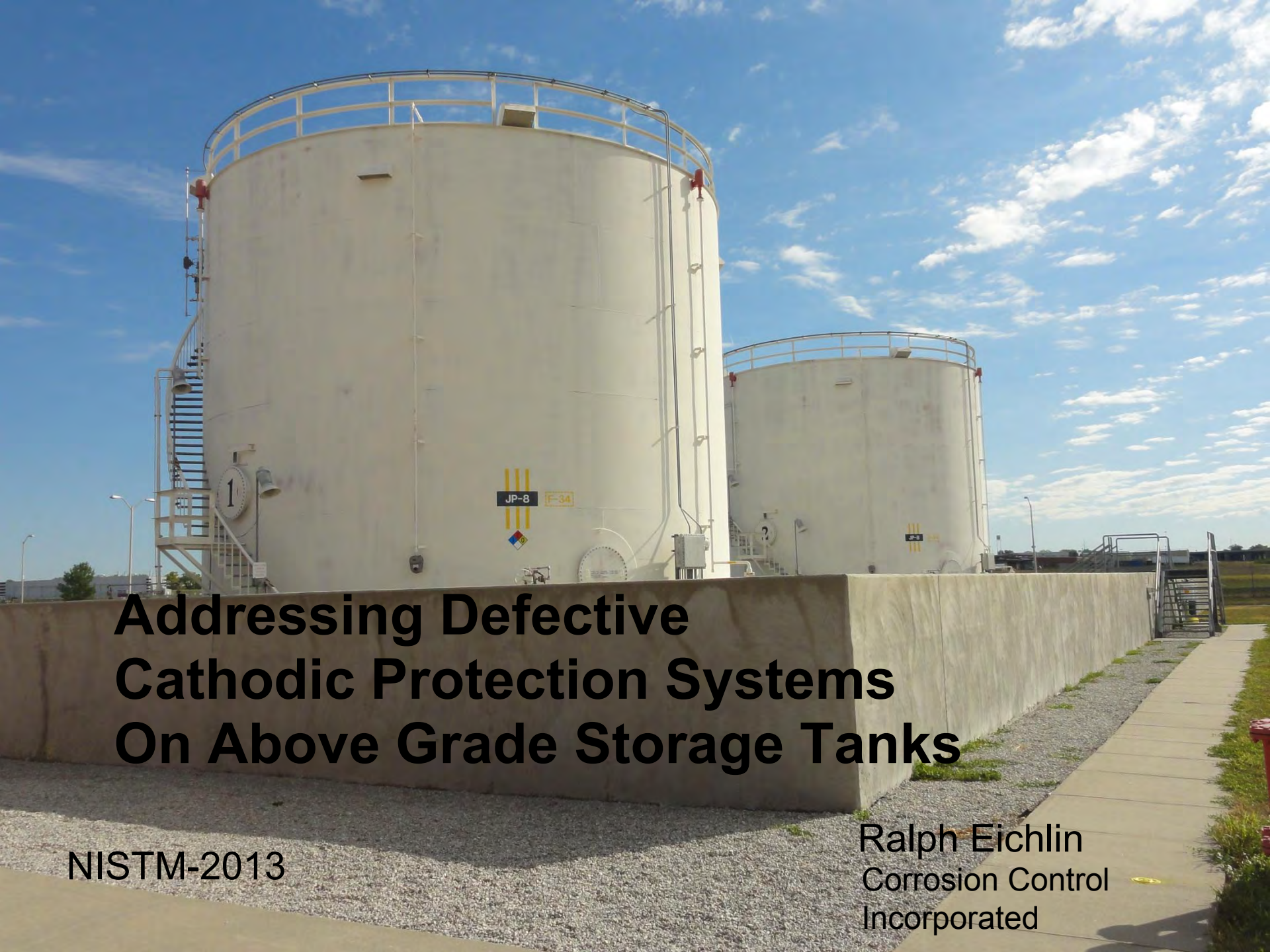

Addressing Defective Cathodic Protection Systems On Above Grade Storage Tanks

NISTM-2013

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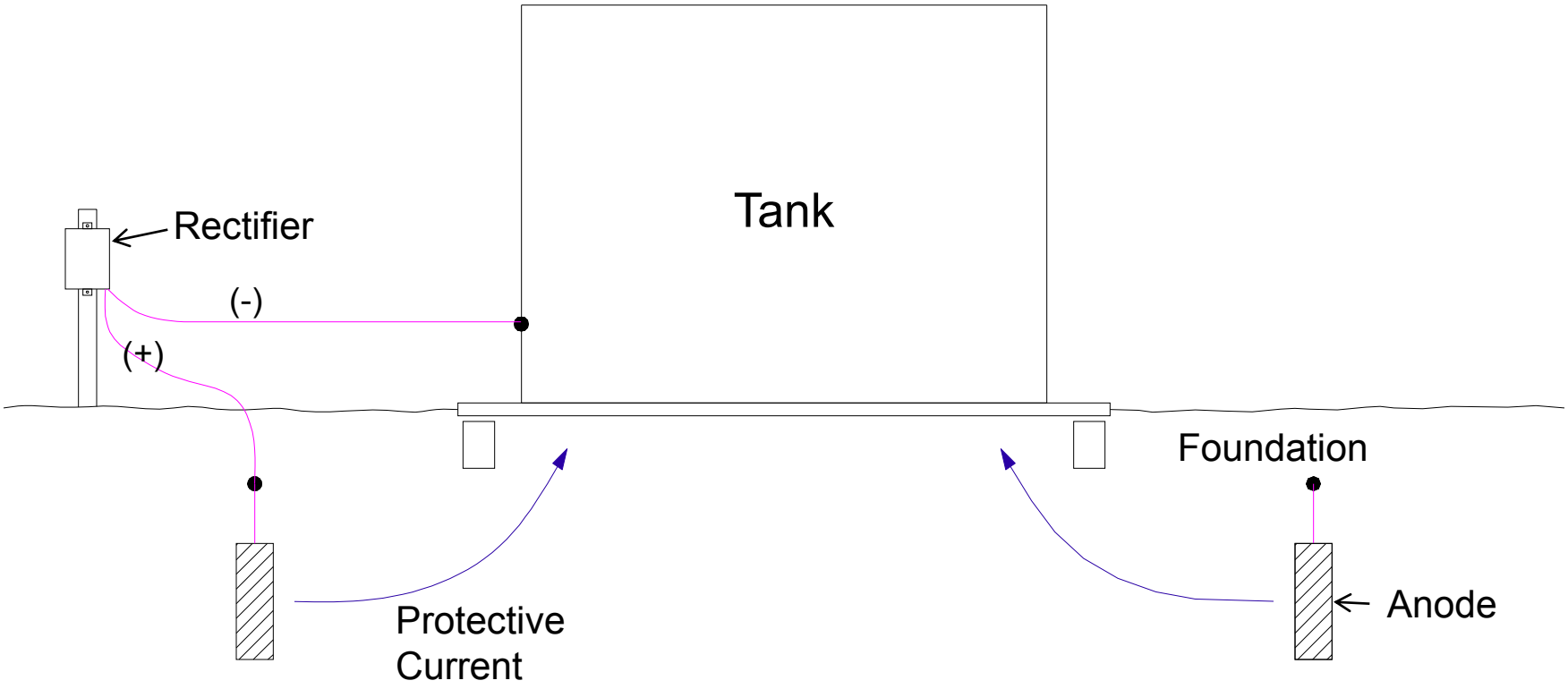
Cathodic Protection Systems

- Cathodic protection is used to control corrosion on the underside (soil side) of above grade petro-chemical tanks
- Effective cathodic protection will increase reliability and reduce costs associated with maintenance and inspection
- Several states, the DOT and the DoD require the use of cathodic protection to reduce product release

Cathodic Protection Types

- Galvanic
- Impressed Current

Single Bottom Storage Tanks

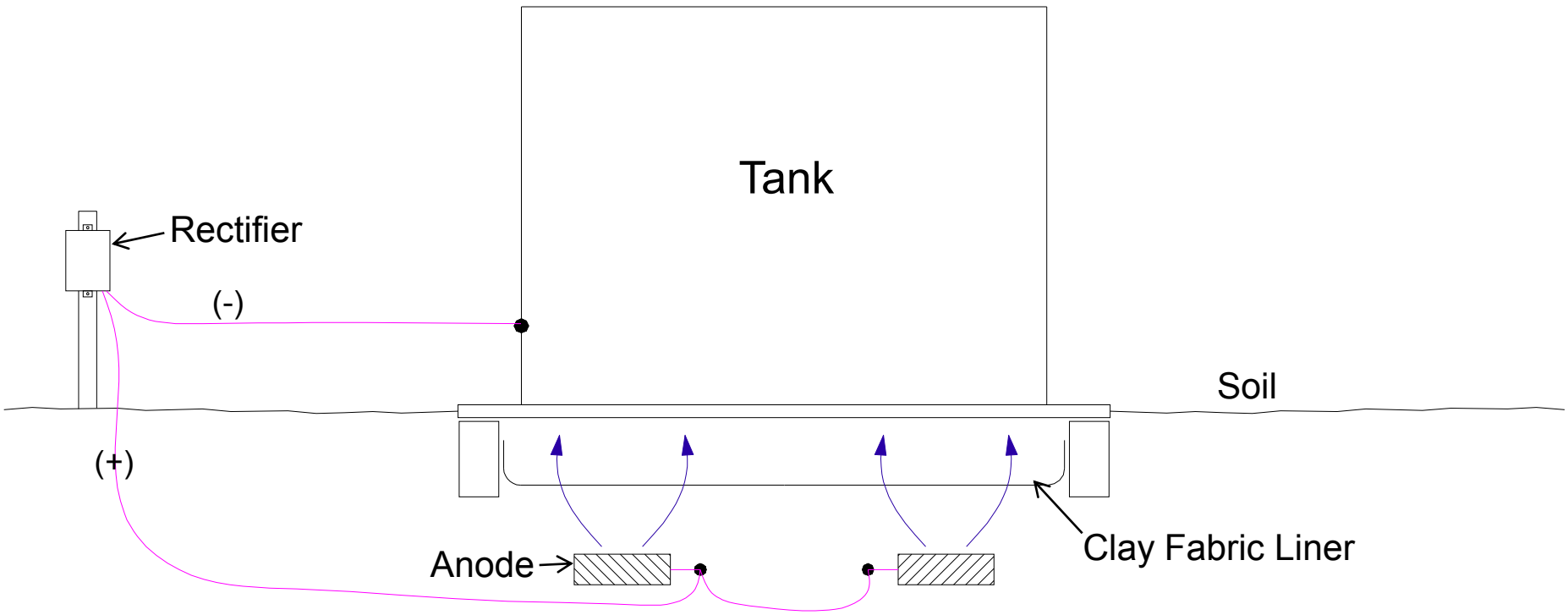


Cathodic Protection Arrangement

- Many above grade tanks are equipped with under floor containment liners

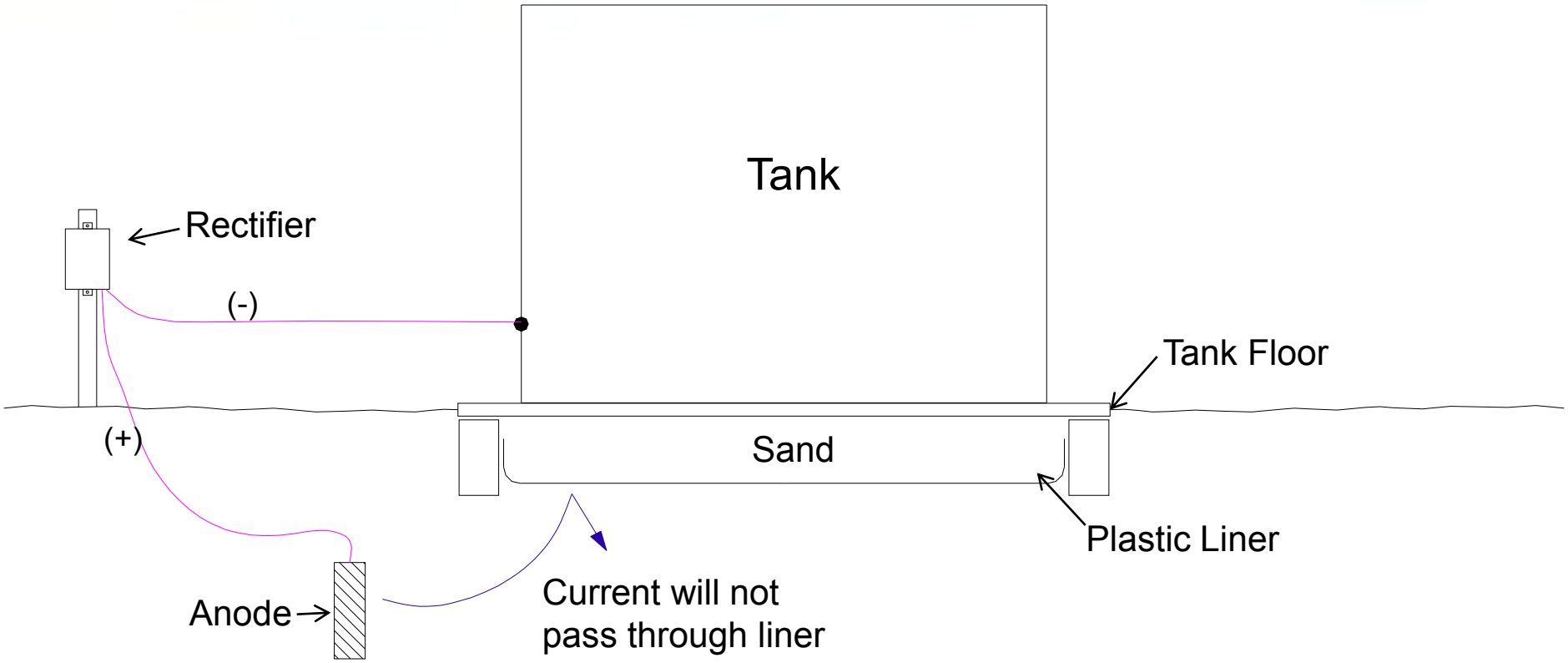
- The type of liner used will determine the anode placement

Clay Fabric Containment Liner



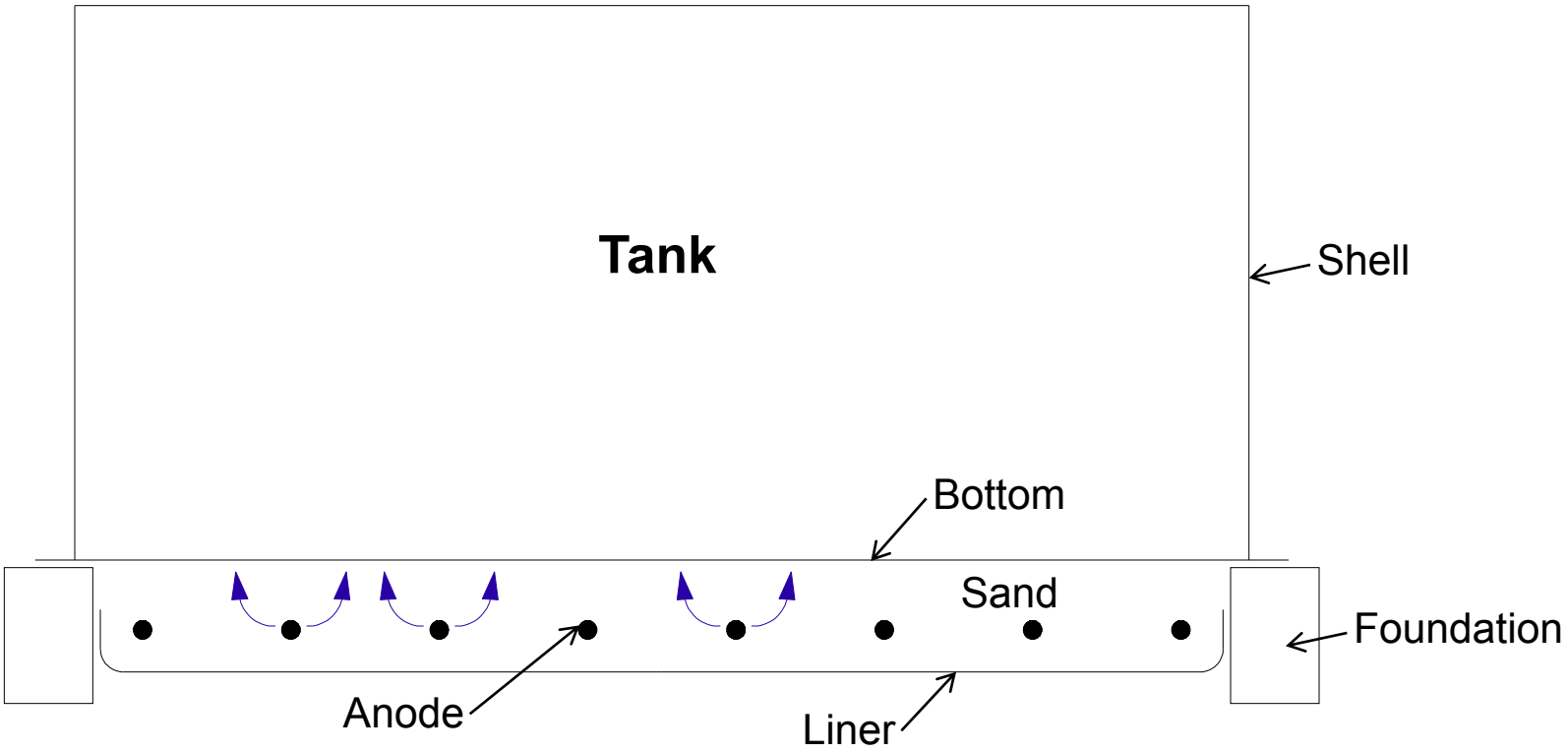
- Current passes through liner
- Anodes can be placed below liner or around tank
- Replacement anodes can be placed around tank

Non-Conductive Liner



- Containment liner blocks current from reaching tank bottom
- Cathodic protection readings around tank give indication of effective corrosion control
- Tank bottom subject to corrosion above liner

Cathodic Protection – Plastic Liner

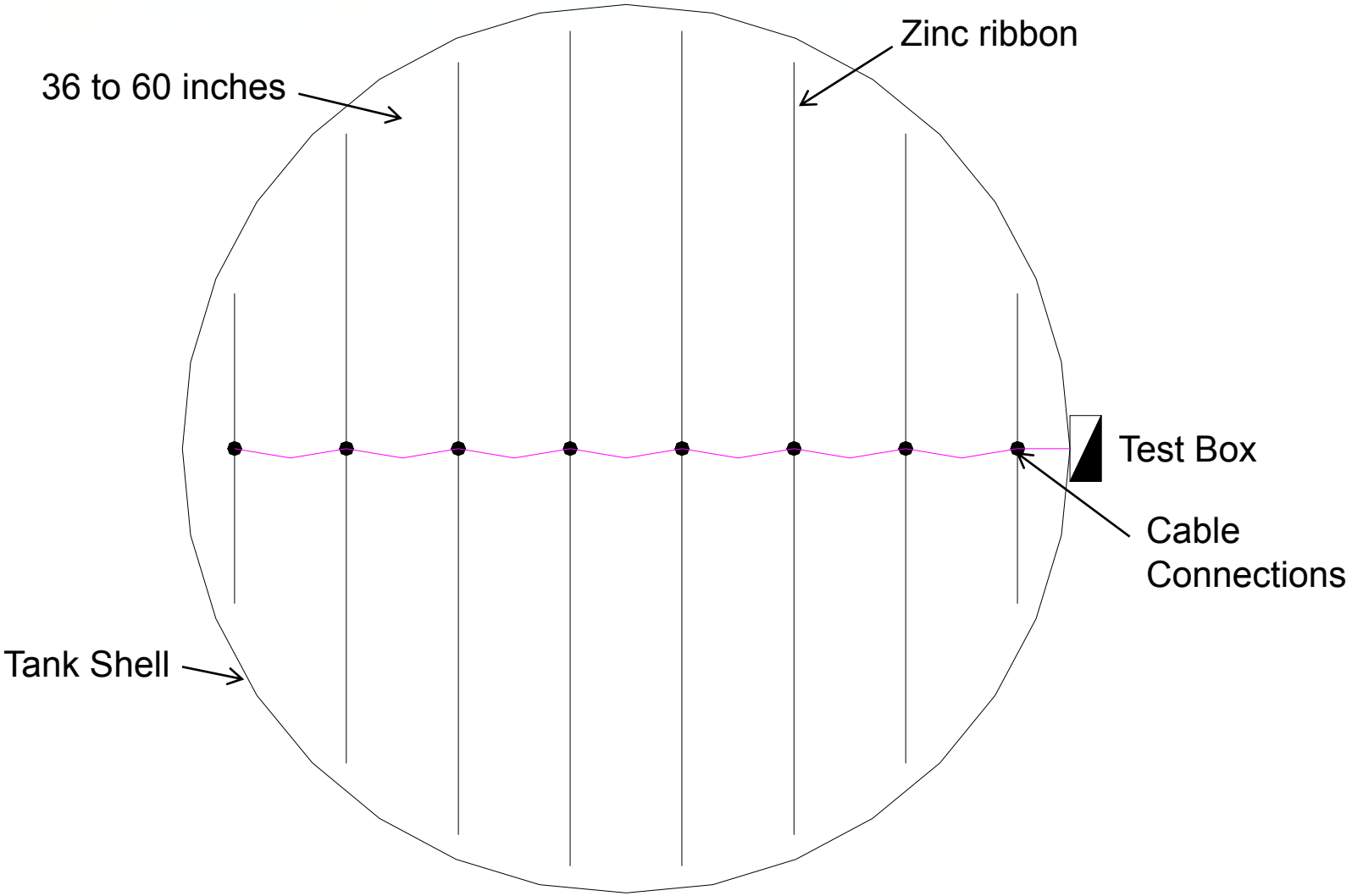


- Anodes are placed in sand between liner and tank bottom
- Anodes can not come in contact with tank bottom
- Distance between anode and floor determines current distribution

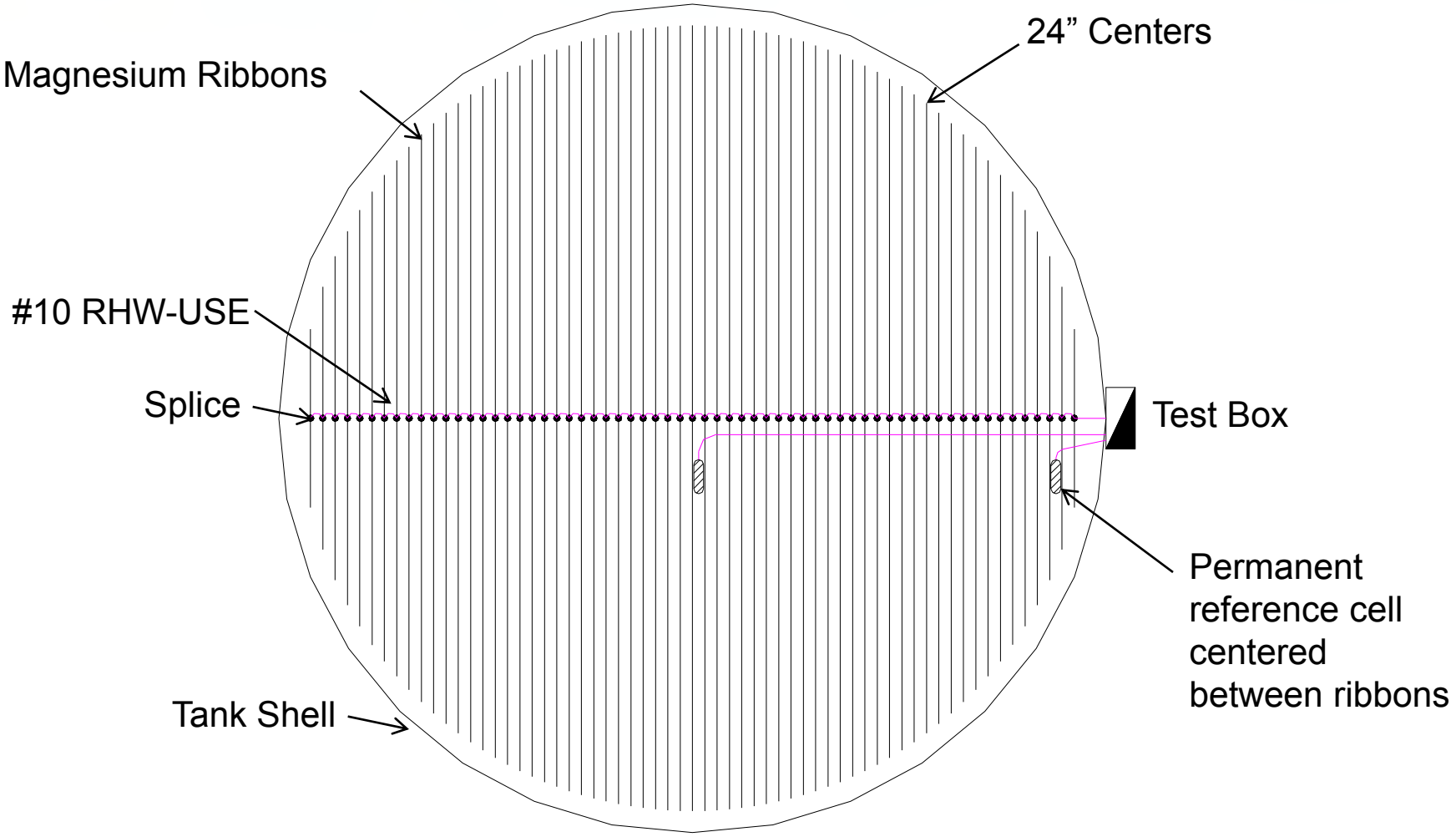
Galvanic Ribbon Systems

- Spacing between ribbons must adequate to provide current distribution
- Sand fill can not be corrosive, and must remain relatively dry
- When moisture enters the sand, most galvanic systems continue to protect the tank bottom but a shorter anode service life may result.
- Some early galvanic ribbon systems were actually used to detect leaks

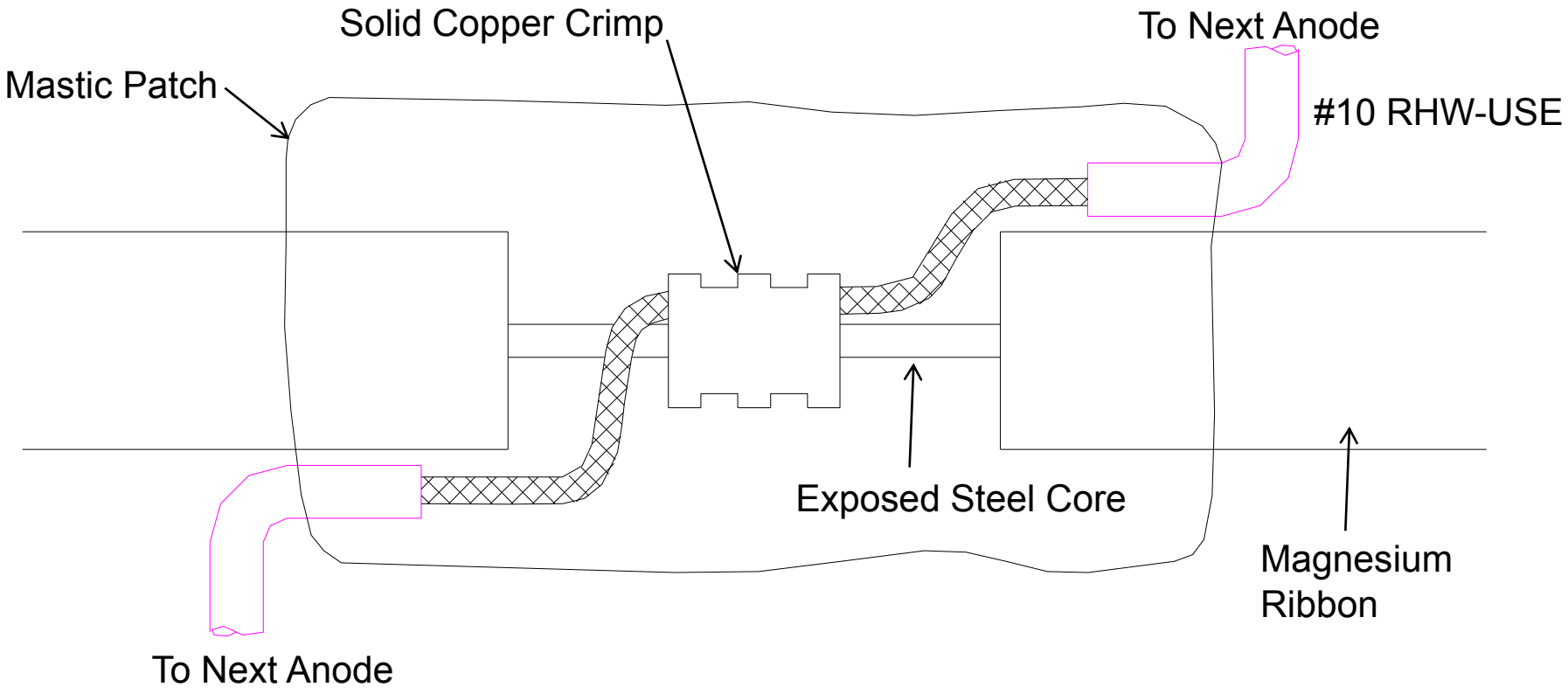
Zinc Anode Ribbons



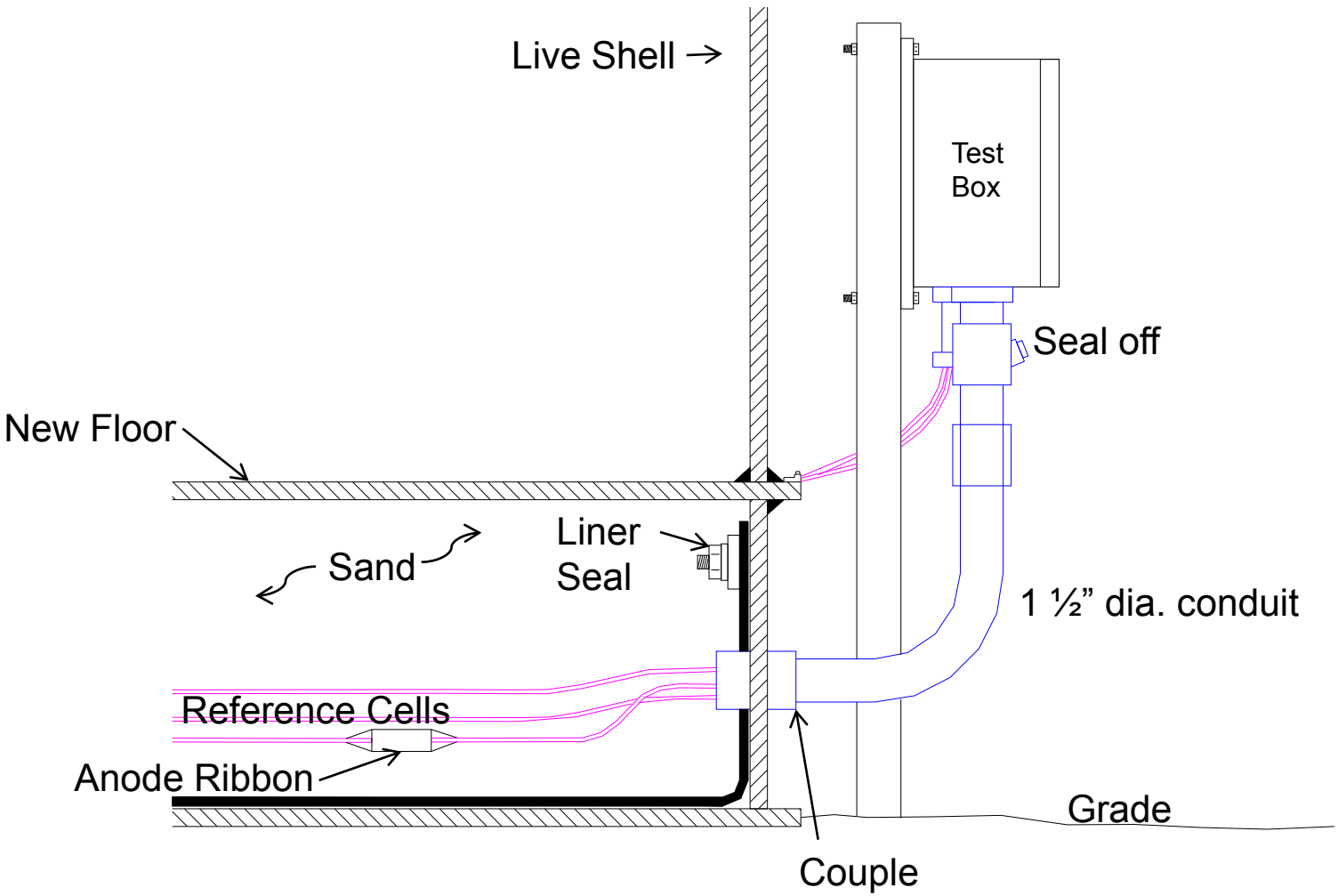
Magnesium Anode Ribbons



Galvanic Anode Splice

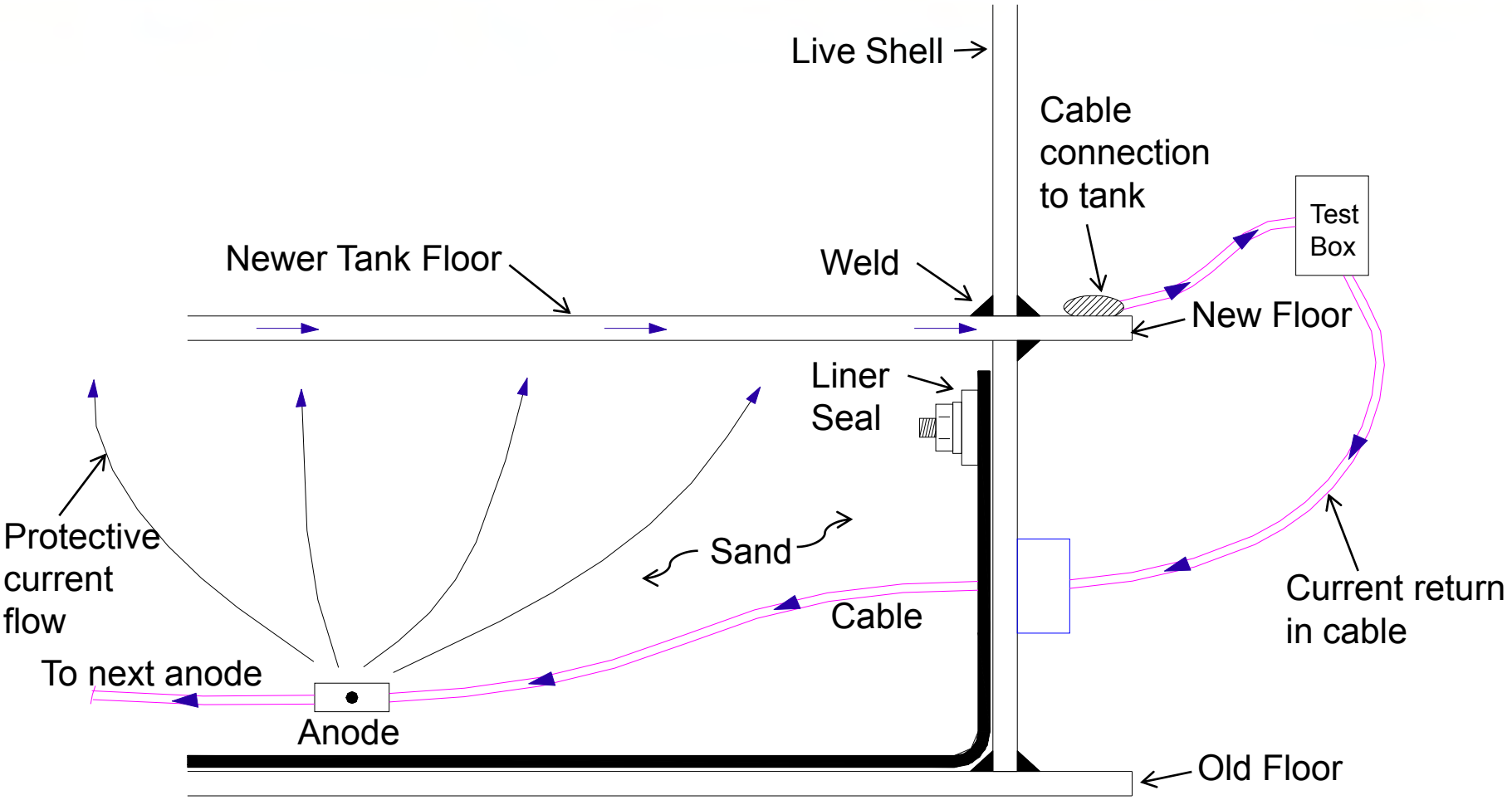


Galvanic Test Box




Hoffman
REF. CENTE
REF MID PT

Current Flow

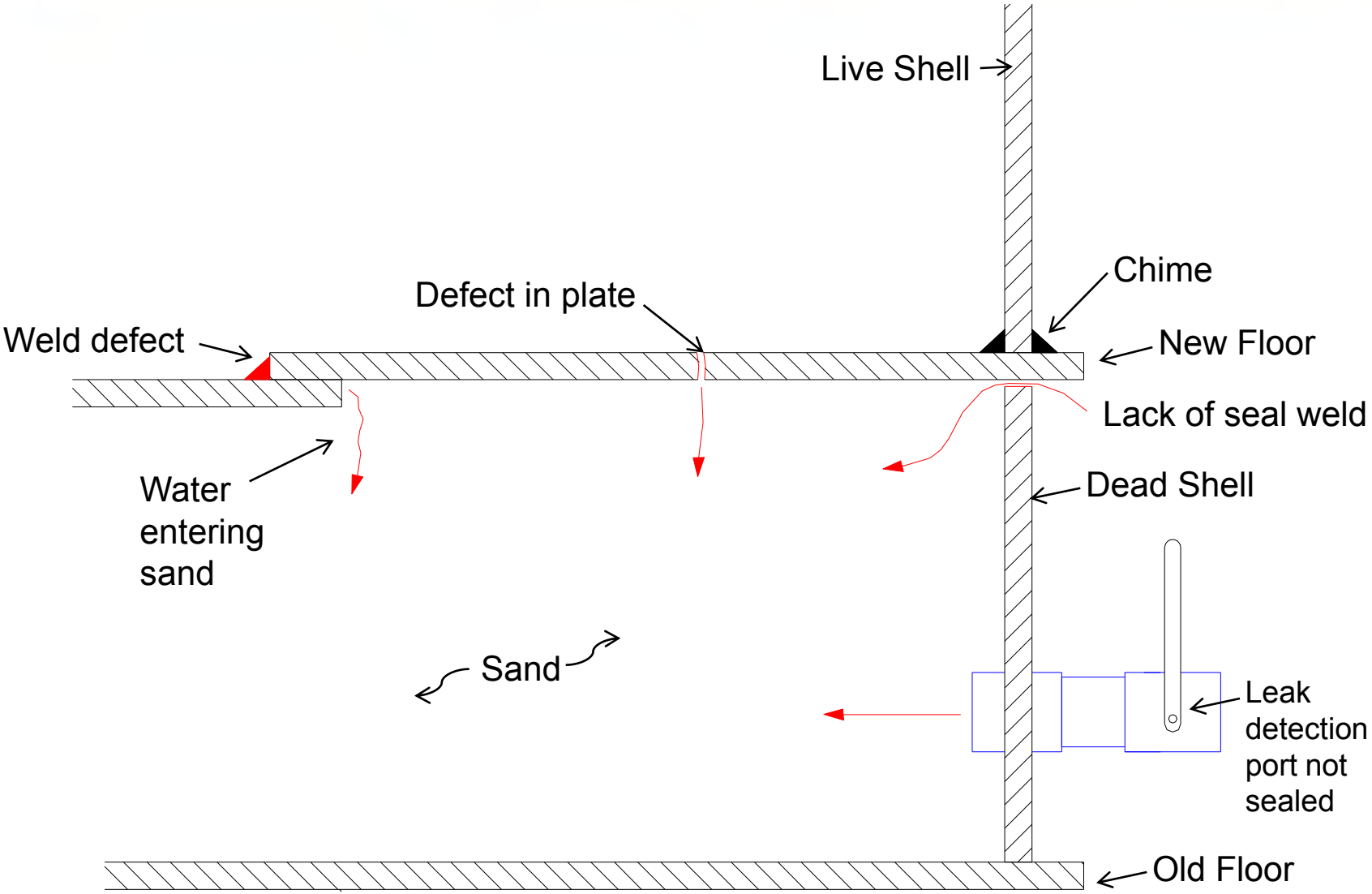


- Current flows off magnesium anode into sand
- Current flows through sand and onto underside of floor
- Current returns in steel and cable to anode

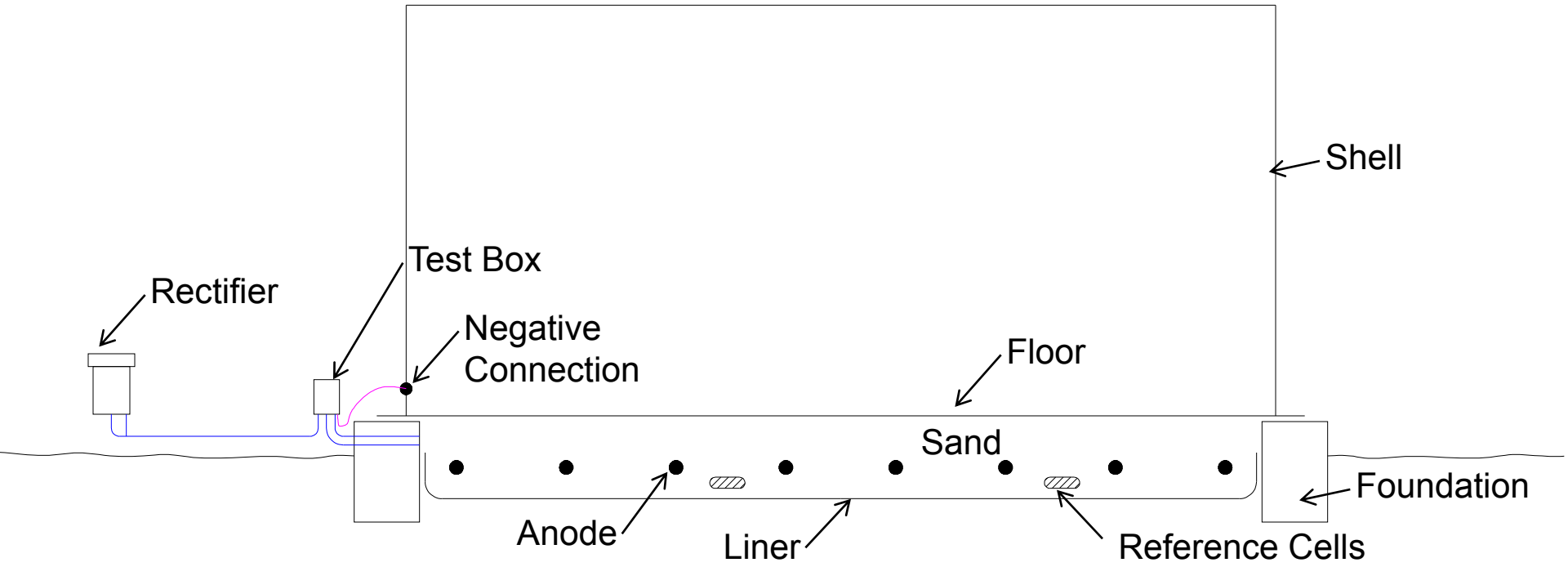
Sand Contamination

- Rain water enters at leak detection tubes
- Rain water enters at chime (new floor to old shell)
- Water bottoms seep through flaws in welds or floor plates

Water Entering Sand



Impressed Current



- Rectifier supplies current to anodes in sand
- Anodes deliver current to floor which is returned to rectifier
- Reference cells are used to monitor protection levels


05/03/2012

Galvanic System Deficiencies

- Anode ribbons are too far apart
- Anode ribbons do not deliver sufficient current
- Sand used as fill is conductive and corrosive
- Water enters sand causing it to become corrosive
- Galvanic anode ribbons are depleted
- Reference cells are inaccurate or inoperable

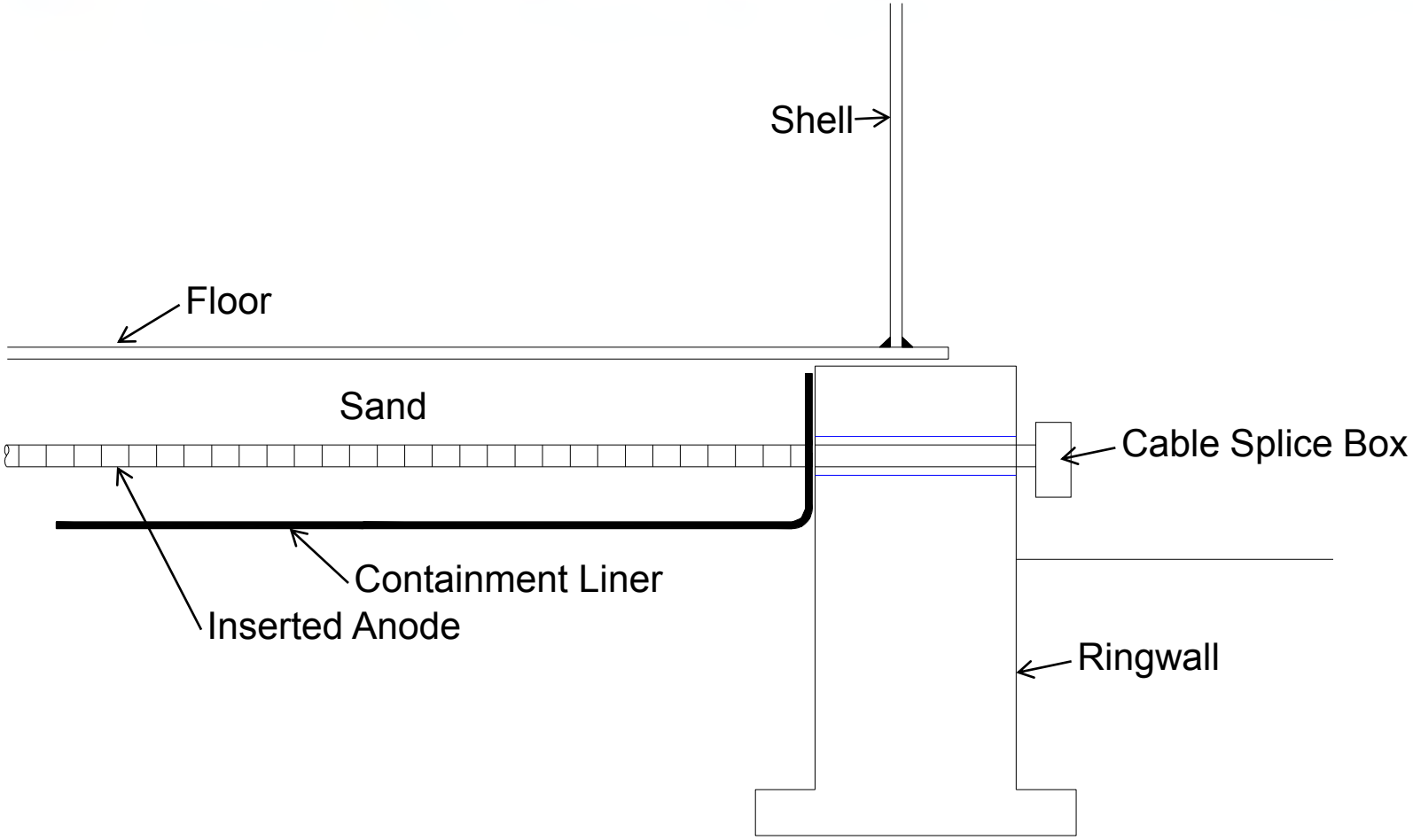
Impressed Current Deficiencies

- Rectifier inoperable or not properly adjusted
- Cables between rectifier and anode box are severed
- Anodes are spaced too far apart
- Anode ratings are too low
- Anodes are grounded to tank bottom
- Reference cells are inacurate or inoperable
- Positive and negative cables are connected with the wrong polarity
- Sand is too dry

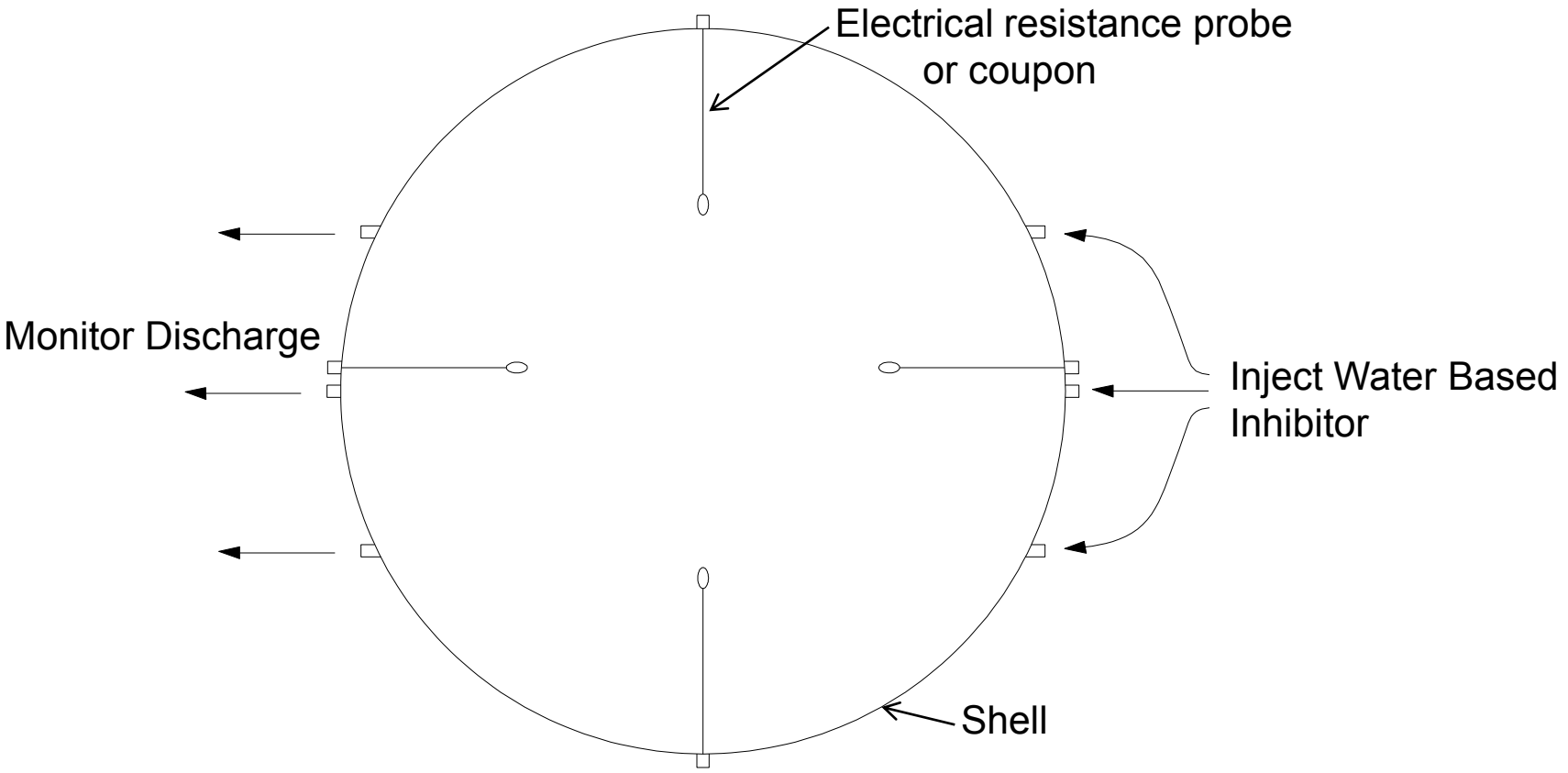
The CP System Doesn't Work. Now What ?

- Monitor tank bottom using API-653 inspection code, take action if corrosion losses are significant
- Lift the tank or remove the floor and replace the cathodic protection system
- Attempt to insert anodes between liner and floor through holes cored in ringwall
- Inject inhibitors into sand in place of cathodic protection

Retrofit Inserted Anode



Inject Water Based Inhibitor



Conclusions

- Best solution is to avoid the problem to start with; specific requirements for construction
- Monitor tank floor using API-653 inspection code, take action based on inspection results
- Inhibitor inject shows promise, concerns are accuracy of corrosion monitoring and life cycle of inhibitor
- Inserting anodes between liners and floors is not practical in most applications
- Lift tank/remove floor – be sure any replacement systems are design and installed to provide long term service

Thank you.