

AC Mitigation Case Histories

Nebraska Pipeline Safety Seminar

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Grand Island, NE

Common ROW Today



General Perspective

- The consequence of well insulated pipelines in High Voltage AC corridors resulted in pipelines suffering high current loads of AC as a byproduct of inductive, capacitive, and direct coupling issues with the power lines.
- The pipeline basically is now a secondary winding of a gigantic transformer, with the AC power line as the primary winding.
- Voltages induced into the pipeline go in the opposite direction to those in the powerline.
- These voltages can build to voltage levels that can become safety hazards, and the current values of the pipe line can result in corrosion to the pipe walls by AC Corrosion
- AC Corrosion is not yet a clearly defined process, however, it does have some characteristic indications that are commonly associated with it from field inspections.

High Voltages Go To Ground

- Note the burned area where high voltage spikes jumped to ground through the connection provided to the mounting pipe by the backplate bolt.
- Indication is the pipeline may need AC Mitigation.



What is Meant by AC Current Density?

- The current density level is important, not necessarily in the pipeline itself, but at the point of discharge from the pipeline into the soil.
- Reported data from field inspections have shown a range of AC current densities of 0 to 20A/m² are not involved with AC corrosion. From 20A/m² to 100A/m² there may be an involvement, while levels over 100A/m² are strongly indicated to have AC corrosion active.

What affects the AC Current Density?

- High soil resistivities are an enhancement to protect the pipeline by lowering the current density.
- Low soil resistivities allow higher current densities as the current flow away from the coating anomaly is enhanced.
- The size of the defect is critically important. Densities of current from a scrape of several inches in length will have lower current densities. While a small defect in the coating, such as made by a grain of sand in the coating will have much higher current densities as the current is being pushed from a much smaller cross sectional area.

Further AC Current Density

- The availability of the current in the pipeline is also a major factor. If the pipeline is in a corridor with low AC current power lines, the critical current densities may be too low induced in the pipeline to be an issue, while large tower like lines with high voltages may indeed be involved with it. Each case is different, which points strongly to the need of field measurements and accurate modeling.
- Normally a length of pipe should be running parallel to an HVAC system to induce high current loads, but not always. In some crossings of shallow angles, these currents can still be achieved.
- There is an “end effect” situation as well, where current tries to preferentially leave the pipeline near the point of its deviations from being parallel

Examples – Look For the Characteristic Shapes



How is AC Safety Mitigated?

- Locations of pipe to soil test leads, and any surface pipeline appurtenance can be measured to determine locations of possibly high enough voltage to require mitigation for safety. Accurate modeling will also disclose areas of expected safety issues.
- These locations can be mitigated with short runs of material that can permanently shunt the current to the power line ground system economically.
- Step potentials must be considered in these areas, and normally, step potential mats are indicated in all locations of surface pipe appurtenances such as block valves and risers to protect personnel
- All Test Lead contacts in high potential power line ROW parallel systems should be dead face front style to prevent contact with personnel. Covers are also indicated as further assurance of protection from public interaction in areas of high population densities.

How are AC Corrosion Issues Mitigated?

- A cookie cutter approach may be used, but cannot be assured of success as there may be areas that have not been modeled and found that can have significant issues of AC corrosion that may not be covered by short isolated segments of parallel or deep well drains.
- Areas for spot installations or longer runs of material may be disclosed by a good interpretation of the topography, and looking for areas of divergence and convergence between the pipeline and the power lines involved.
- Areas of known high current density may be generally indicated at major divergence points, and near power line substations, but many others may be on the line, and not discovered without field surveys and appropriate modeling of the systems. It is strongly suggested any line with discovered AC corrosion wall losses should be modeled and an appropriate complete system installation designed and proposed for consideration.

How is AC Mitigated?

- Have a survey company that can efficiently do all field surveys required for modeling the line.
- Use appropriate (CDEGS/ROW) modeling software especially for complex multiple power line ROW and pipeline issues.
- Consider two methods of AC mitigation, linear system beside the pipeline and/or deep point drains for concentrated areas of impact. A combination may be best.
- Isolate your CP system by using decouplers to isolate from the cathodic protection system, but capable of handling the AC drainage currents indicated.
- Consider using a solid forming conductive backfill to enhance performance and life of the system.

Field Installations of Linear AC Drains

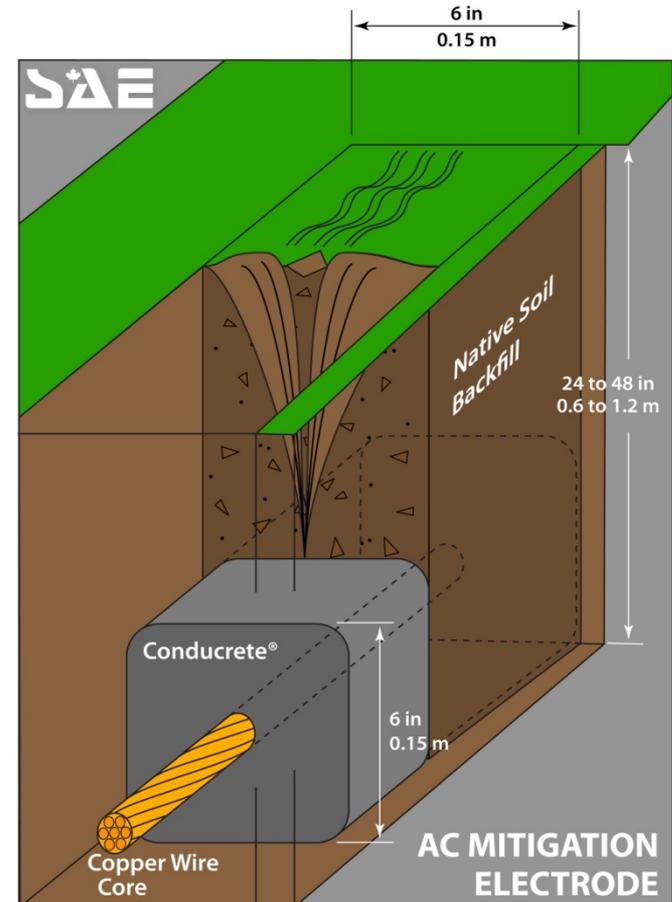


Ripper Installation



Solid Media Backfill – Ground Enhancement

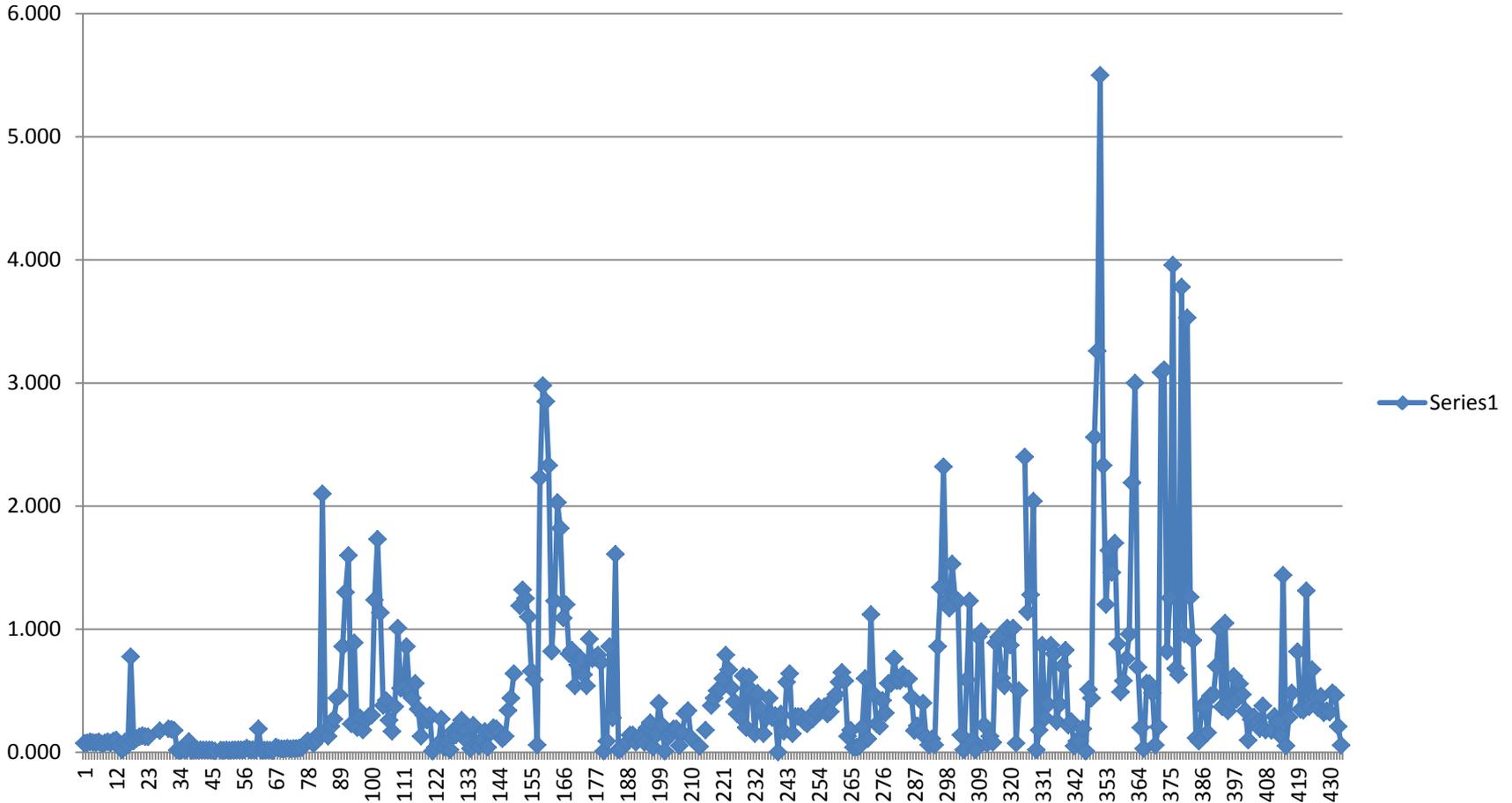
- Diagram of an AC Mitigation electrode as installed:
 - A large copper core is encapsulated in a conductive solid forming backfill
 - When set up, the AC Mitigation electrode becomes a single, solid conductor with a large surface area able to safely dissipate large amounts of current
 - The electrode system protects the copper core from corrosion and deterioration, thus extending the operational lifetime by 10 times normal
 - The backfill reduces system impedance to allow faster current flow in peak conditions



A 42" Gas Transmission Line

- The line is in Eastern Texas, running eastward
- The line is parallel to high tension lines for 40 miles
- The area was modeled using CDEGS Software from data on the location prior to construction
- The AC Mitigation system was installed per the modeling during the construction phase.
- The results are most areas are below 1 volt AC
- The highest single point location is 5.4 VAC.

Results Copper/Conductive Concrete



Wire in solid backfill, Bare, Bare no backfill, Exposure 10 years



Point Drains



Point Drain AC Mitigation

- Point drains are effective for localized problems or intense AC drains are needed
- Point drains are excellent alternatives when there is no ROW for long length linear AC Mitigation systems
- Deep soil resistivities are important in the design of these installations
- Some specific locations best for point drains are areas near power substations, and shallow angle crossings of pipelines by High Tension lines

Solid Media Backfill

- Conductive concrete has a resistivity of 3 ohm/cm
- It is hygroscopic and will absorb and retain moisture
- It has been used to enhance grounding systems for over 100 years
- It reduces impedance and resistance of AC mitigation systems and enhances their ability to pass current to the earth, including when appropriately designed and installed, Fault and lightning currents.
- The backfill reduces impedance significantly to improve the rapidity of current drain of AC, during faults or lightning surges.
- It reduces the electrolytic corrosion process of copper by over 85%, extending copper life to 50 years or more in AC Mitigation service.
- Point drains use a bare copper wire in a drilled open hole, filled with conductive concrete, and connected to the pipeline by a DC decoupler.

AC Interaction on Municipal Lines

- A common misconception is that there is no need for AC Mitigation on city mains or small intrastate pipeline systems.
- AC can be induced to high levels on these lines even from low municipal AC systems.
- Key locations may be
 - New well coated lines parallel to AC systems
 - Passing by an HVAC Substation
 - Buried AC Systems crossing at shallow angles and little separation from the pipeline

Point Drains/Linears in Kansas

- The location was near a power sub station
- The company had installed zinc ribbon and bare copper wire tests and tested copper wire with conductive concrete backfill
- Prior to installation of the point drains, an AC Current Density monitor coupon was installed
- The AC voltage decreased below safety levels and the current dropped to below AC Corrosion levels using these Point Drains.

Model Results

- The models presented are to show the unmitigated Voltage and Current ranges in their current status and in their post mitigated status.
- These models were produced using the available information from the facility owner, the power line company, and field inspections of the areas concerned.

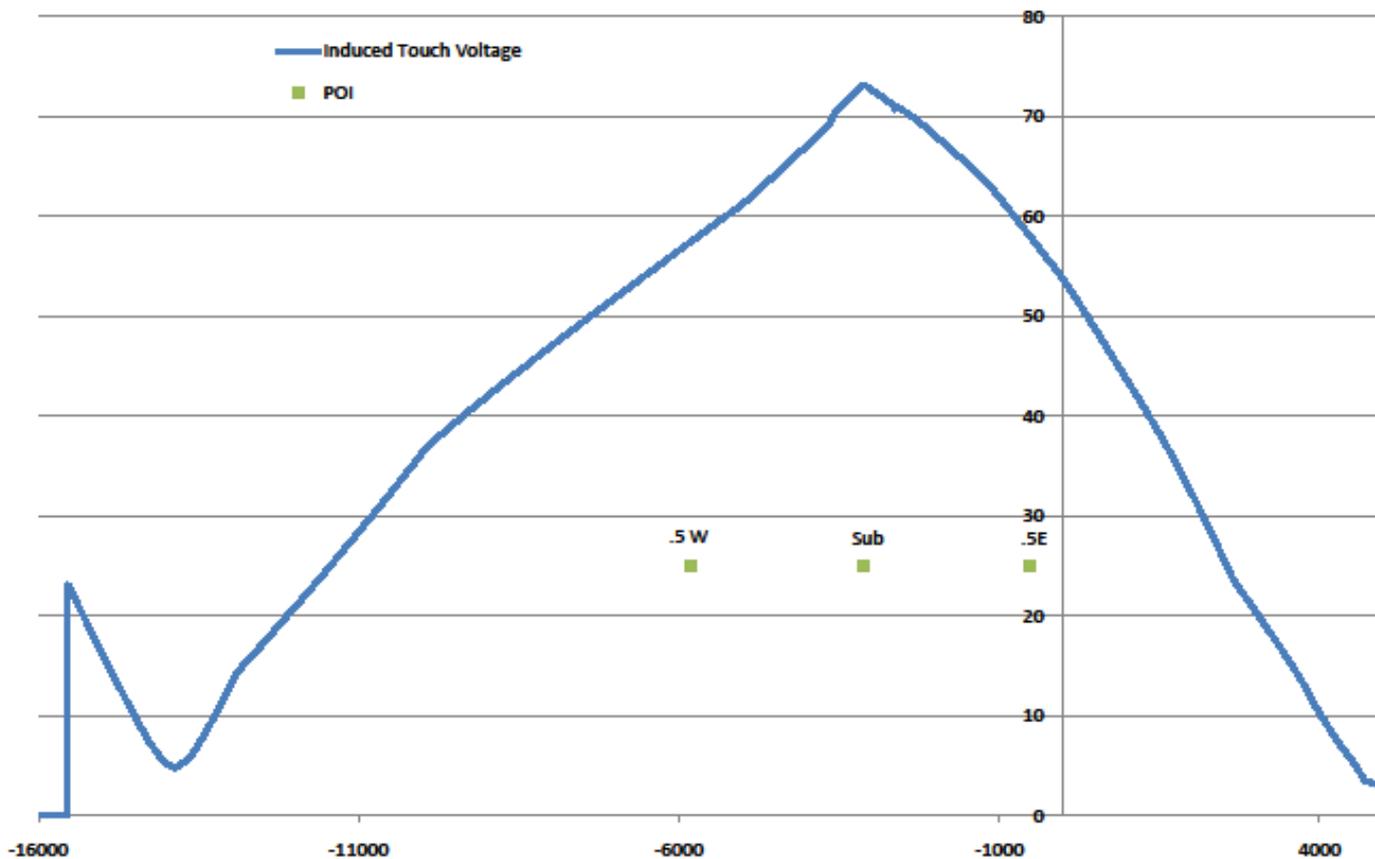


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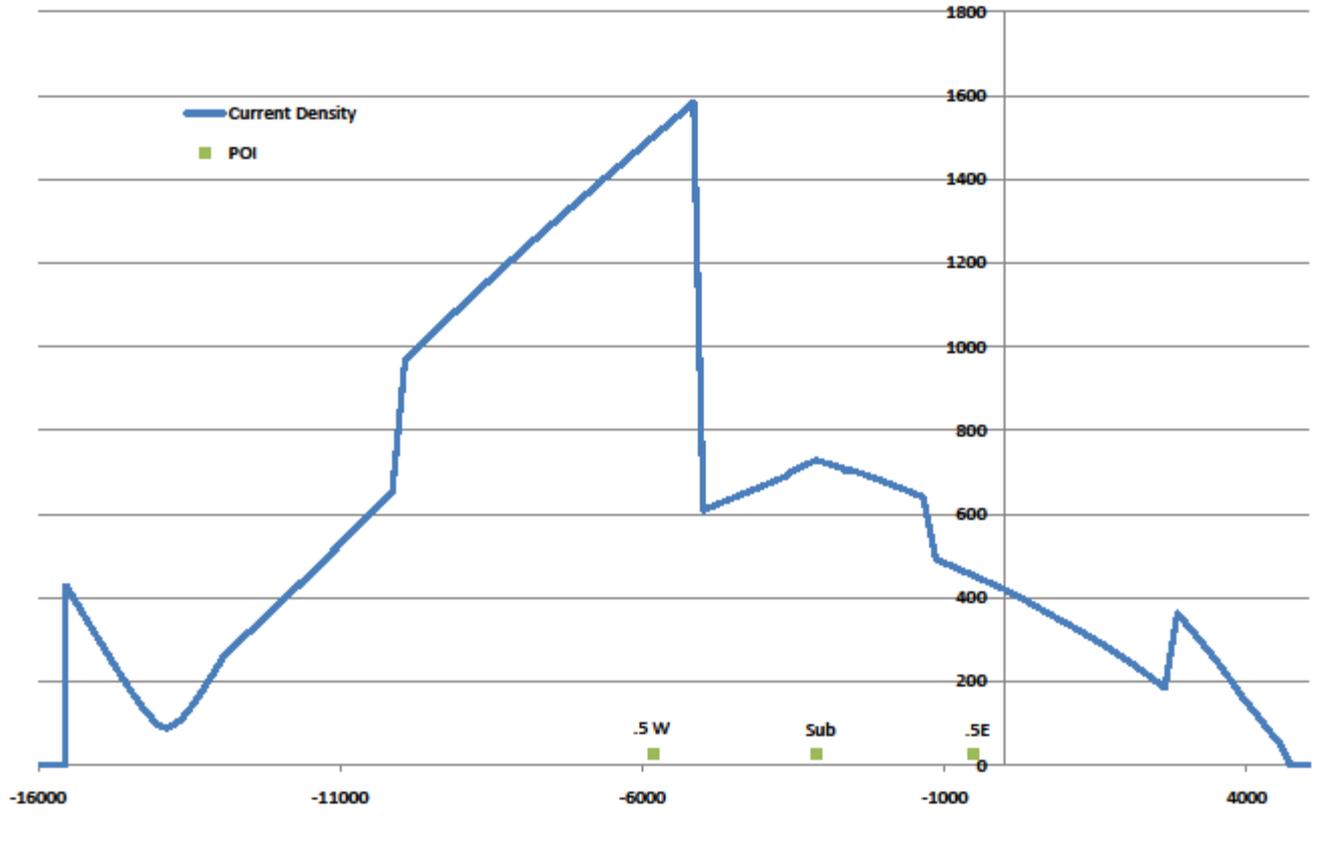
Drawing Title:

AC Mitigation Plot Layout

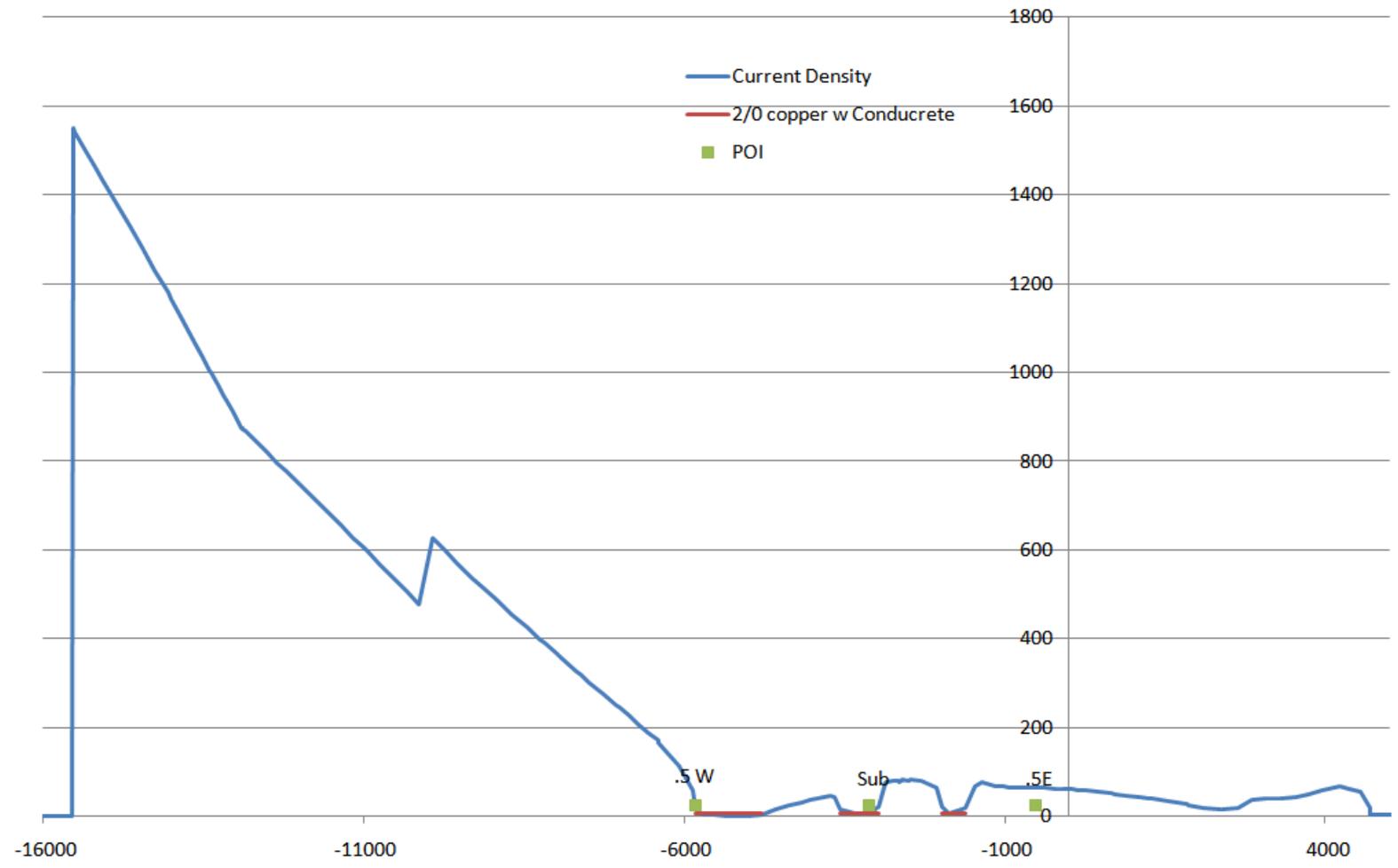
Induced Touch Voltage No Mitigation



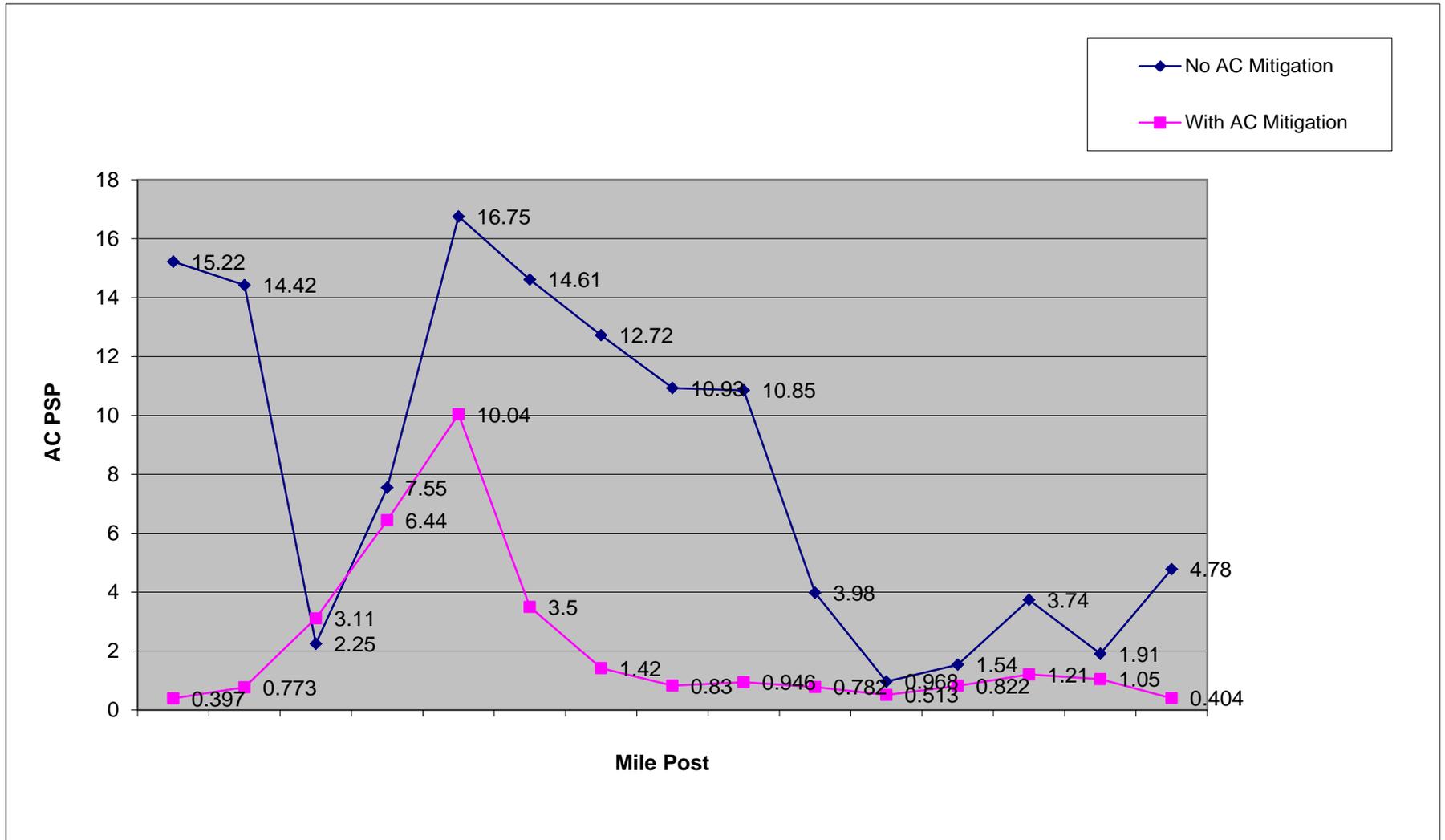
AC Current Density No Mitigation



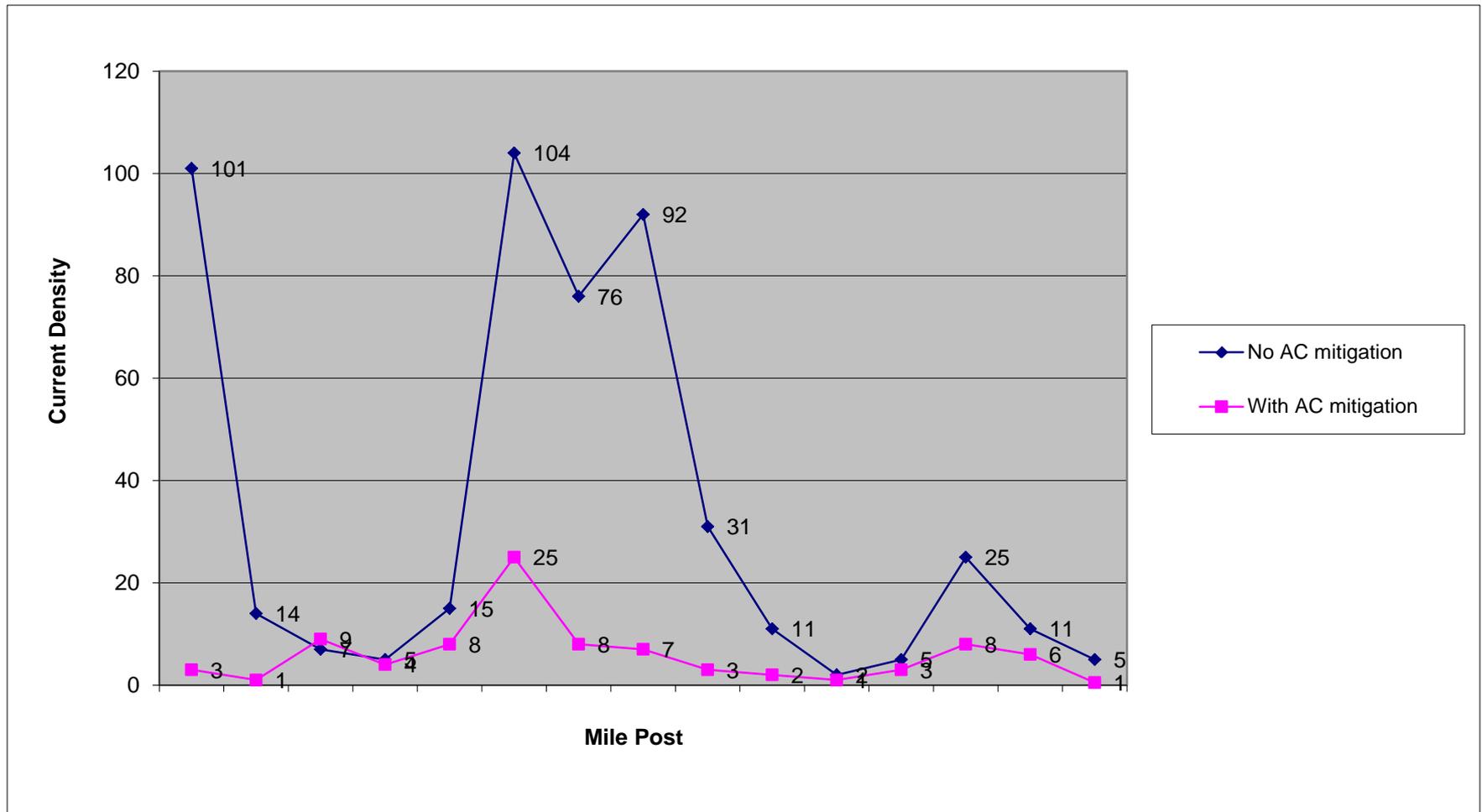
AC Current Density Mitigation



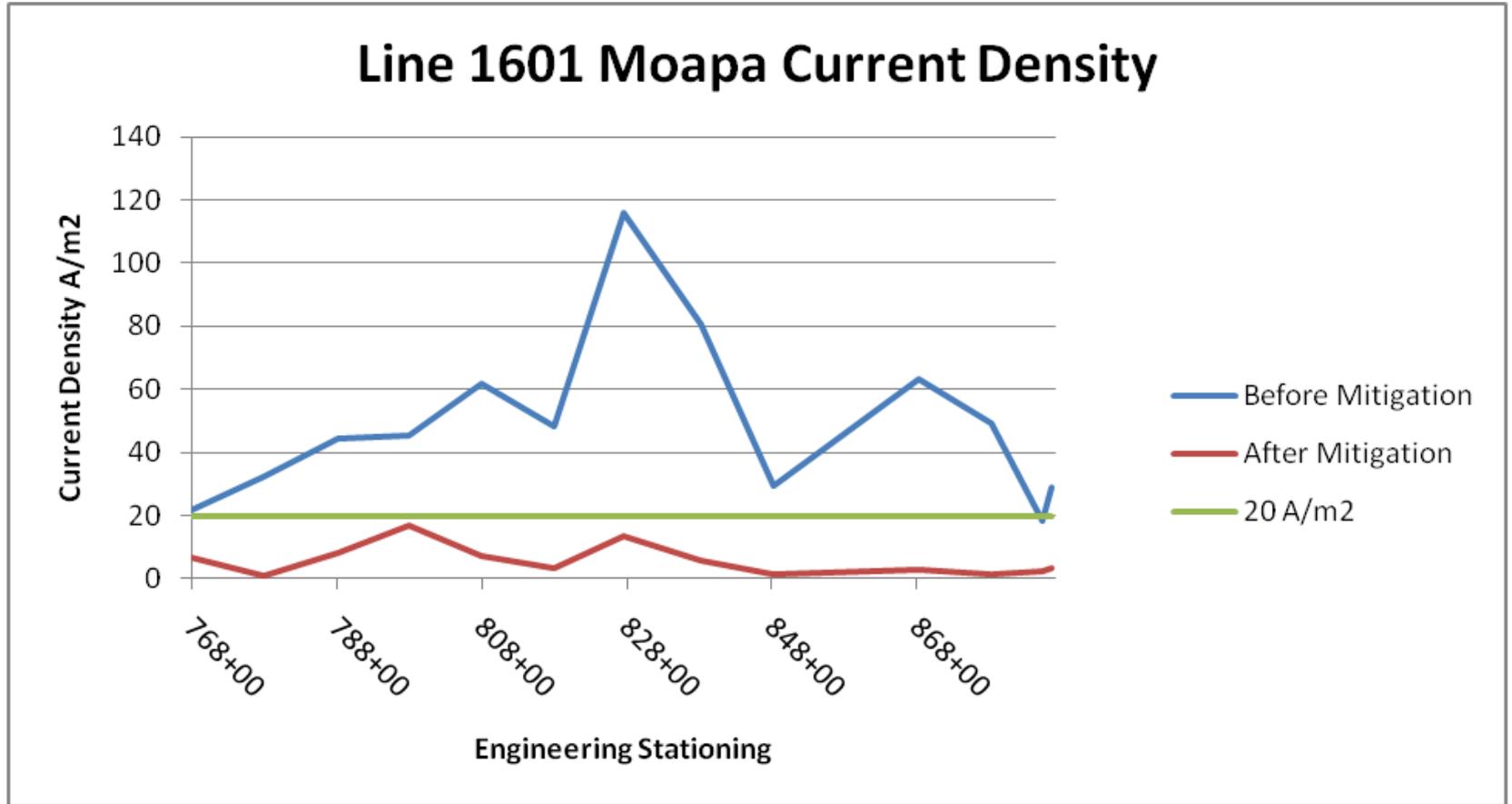
Point Drains in SE Kansas



Current Density WO/With Point Drains



Mitigation Target < 20 a/m²



Would your AC Mitigation System Survive?



Questions or Comments

- For technical support contact

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