonding Around Swimming Pools and Spas – August 2009


23,000 V Overhead Line
~800 feet
23-kV Feed from Utility
23-kV
Substation
23-kV to
4160 V
stepdown
bank
Stray Voltage
Test Structure
4160 V Overhead Line
~1200 feet

Source
XF

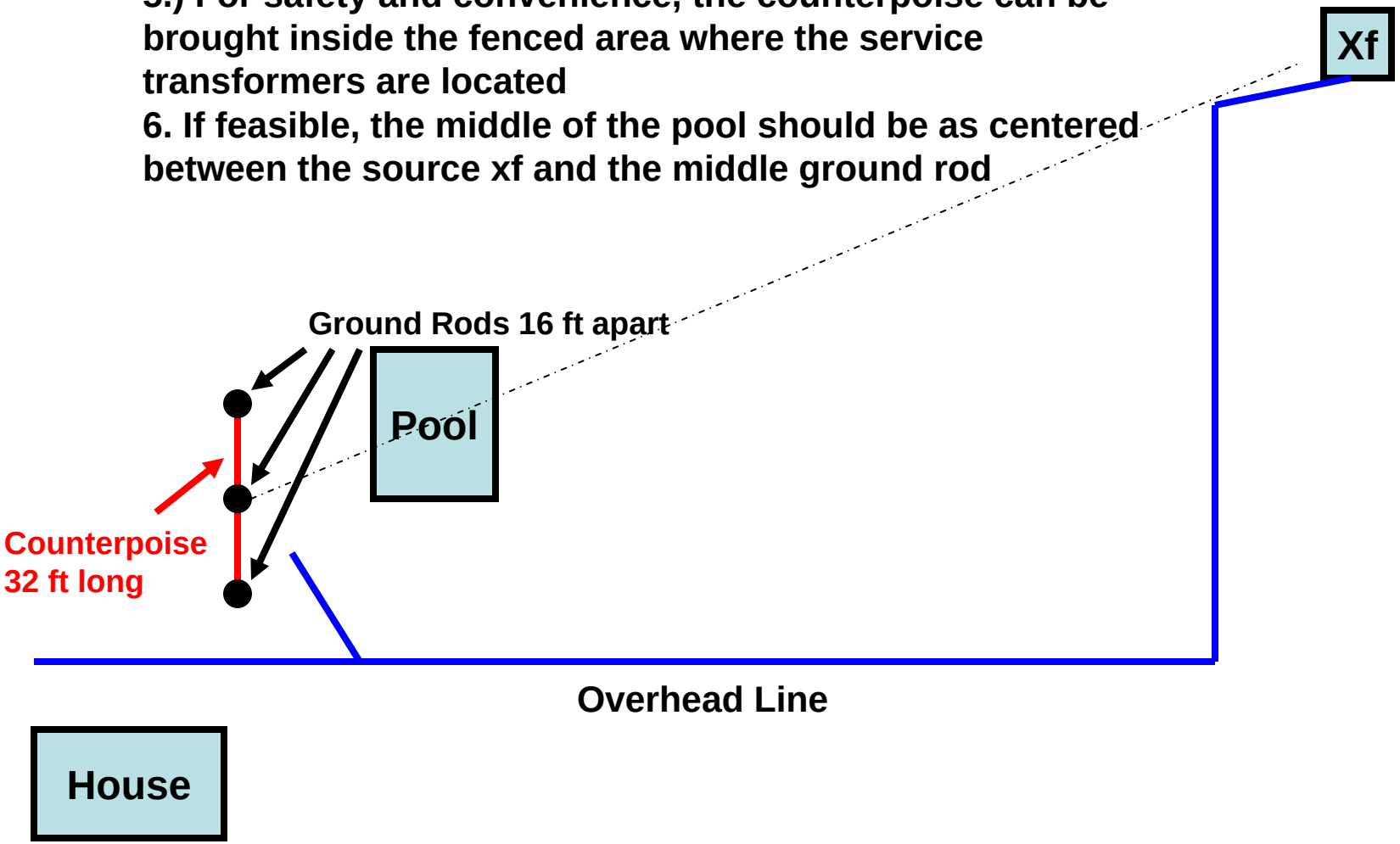
Overhead Line

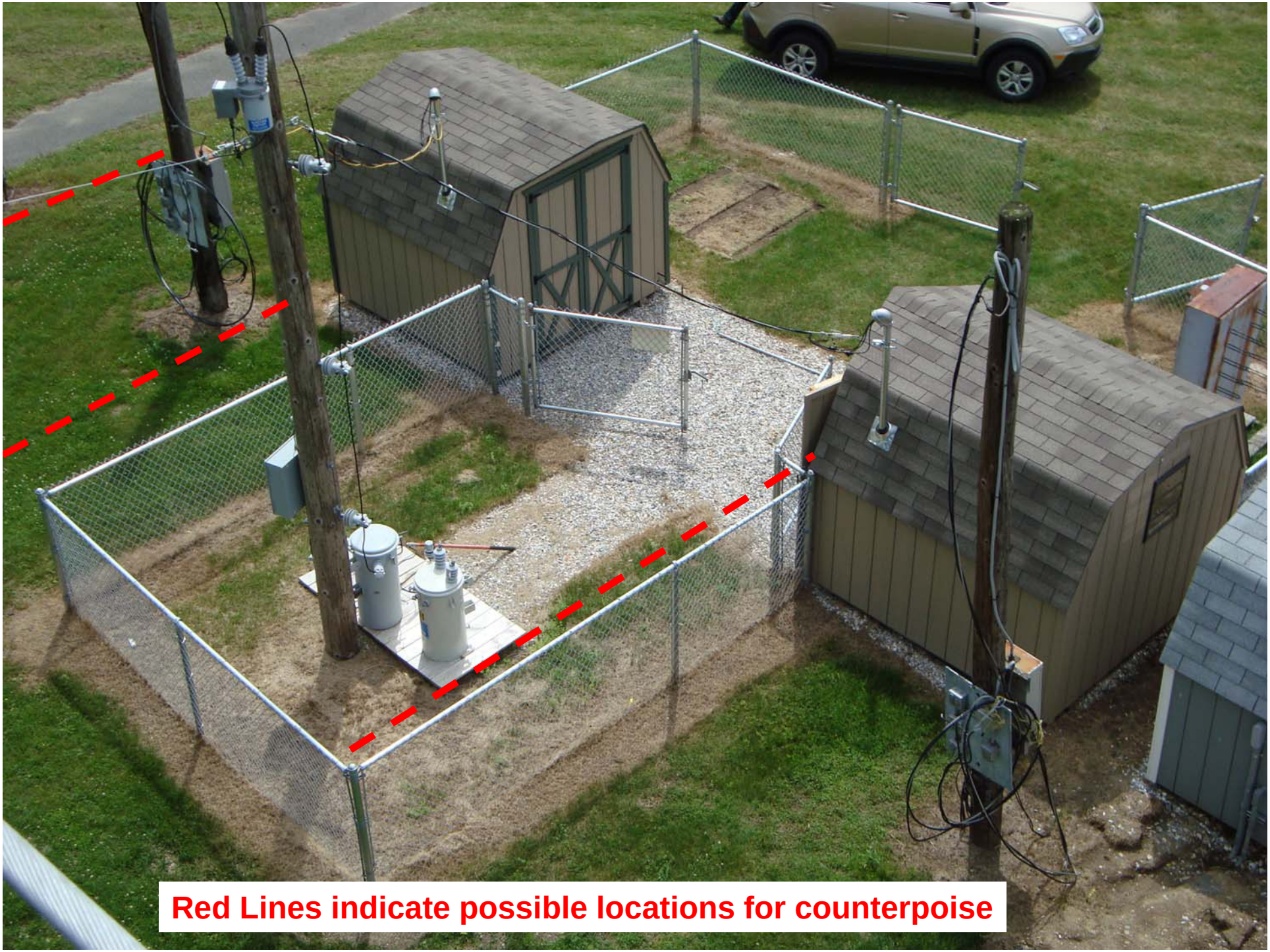
Fault
Point 1

Remote
Fault Point 2

EMI
House

1.) Red Line indicates location of trench for counterpoise
2.) Specifications: 1 ft deep, 1 ft wide, 32 ft long
3.) In the center and at each end, there will be one 8ft vertically driven ground rod clamped on to the counterpoise
4.) The preferred wire size for the counterpoise is #4 copper
5.) For safety and convenience, the counterpoise can be brought inside the fenced area where the service transformers are located
6. If feasible, the middle of the pool should be as centered between the source xf and the middle ground rod




Red Lines indicate possible locations for counterpoise