# MIT Research Reactor

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## MITR Cathodic Protection System Upgrade

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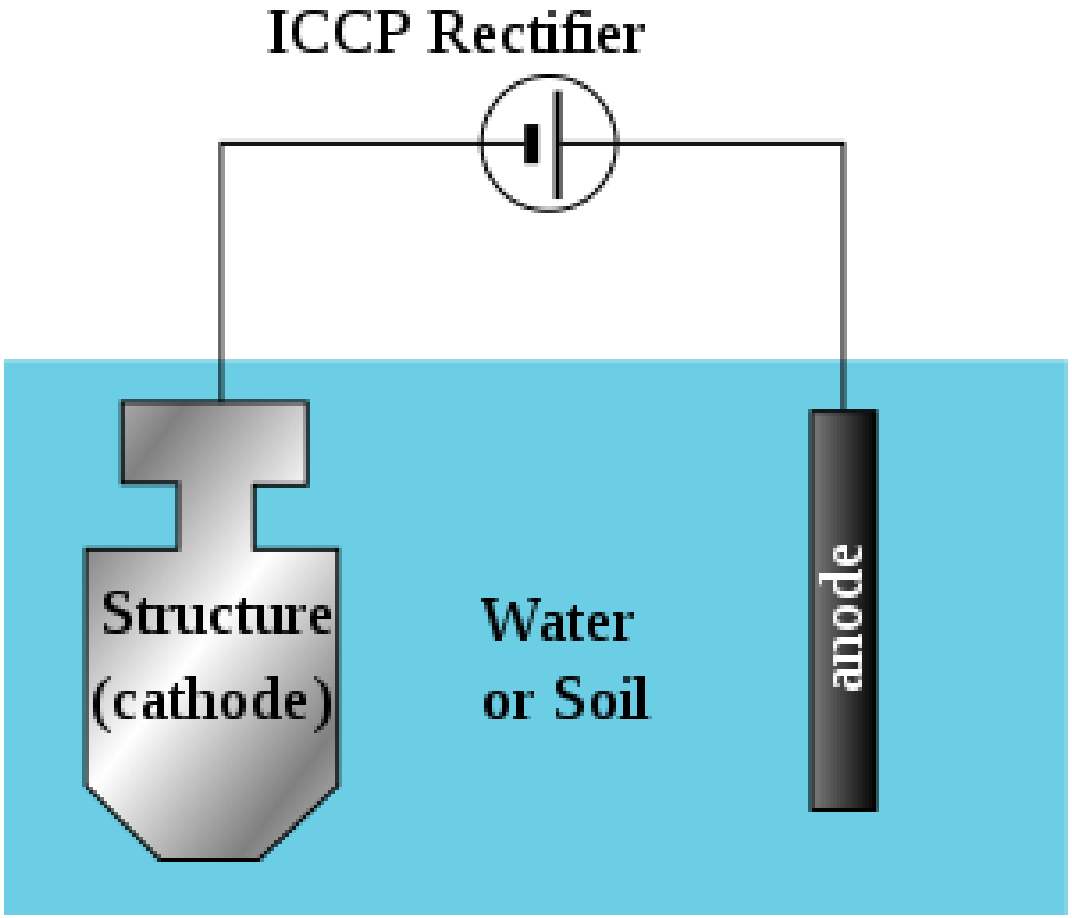
# Discussion Topics

- Cathodic Protection to Prevent Corrosion of Containment Building
- Comprehensive Engineering Evaluation
- Installation
- Standards and Results

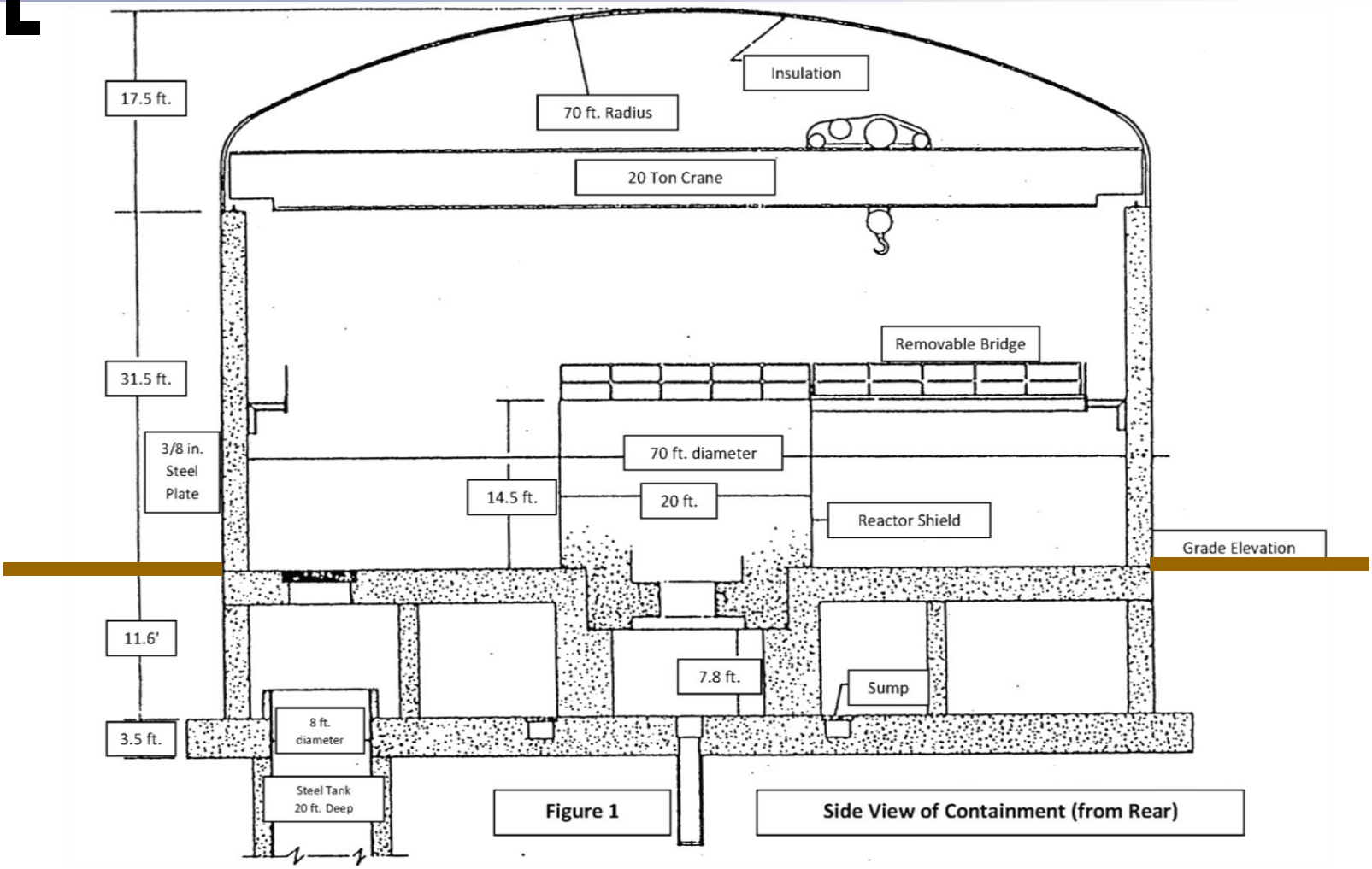
# Cathodic Protection to Prevent Corrosion of Containment Building

- Buried metal is subject to corrosion – and hard to paint!
- Four naturally-occurring factors of corrosion
  - Cathode
  - Anode
  - Metallic path
  - Electrolyte (usually moisture in the environment)
- Removing any one of the factors will stop corrosion
- Cathodic protection prevents corrosion by applying a competing DC electrical current to the underground surface of the structure to be protected

# Cathodic Protection to Prevent Corrosion of Containment Building



# Cathodic Protection to Prevent Corrosion of Containment Building



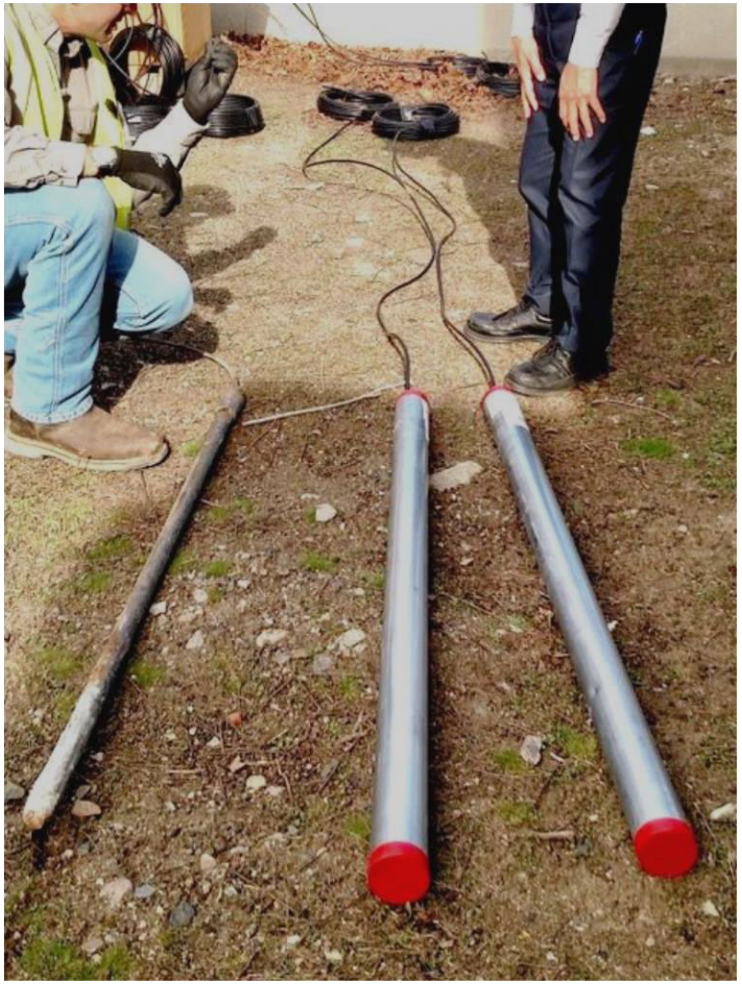



- MIT Reactor containment building has ~3600 square feet of buried steel surface

# Engineering Evaluation

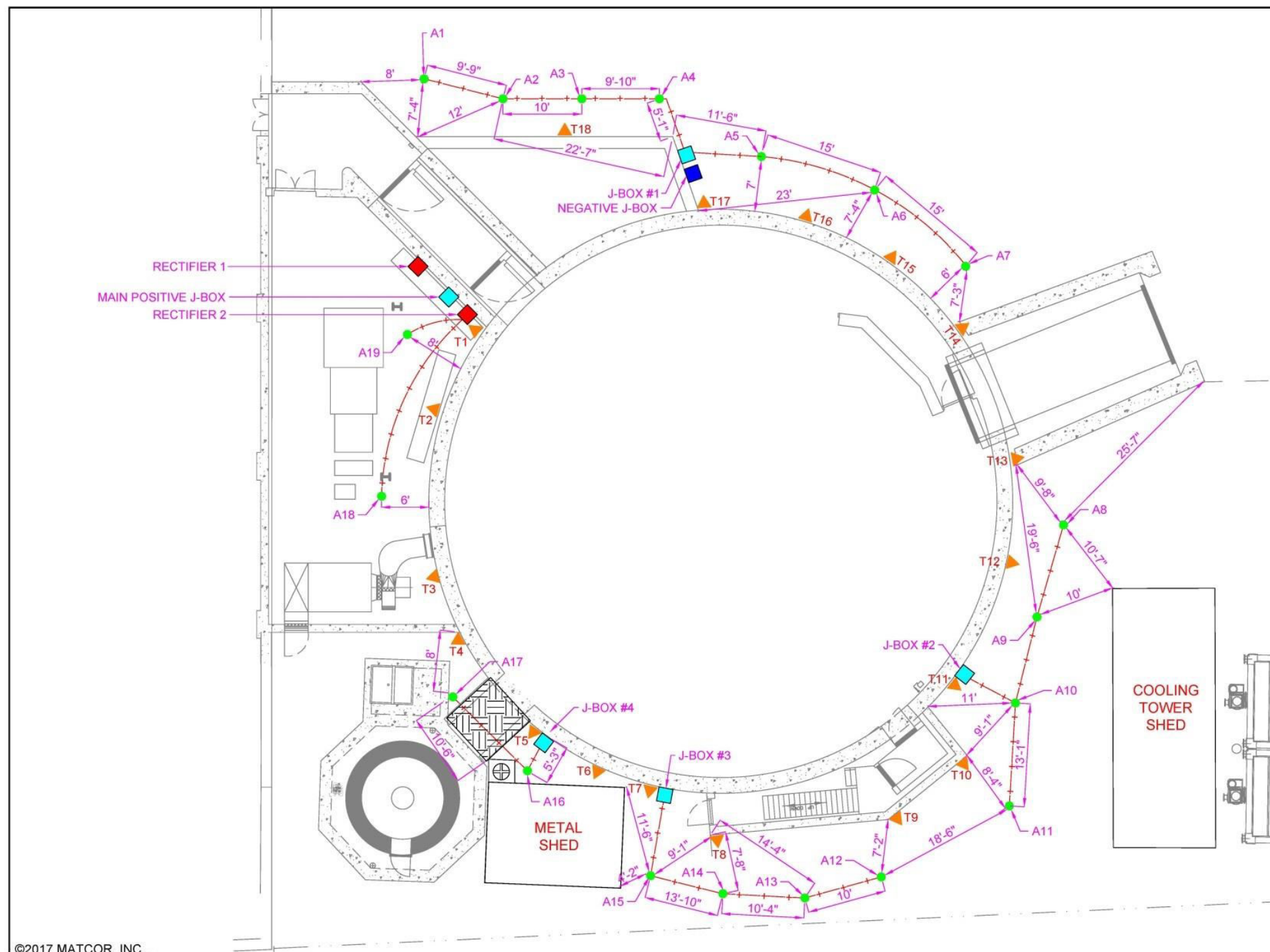
- Last upgrade was in 1992, with six anodes, and a 30 $V_{DC}$, 8 amp rectifier
- System was rated for 20 years
- Anodes subject to aging
- Electrical leads had been damaged or broken by weathering, snow removal, or excavation work

# Engineering Evaluation



# Engineering Evaluation

- New design criteria:
  - 2 mA per square foot, for 3600 square feet of buried surface
  - Must account for nearby buried metal structures such as the reactor's secondary system piping
  - Must counter uneven current distribution along the containment shell
  - Starting assumption is therefore a 20 amp rectifier
- 19 anodes, with two new locations indoors
- Drill holes 8 inches in diameter, 15 feet deep;
  evenly spaced, at least 6 feet from the containment shell
  - 4 of the anodes are 20 feet deep, to cover 20-foot deep SFP
  - Some holes had to be created by vacuum excavation only



# Two Air-Cooled Rectifiers

- Rectifier #1 (30 $V_{DC}$) provides current to anodes 1 through 15, which have low resistance to earth
- Rectifier #2 (80 $V_{DC}$) provides current to anodes 15 through 19, which all have high resistance to earth

# Six Junction Boxes

- One main positive box, one negative box, four auxiliary
- Variable-slide resistors added for 11 of the 19 anodes to balance anodes' output for an even current distribution


# 19 Mixed Metal Oxide Anodes

- Titanium electrode with mixed metal oxide coating, housed in a steel canister packed with graphite
- 3 inch diameter, 5 feet long, 5 amp output capacity

# Installation

- After 3 years planning, installation was completed in two weeks

# Installation

- Vacuum excavation truck  (not as noisy as we expected)

# Installation

- Augur truck  (drills faster, but too bulky for some spaces)

# Installation

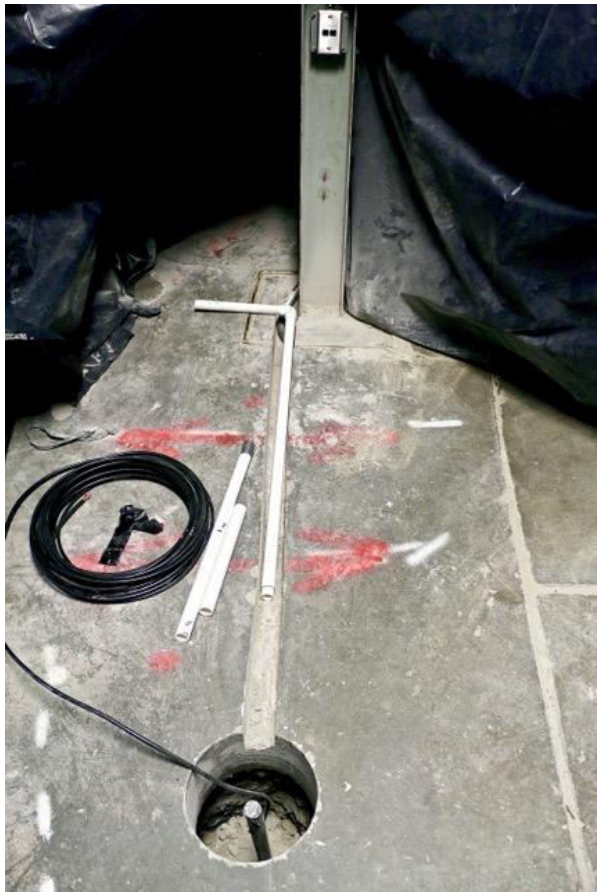
- Anode header wires run 18" below ground to junction boxes

# Installation

- Small amount of soil is left after holes are back-filled with coke breeze, and then soil for the top few feet

# Installation

- Dust control tent for cutting and vacuum excavation indoors



# Installation

- Cleanup and restoration of ground surface

# Installation

- 18 measurement points for structure-to-soil potential

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# Standards and Results

- Applicable standard is NACE International Standard SP0285-2011 Corrosion Control of Underground Storage Tank Systems by Cathodic Protection
- Optimal condition is negative potential of at least 0.850 $V_{DC}$
- Corrosion has been significantly mitigated, with polarized potential ranging from -0.530 $V_{DC}$ to -1.093 $V_{DC}$
- Polarization result ranges from 0.196 $V_{DC}$ to 0.617 $V_{DC}$ at the 18 test points
- The CP system polarized the containment shell and surrounding metal structures by a minimum of 0.196 $V_{DC}$ after 12 hours of 20-amp application. The system will continue to polarize further with time, and will be re-measured after a year.

# Concluding Material

- Questions & Answers