

**Hello, NACE/SSPC/AMPP
Kansas Section, Great Bend, KS
March 11, 2026**

**ELECTRICAL SAFETY AND
FACILITY INTEGRITY:
EVALUATION OF AC POWER &
GROUNDING SYSTEM ISSUES, WHICH
FOUND . . . MORE ISSUES.**

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WEST TEXAS PRODUCED WATER MANAGEMENT FACILITY



Site electrical system spreads across three tank batteries and measurement devices at ponds.

For scale, each pond is about 500 feet square.

WHAT TROUBLE BROUGHT US TO THE SITE?

- **Electrical grounding (all copper construction) showed 8 amperes (A) of AC current flow on bonding and grounding wires, according to company's I & E Technician working at the site. That's not normal or safe.**
- **I & E Tech had a second problem. A starter motor was tripping a breaker periodically, but because of the tramp currents on bonding and grounding, he could not troubleshoot. These two factors were the reasons for our visit;**
- **Site consists of multiple API-12F tank batteries, water pipelines delivering water to site, two large water storage ponds with fluids transfer and aeration, and four large motor/pump assemblies flowing produced water under high pressure to two on-site water disposal/injection wells.**
- **Limited underground metal pipelines present (stainless steel). No need for cathodic protection for the assets on site, based on Client descriptions.**

WHAT IS GROUNDING, EARTHING? BONDING?

- **Grounding or Earthing** – Every electrical device is supposed to be grounded (as well as towers and many other structures). If an electrical fault (or lightning strike) occurs, the current flows to “ground mass” (Earth), and then goes “home” to point of origin. **Let’s avoid using a person or high-value asset to flow current;**
- **RISK MATRIX FOR FAULT CURRENT AND LIGHTNING EVENTS – VERY LOW FREQUENCY OF OCCURRENCE, BUT CATASTROPHIC CONSEQUENCES.**
- **Electrical Bonding** – used to join all structures and grounding devices on a site/block together. No voltage builds up and causes static-electric spark or other shock. Reduces total resistance for every ground . . . **All is electrically common/EQUI-POTENTIAL.**

INCOMING AC POWER TO TWO TRANSFORMERS



Power distribution rack for the site, above.

Two pad-mounted transformers on site, one rated at 2,500 kVA, second at 2,000 kVA. At 480 VAC output, up to 8,900 amperes of AC current available (at 0.95 power factor).

MAIN TANK BATTERY AND SUPPORT EQUIPMENT

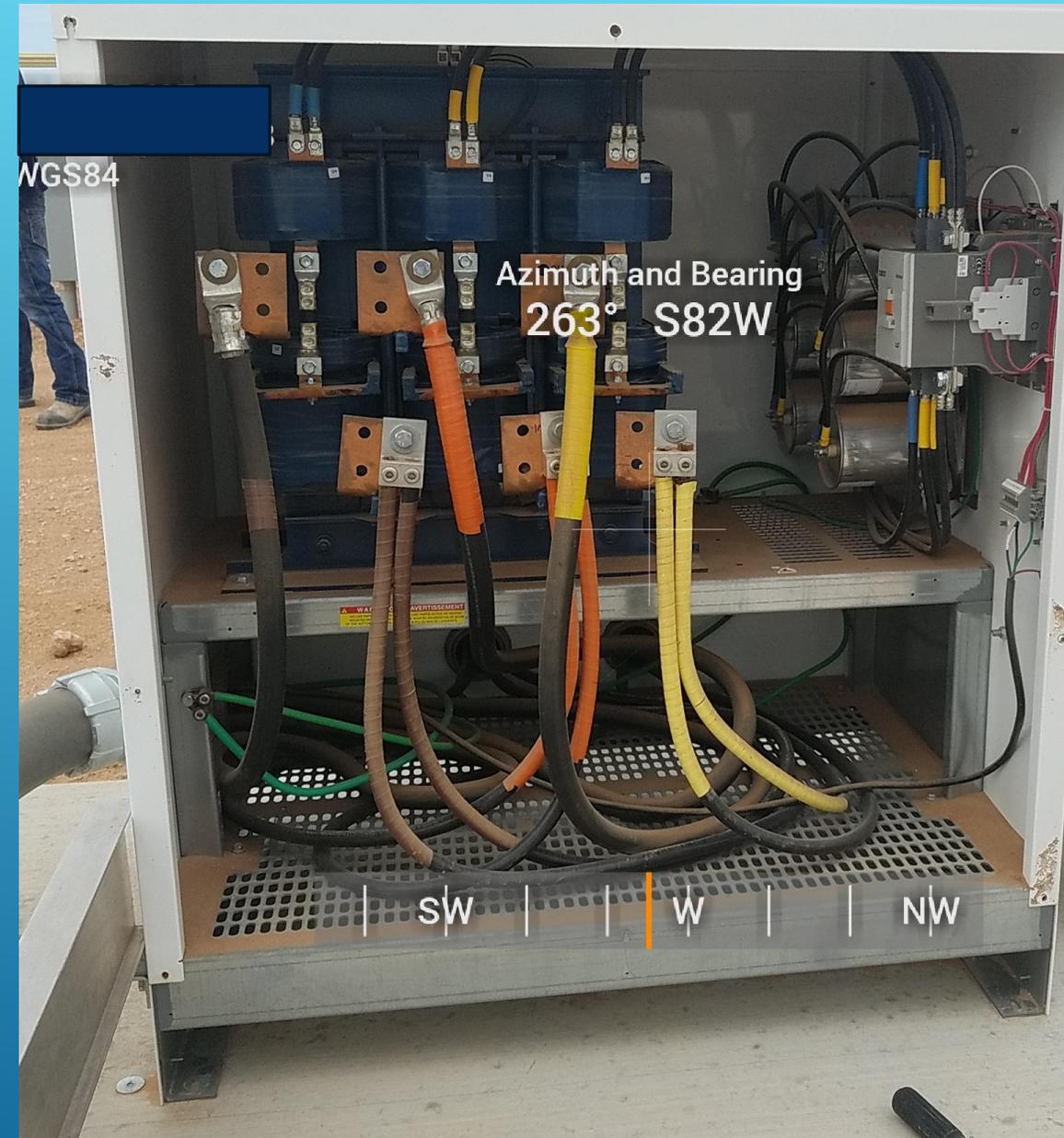


Azimuth and Bearing
144° S53E

Four Skim Oil Tanks in foreground.

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BIGGEST POWER CONSUMERS? VFD'S.



A Variable-Frequency Drive takes 60-Hertz power and converts it to power delivered in frequencies of approx. 100- to 4,800-Hertz. Frequency management varies motor speeds.

Interior View of VFD Reactor Cabinet

PROBLEM FOUND? HIGH-FREQ NOISE FROM VFD'S.

Azimuth and Bearing
339° N68W

-6.9°

P-0005

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The VFD wiring, from inside reactor and conditioner cabinets out to each motor and pump combination on site, was not shielded to limit high-frequency noise transmission and induction onto other conductors.

How did this affect the site?

WHY? NON-SHIELDING GEAR AND WIRE RUNS.



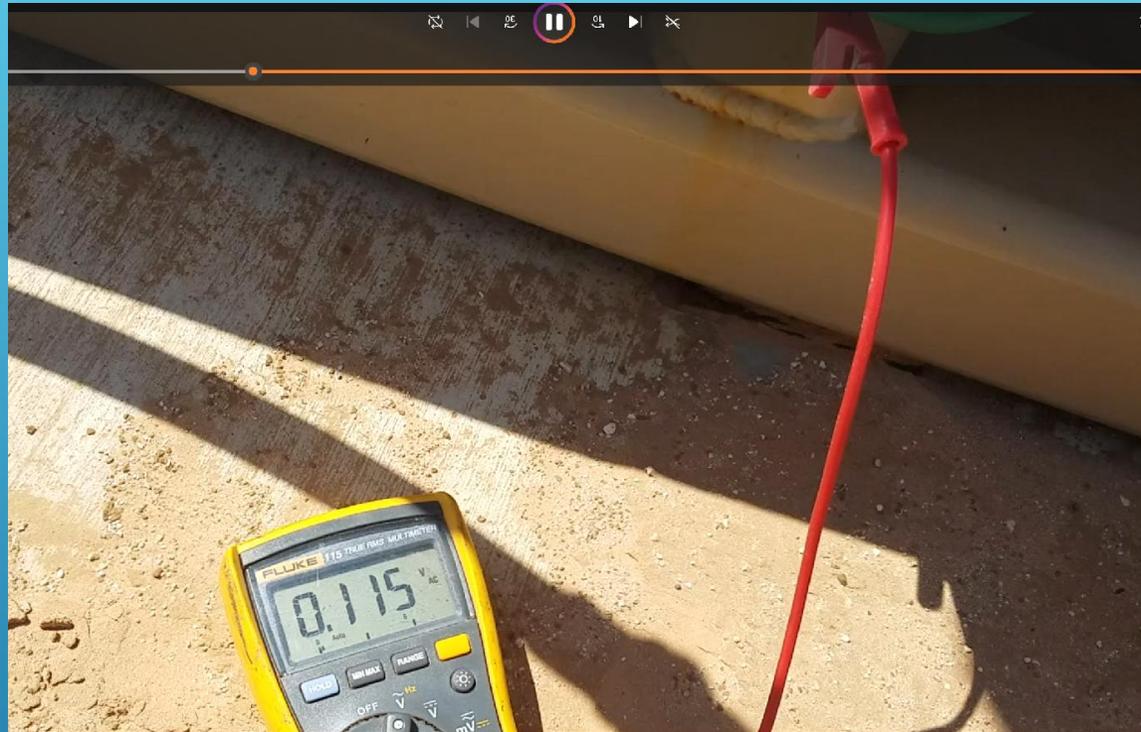
VFD reactors, conditioners and wiring to motors, for each of three power phases, was in non-shielding rubberized conduit. Noise was transmitted downstream and induced onto nearby, adjacent conductors – for instance, the green bond wire at bottom of photo.

Put VFD in steel conduit and mitigate most noise energy.

Even the VFD cabinet gear was not shielded properly.

MEASUREMENTS SHOWED:

AC CURRENTS MEASURED ON GROUNDS AND BOND WIRE RUNS AT 3.5 TO 18 AMPERES AC. THIS WAS TRUE ONLY ELECTRICALLY DOWNSTREAM OF VFD REACTOR AND CONDITIONER CABINETS, NOT IN TANK BATTERIES.



0.115 V AC PRESENT AT MOTOR BOND POINT

**POWER = VOLTS X AMPS, OR
0.115 V X 18 A AC, MAX OF 2.1
WATTS AT 4-KHZ.**

This is related to skin effect.



THESE VOLT AND AMP MEASUREMENTS WERE RELATED TO HIGH-FREQUENCY POWER, FAR WEAKER THAN 60-HZ POWER IN ENERGY CONTENT.

WHAT DO WE SEE AS THE PATTERNS? WHAT'S IN THE ELECTRICAL CIRCUIT?

- ▶ First piece in pattern is people attempted to save money, on electrical design and build, the VFD gear, on wire runs and conduits. This sacrificed project performance and quality by introducing electrical noise issue;
- ▶ Why worry about noise? I & E Tech could not isolate the starter motor issue, with 60-Hz current on the loose, unless all VFD's were shut down. **This is safety issue, as the 60-Hz power signature is hidden in the noise;**
- ▶ Other communications and measurement problems also caused by noise presence;
- ▶ **Of interest is this: high-frequency noise does not propagate for long distances, so all grounding and bonding electrically upstream of VFD's did not receive even a fraction of the noise compared to downstream locations. Tank Battery #1 showed no noise issue.**

What is US NEC (NFPA 70) requirement for electrical grounding? (Or equivalents?)

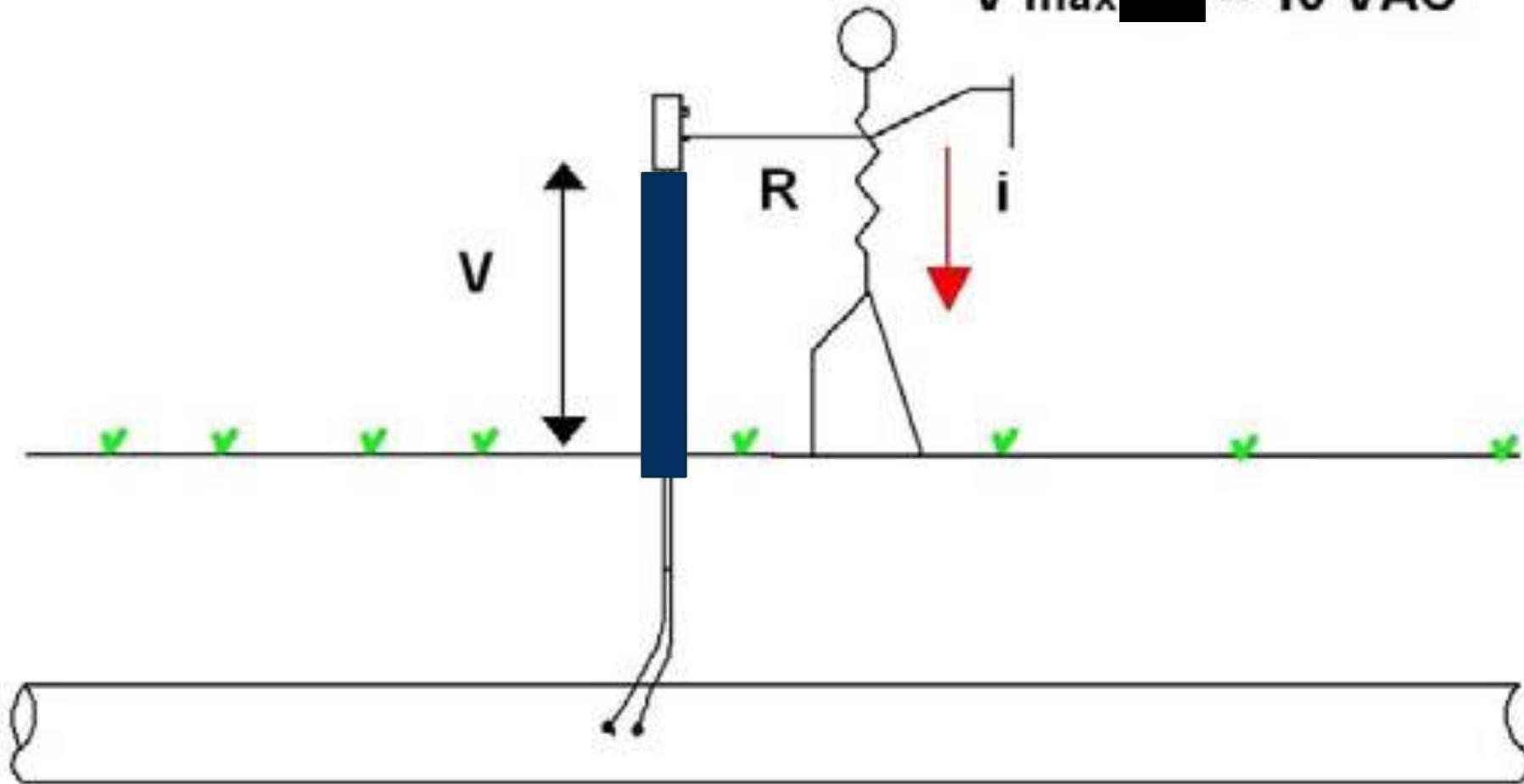
- Every electrical ground must have total resistance of 25 ohms or less;
- In most conditions, we want to see 5 ohms or less – virtually always obtainable in the plains, river regions, steppes, coastal flats, but often not in rocky geographies, and sometimes not in semi-desert and desert conditions;
- If you have 480 VAC and 5-ohm resistance, fault current flow will be about 96 amps. Yes, we think breaker will trip – but how soon?
- What is the regional AC neutral system's magnitude? What is local grounding system's size and extent?

TOUCH VOLTAGES (EITHER AC OR DC)

$i =$ Let go current = **10 mA**

$R = 1500$ Ohms

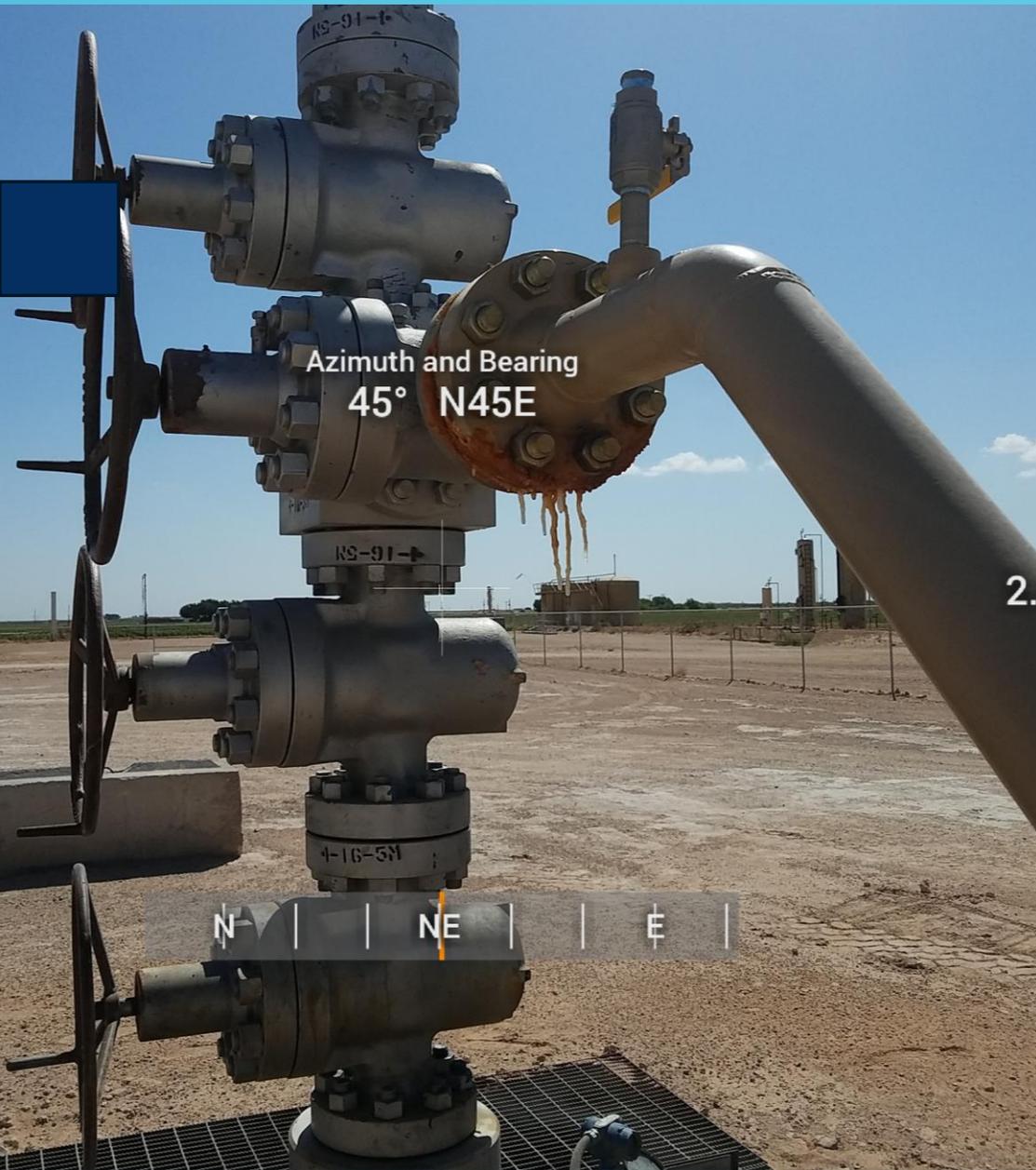
$V_{\text{max}} = 15$ VAC



OTHER PROBLEMS THEN IDENTIFIED THROUGH SITE OBSERVATIONS:

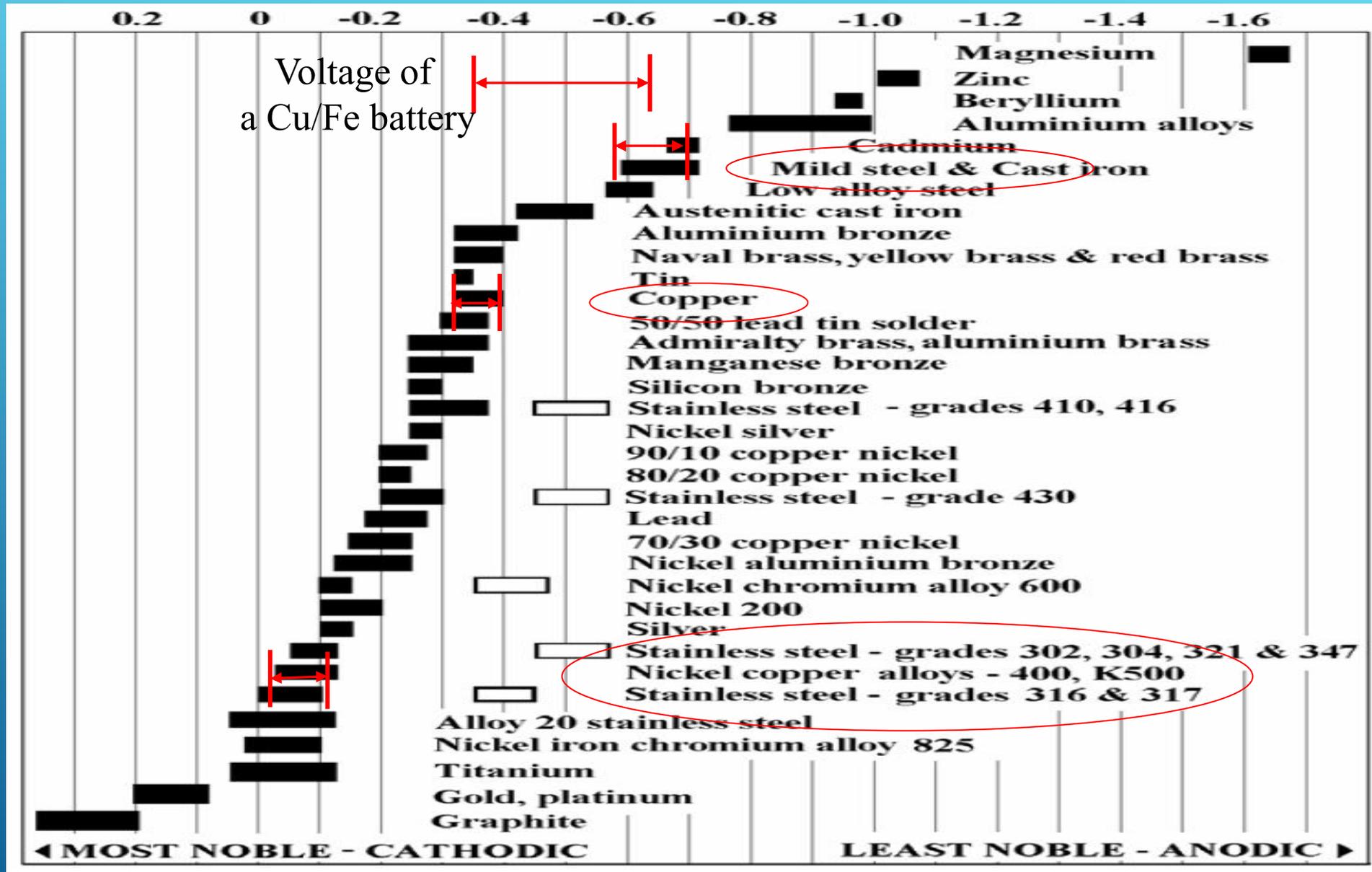
- Corrosion products found emanating from valve and fitting LEAKS on high-pressure piping runs and disposal well trees;
- High electrical resistances found on bond wires inside tank battery containment. Why?

WHAT ABOUT SALT WATER AND METALS?



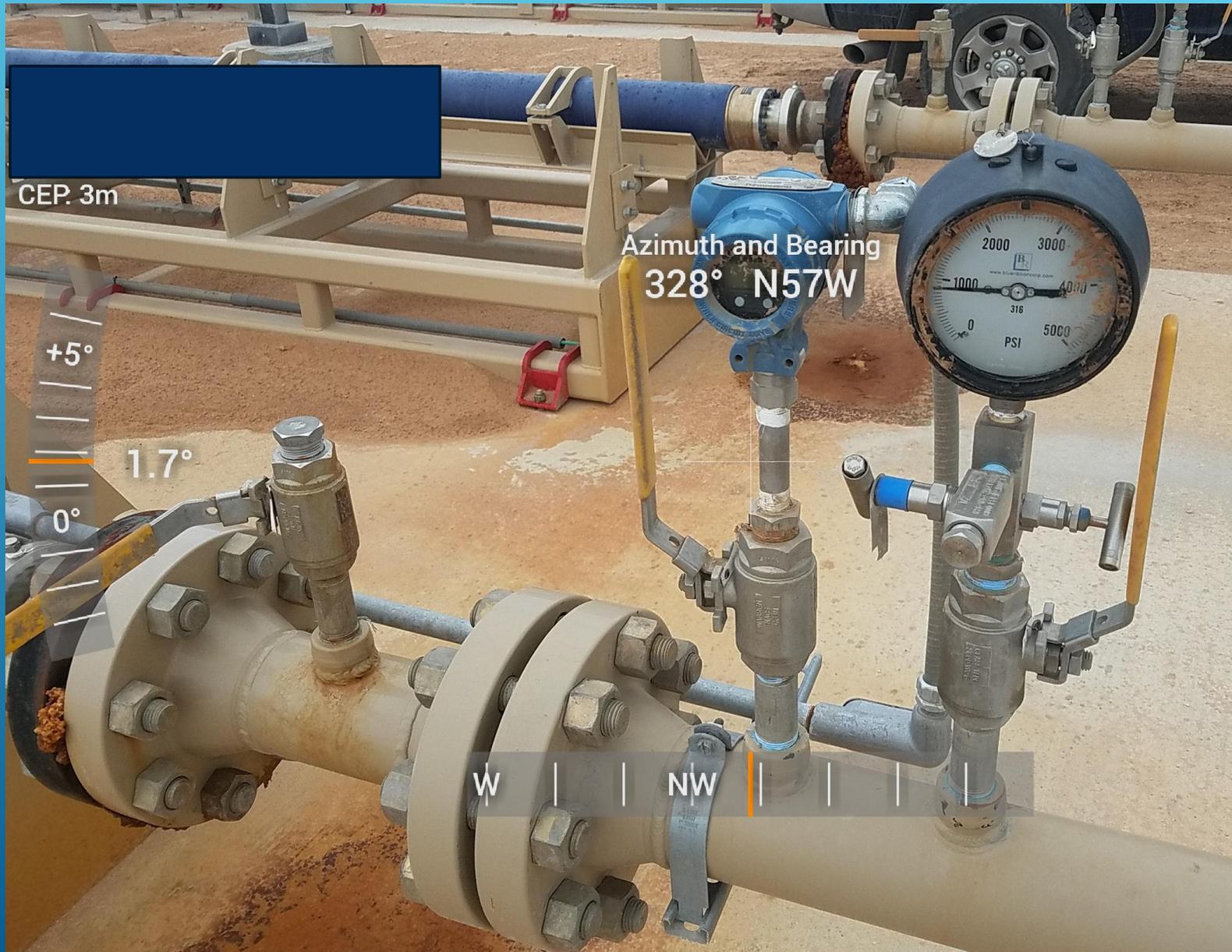
Carbon steel piping mated to stainless-steel valves and well tree metal does not work with salt water on the inside. What is corroding and leaking to create all this rust product? Bolts? CS flange face metal? What kind of pressure is involved?

THE GALVANIC SERIES OF METALS



From Atlas Specialty, tech note #7; voltage compared to Cu-CuSO₄ half-cell. Unshaded boxes are metals in acidic water.

PRESSURES INVOLVED? WELL #1.



While we worked on site, pressures to each disposal well were held lower than normal. This gauge shows 900 psi, whereas normal operation was 1,500 to 2,000 psi.

See the small leaks and rust blooms at far left, some at 6 o'clock and more at 9 o'clock.

PRESSURES INVOLVED? WELL 2.



This gauge shows 1,200 psi, whereas normal operation was 1,500 to 2,000 psi.

Want to be close by when a corrosion failure occurs?

THE FACILITY MANAGER WALKED US THROUGH THE MAIN TANK BATTERY.

We measured resistances along particular runs of bonding cables, up on the catwalks and then down in the floor level of the battery.



Numbers were not good.

LOOK UP AND CATCH THE DETAILS.



Bonding cable (bare copper) run, measurement cabling for tank levels, other instrument wiring all running up the tray.

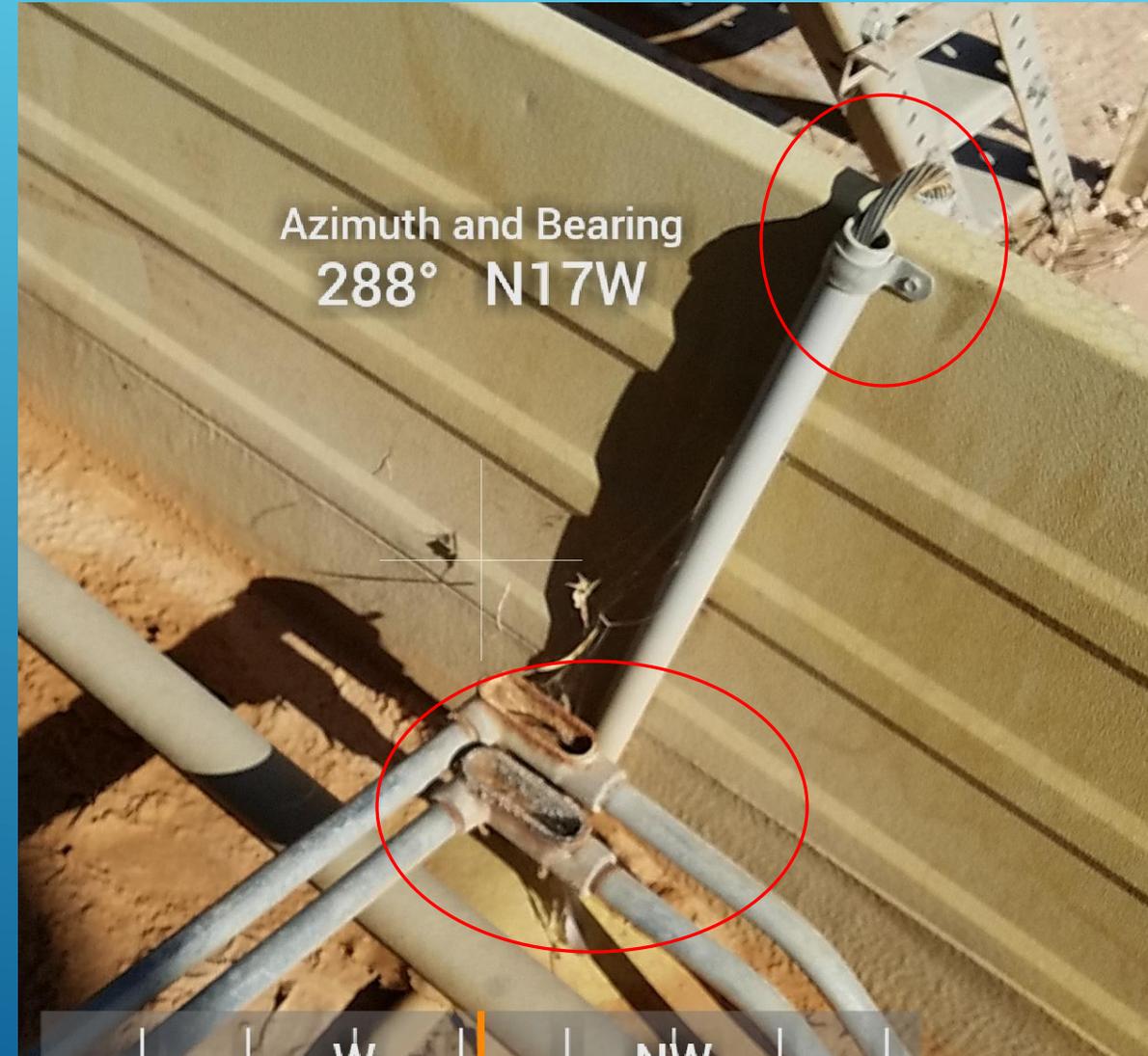
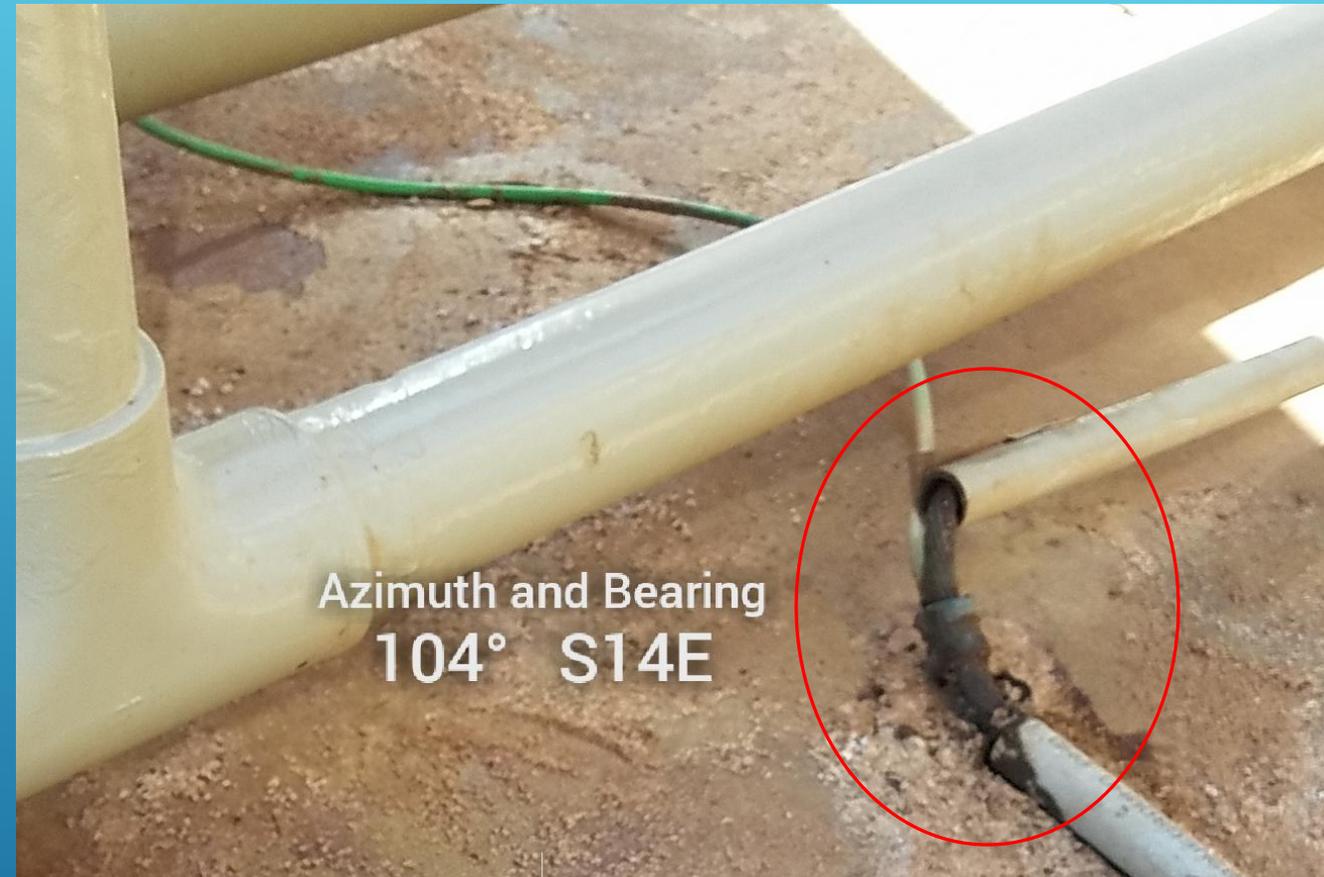
CLIMB UP AND CATCH THE DETAILS.



Bonding cables (green insulation), measurement cabling for tank levels, other instruments, and all tanks generating light hydrocarbon vapors.

We do not want static sparks on site.

NOW LOOK DOWN.



Bare copper bonding wires down low looked damaged by chemical attack (salt residues, right). Manager admitted there had been a significant salt-water spill inside the containment, with water depth up to eight inches.

SALT WATER DAMAGE TO COPPER WIRE BONDING HAD CORRODED EVERY BOND AND COMPROMISED WIRES.



295 ohms on grounding tester.

We recommended replacement of all damaged copper, and new testing.

HOW DID BONDING INSIDE THIS CONTAINMENT GET TIED TO GROUNDING IN THE EARTH?



Bond runs ran with stair sets (and other runs) from inside containment to join grounding ring outside the containment. But some did not connect properly. Lots of digging was done to locate cables, then improve connections.

WHO DOES PERIODIC TESTING OF ELECTRICAL
BONDING AND GROUNDING SYSTEMS?

THAT'S A GOOD THING.

AVOID **DISSIMILAR METALS** IN COMMON
ELECTROLYTE.

*TAKING CARE OF YOUR ASSETS calls for Continuous
Improvement.*

Get good data! Study it.

APPLY LESSONS LEARNED.

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