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Mitigation of Electromagnetic Effects on Railroad Signal Systems

Electromagnetic Effects on Railroad Signal Systems

Over the last several years, railroad signal systems have migrated from electromechanical systems to microprocessor based systems. As a result, the signal systems have become more susceptible to electromagnetic effects, including lightning strikes and power line induction.

Since 1997, EMA has been involved in intense efforts to provide electromagnetic effects protection for railroad signal systems, including both wayside, hump yard and dispatch center applications. The extensive EME experience and background EMA brings from the Aerospace and Military environments has proven to provide comprehensive protection for railroad signal systems, which must provide highly reliable train control.

Lightning Protection of Railroad Signal Systems

Wayside Lightning Protection

EMA has extensive wayside experience and a thorough knowledge of signal system architecture and installations and how they can interact with lightning.

EMA has done extensive field surveys of wayside installations, including crossings, radio code, defect detectors, electronically coded track circuits, pole lines, movable bridges, etc., on installations in both the USA and Canada. Based on these surveys, EMA has identified the equipment, wiring practice, and installation issues affecting the lightning vulnerability of these systems.

EMA has then developed a comprehensive lightning protection approach, based on faraday cage shielding, cable shielding, improved wiring practices, and the fielding of a newly designed low voltage arrester for track circuits, signals, etc. This approach has been formally implemented on a large scale on some of the largest Class V railroads in the United States.

The approach is completely implemented for new wayside applications, but EMA has also developed retrofit methods for improving the protection level of legacy installations.

For more information, EMA has published a paper summarizing our approach in the 1999 AREMA conference [HTML Link to paper on our website?] proceedings.

Hump Yard Lightning Protection

EMA has performed lightning protection audits and surveys of many hump yards in the USA and in Canada. As a result, EMA is very familiar with hump yard process control and the related lightning protection issues.

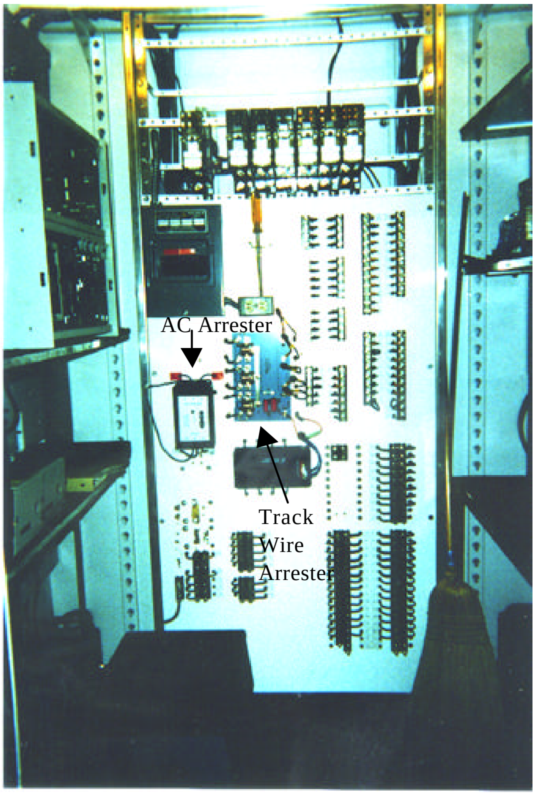
EMA has worked with one of the largest Class V railroads in the USA to provide a comprehensive lightning protection approach based on the proven concepts of faraday cage shielding, cable shielding, terminal protection, fiber optics, and improved wiring practices. This approach has been implemented on several recent upgrades of hump yard Process Control Systems (PCS), providing highly reliable operation in severe lightning environments.

Dispatch Center Lightning Protection

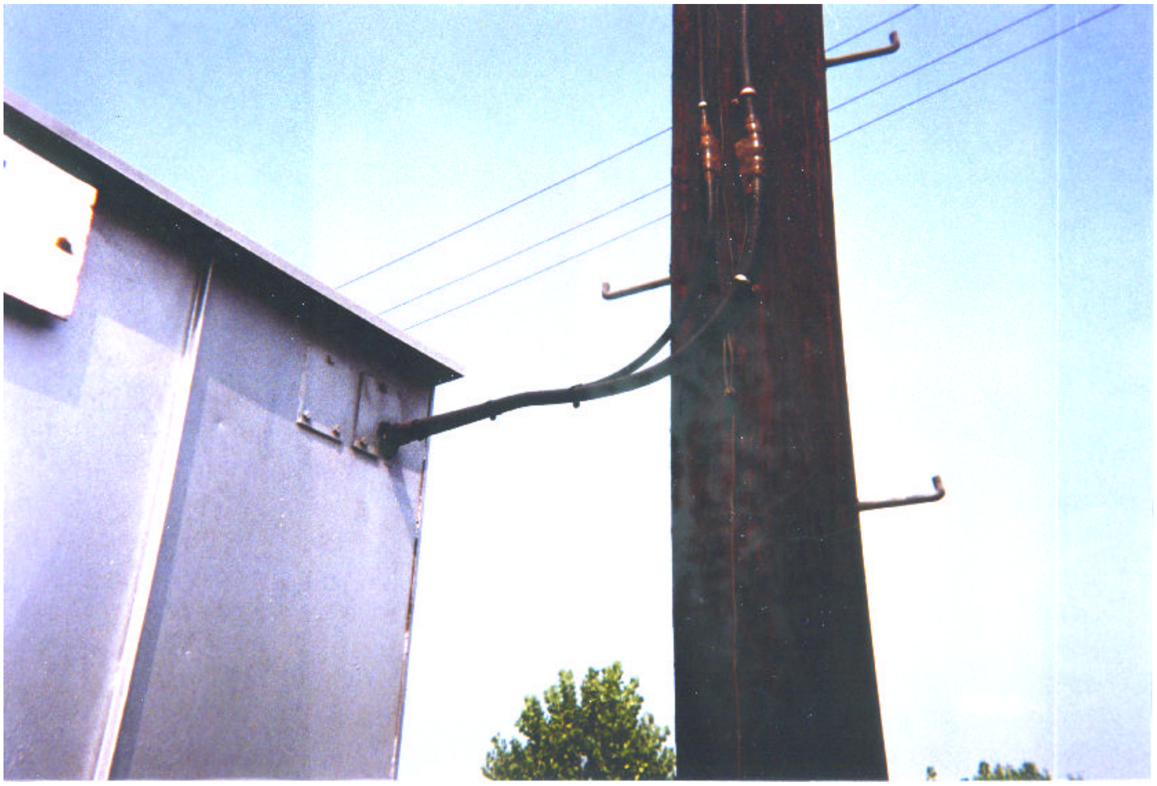
EMA has also performed lightning protection audits and surveys of many dispatch centers in the USA and in Canada. As a result, EMA is very familiar with dispatching functions and the related lightning protection issues.

EMA has worked with one of the largest Class V railroads in the USA to provide a comprehensive lightning protection approach based on the proven concepts of faraday cage shielding, cable shielding, terminal protection, fiber optics, and improved wiring practices. This approach has been implemented on some major dispatch centers to provide significant improvements in operations reliability.

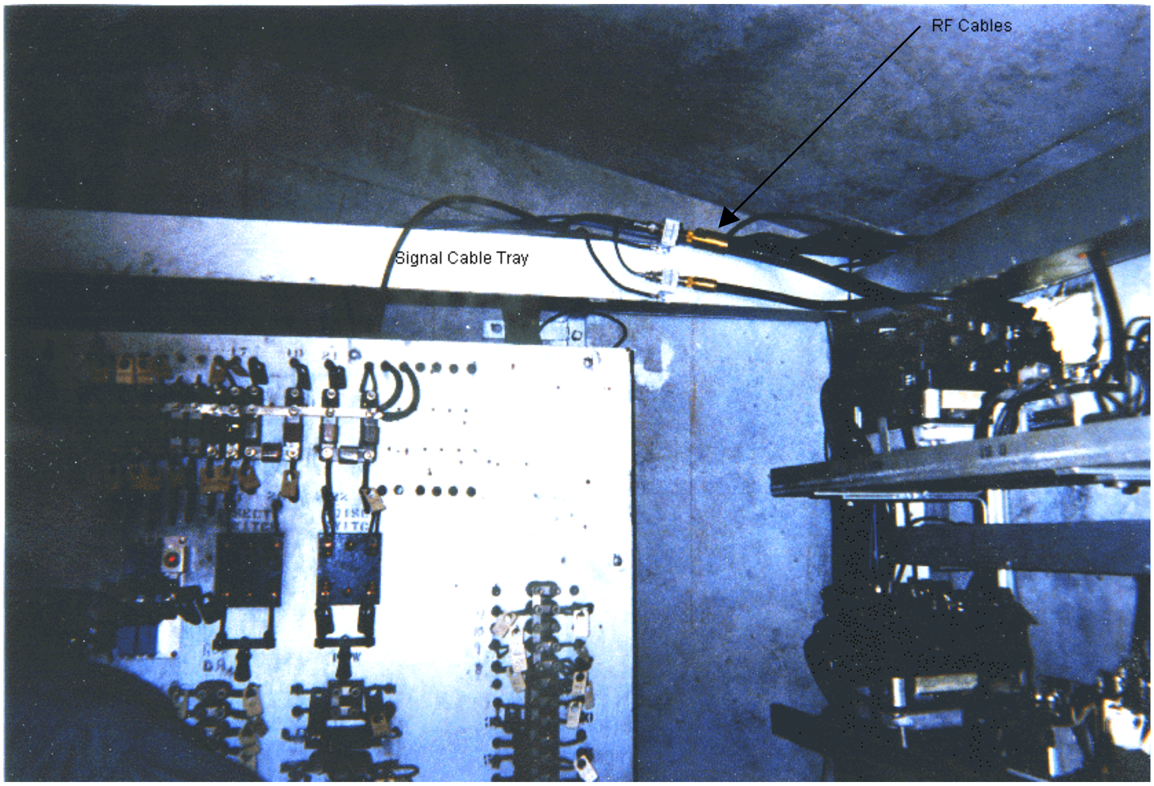
Back Door of a Bungalow Showing Black Dirty Wires and Blue Clean Wires Intermingled



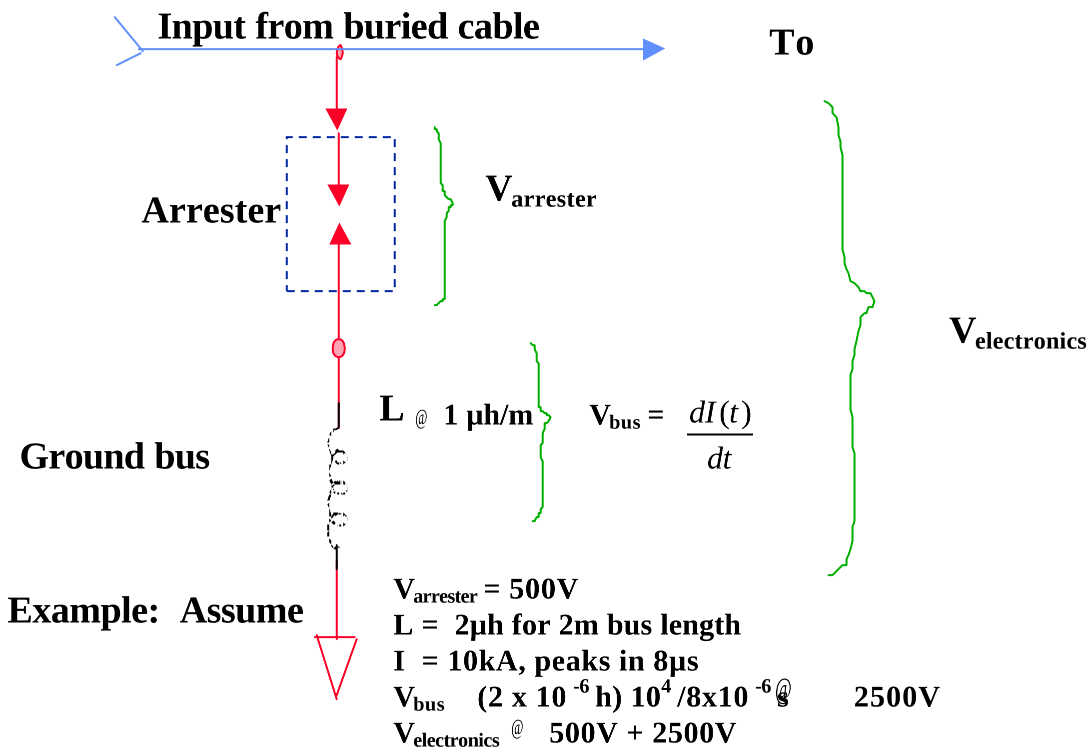
Front of Terminal Board Showing Long Lead Lengths on AC and Track Wire Arresters



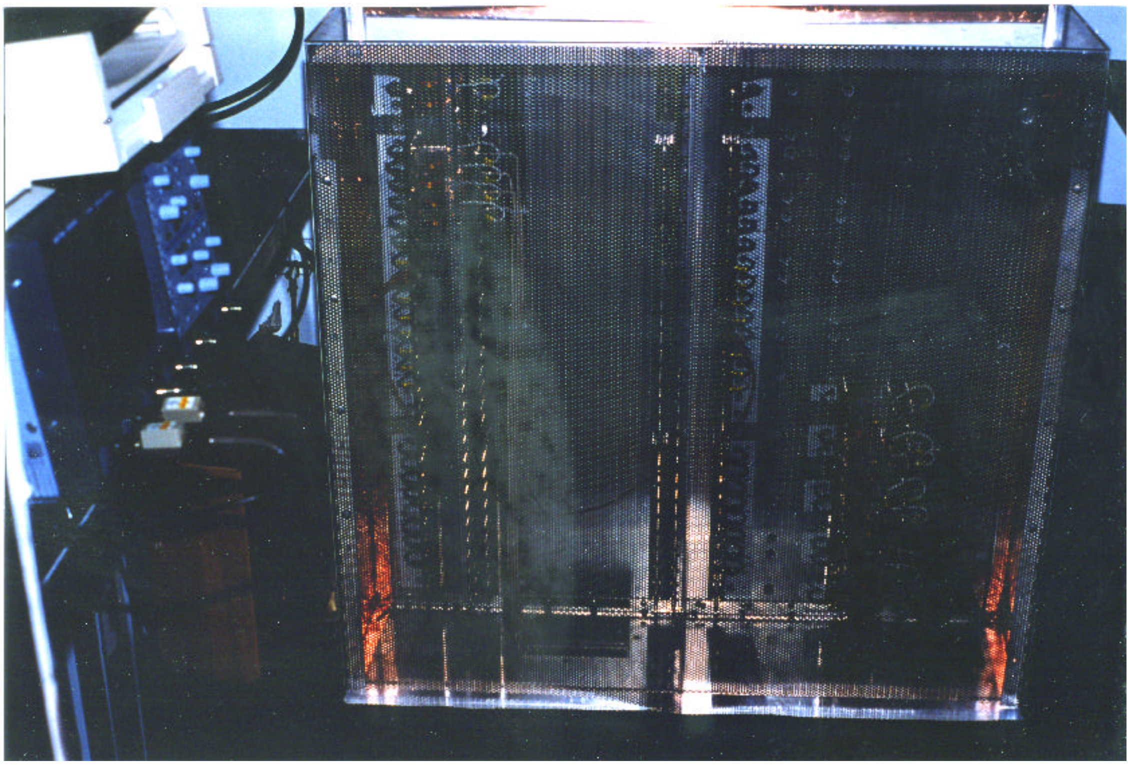
Direct Penetration of RF Cable Shields through Bungalow Skin to Interior



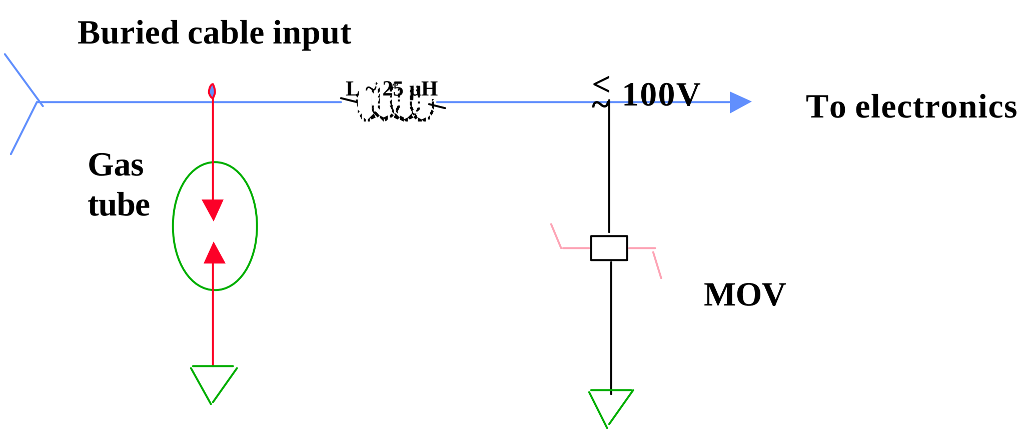
Direct Penetration of RF Cables into Bungalow and in Close Proximity to Signal Cables



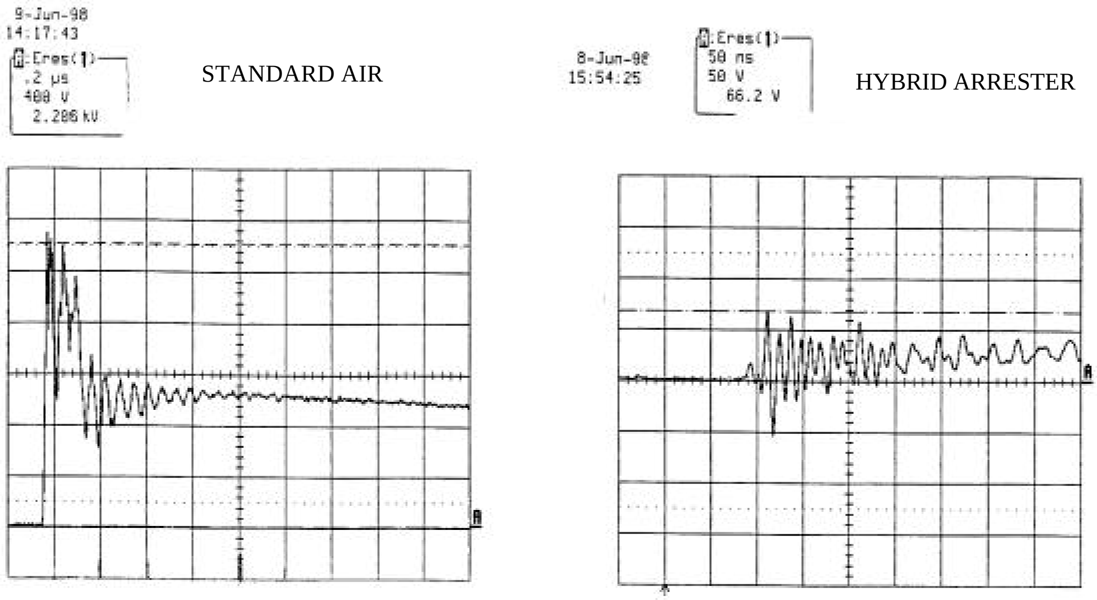
Degradation of Arrester Effectiveness by Long Leads



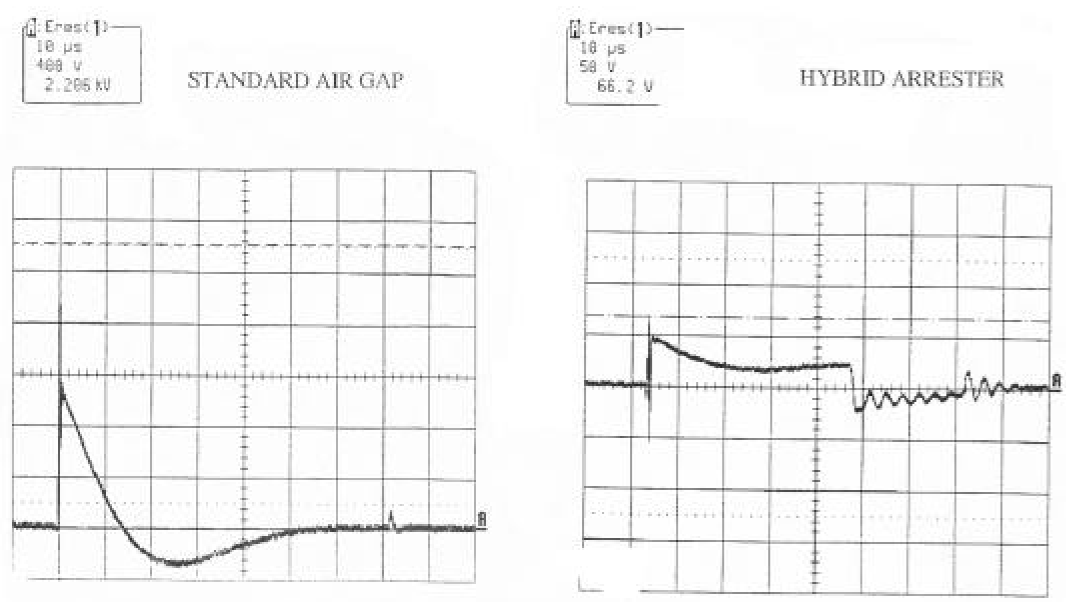
An Example of a Faraday Cage Installed in a Bungalow



Basic Hybrid Arrester Configurations

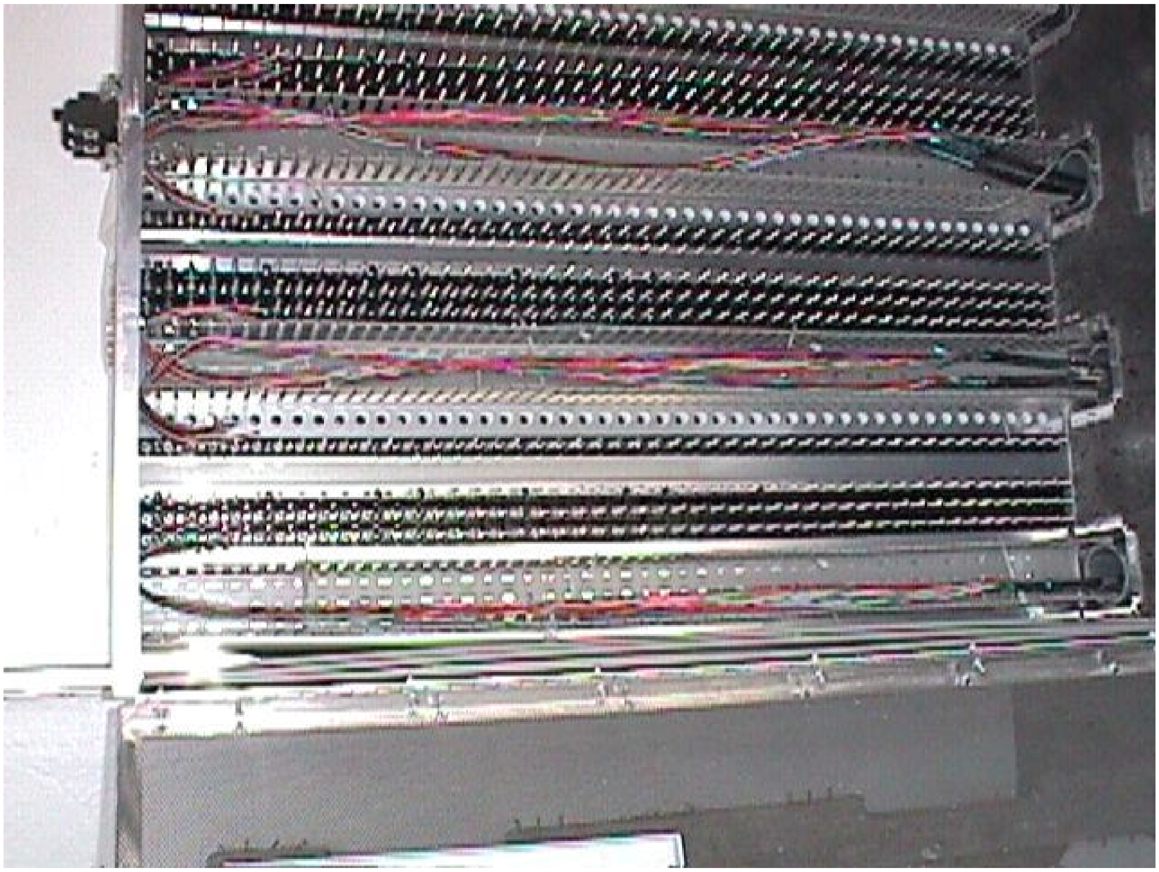


Comparison of Arrester Responses mounted on a Ground Plane in a Bungalow (Fast Time Scale)



Comparison of Arrester Responses mounted on a Ground Plane in a Bungalow (Slow Time Scale)

An Example of a Lightning Protection Retrofit Kit



An Example of a Faraday Cage Implementation for Hump Yard PCS Protection

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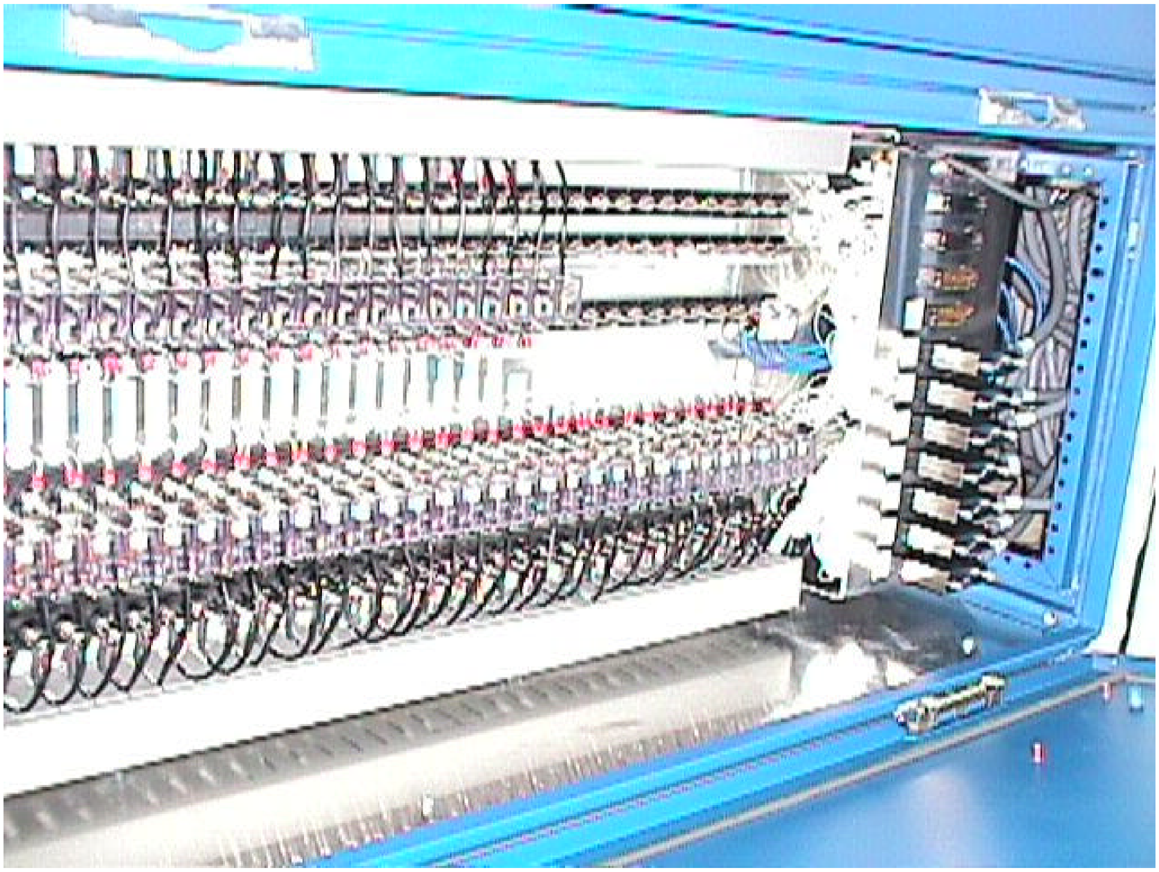
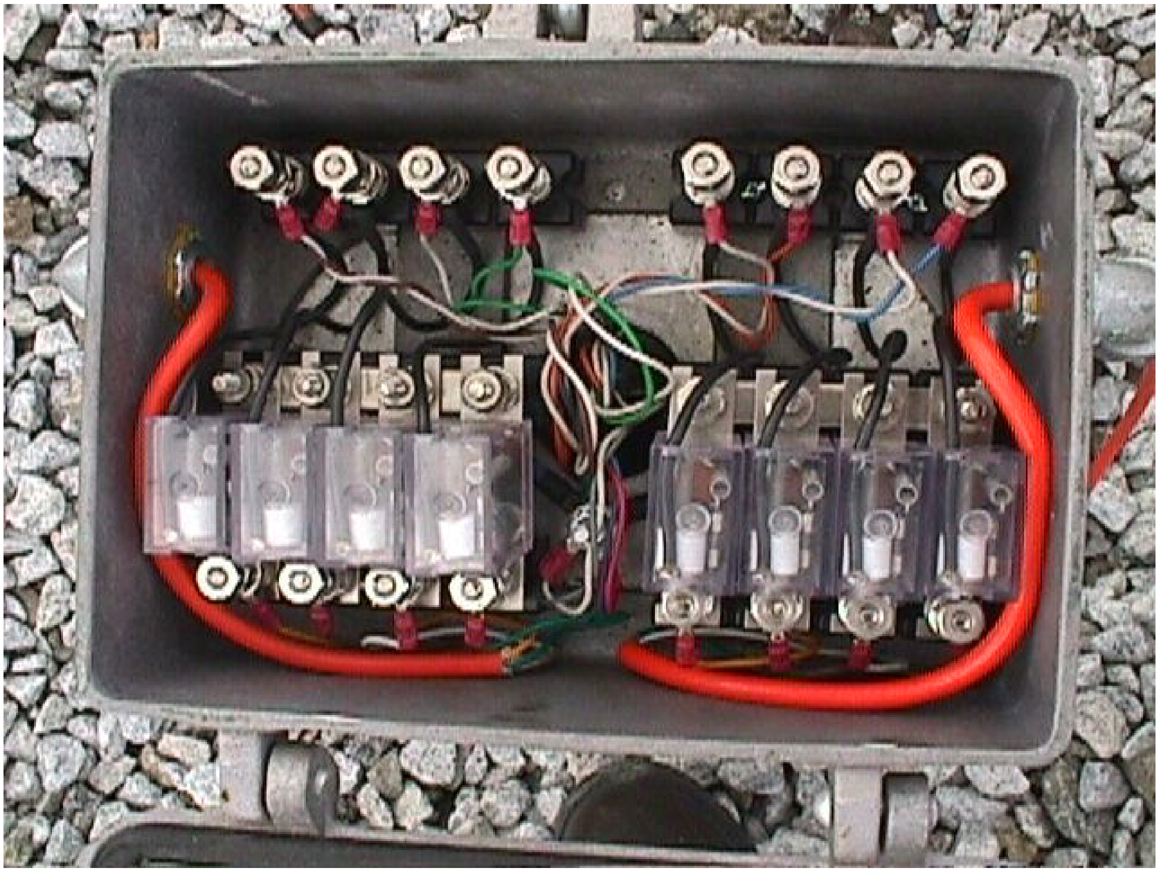
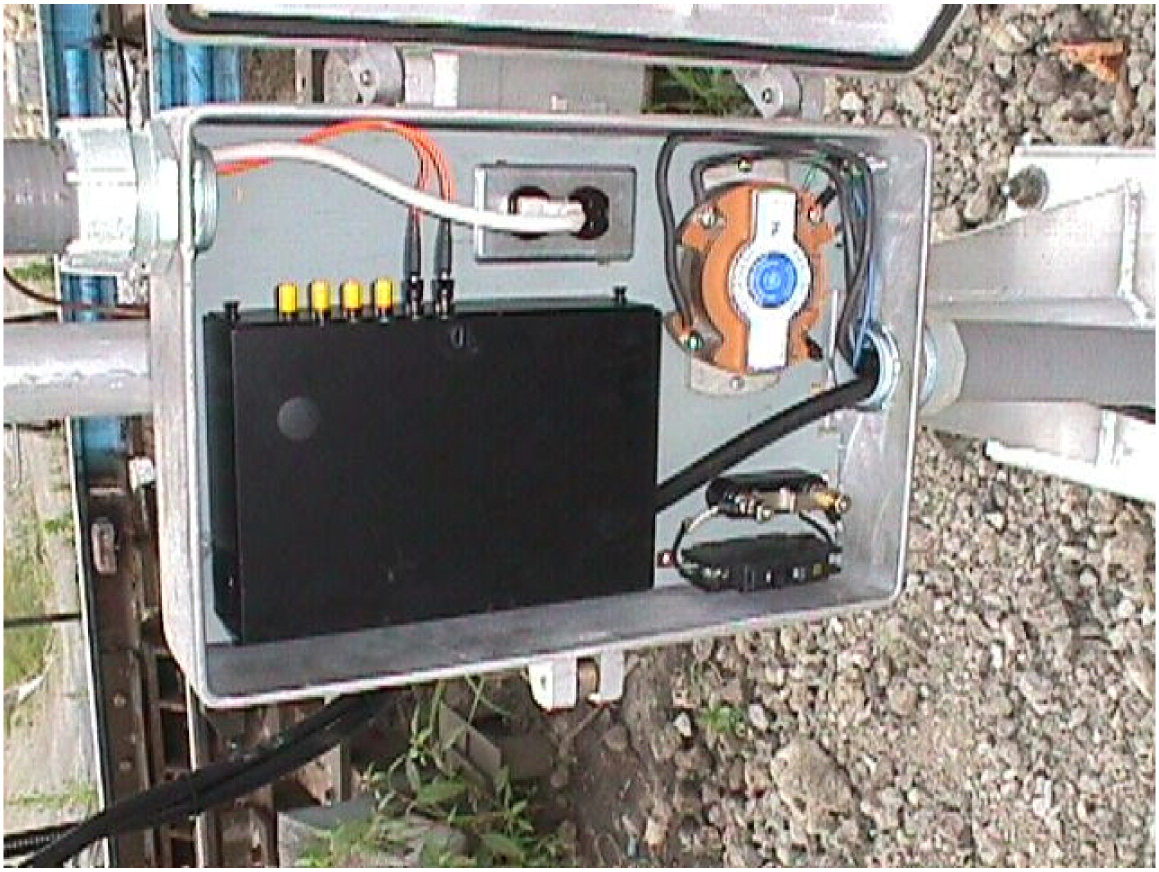


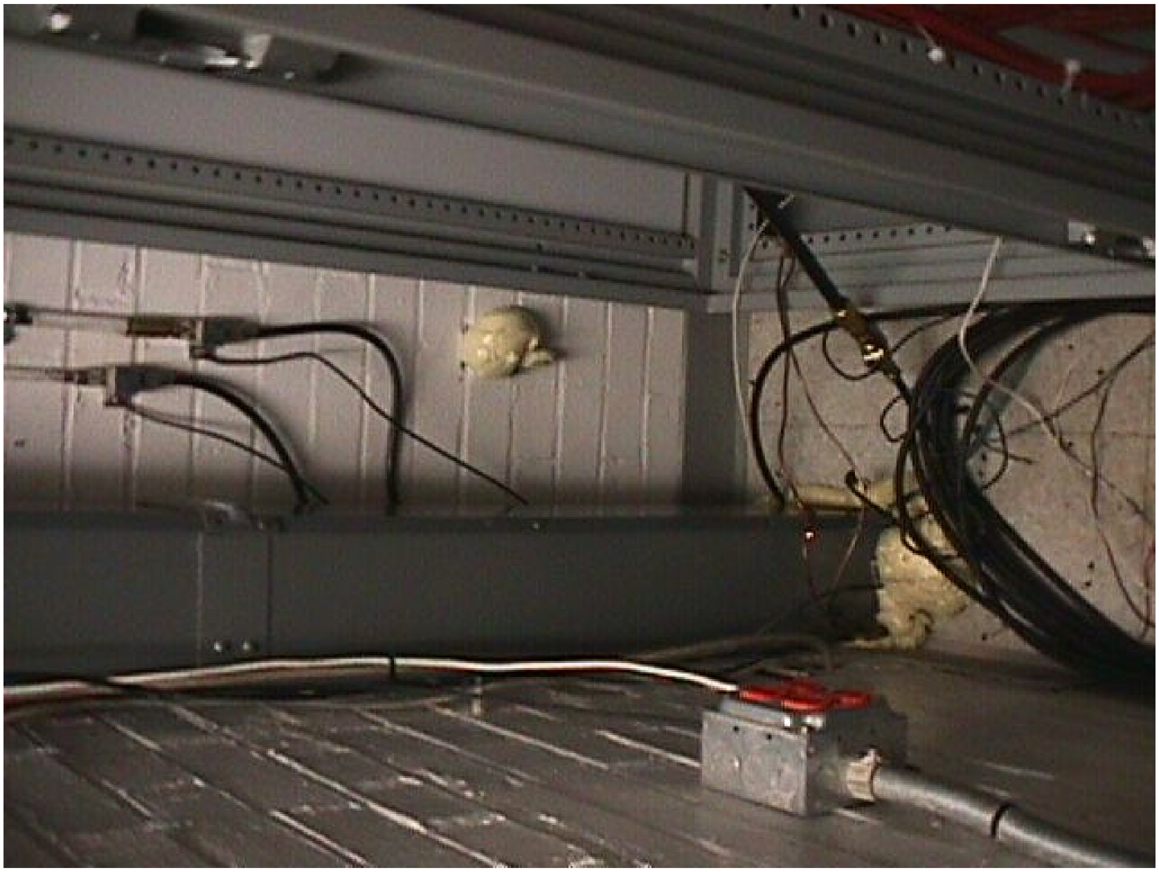
An Example of a Faraday Cage Implementation for Hump Yard PCS Protection



An Example of a Hybrid Arrester implementation for Yard Equipment



An Example of Improved AC Power Protection



The penetration of RF cables from a communication tower near a PCS in a Retarder Tower can bring lightning directly into the PCS itself.

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A communication tower near a retarder control tower provides significant lightning exposure to any PCS electronics in the retarder tower.

The penetration of communication cables into bungalows provides a large lightning point of entry.

Induction Mitigation for Railroad Signal Systems

Induction can have significant effects upon signal systems, including interference, upset, and equipment damage. In some cases, induced voltages can present a human safety concern.

There are basically two types of induction:

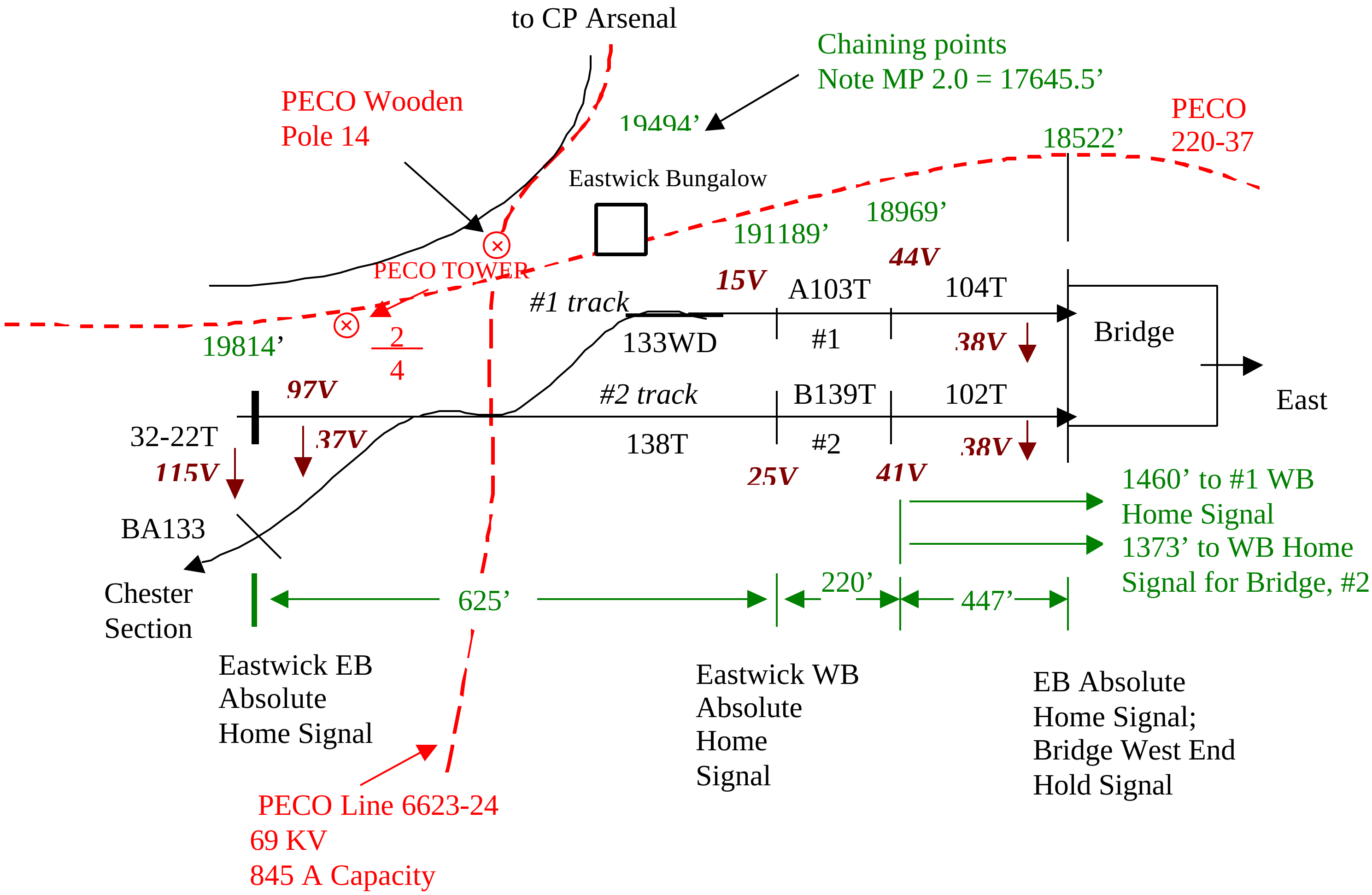
- A transient event caused by a power line fault
- Steady state induction

EMA has significant experience in the mitigation of both of these types of induction effects on shared corridors. EMA has performed several field activities and theoretical studies to provide working solutions for induction problems.

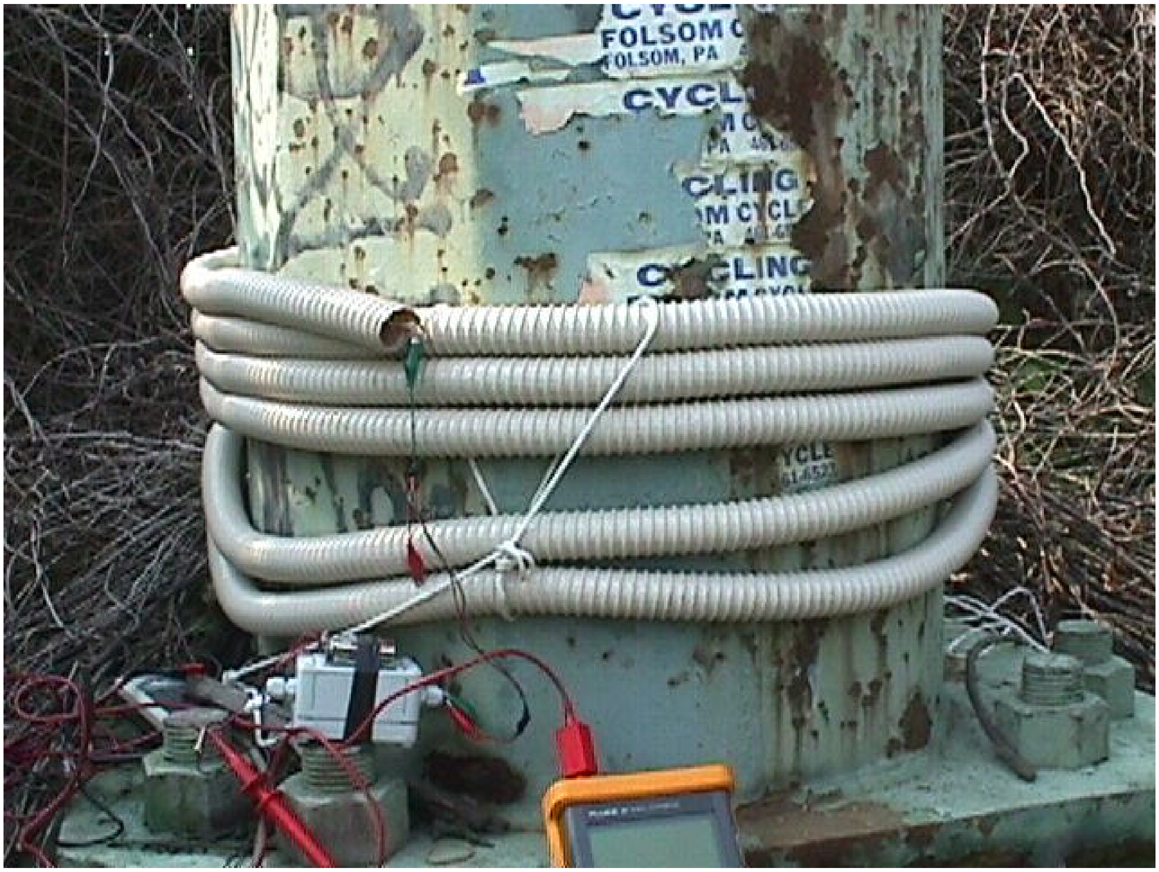
EMA has the capability to perform site surveys and measurements of complex induction problems. EMA also has the theoretical and numerical computational capability to perform state of the art analysis and simulations of complex induction problems. EMA can work with both the railroads and power companies to provide effective mitigation approaches.

Recently, EMA has validated the effectiveness of an impedance bond approach to mitigate effects on a shared corridor about 30 km long. This approach involved considerable coordination between the railroad and the power company, including coordinated measurement and validation programs. This project also involved the development of a novel probe to measure AC currents in large transmission line towers.

A typical shared corrider

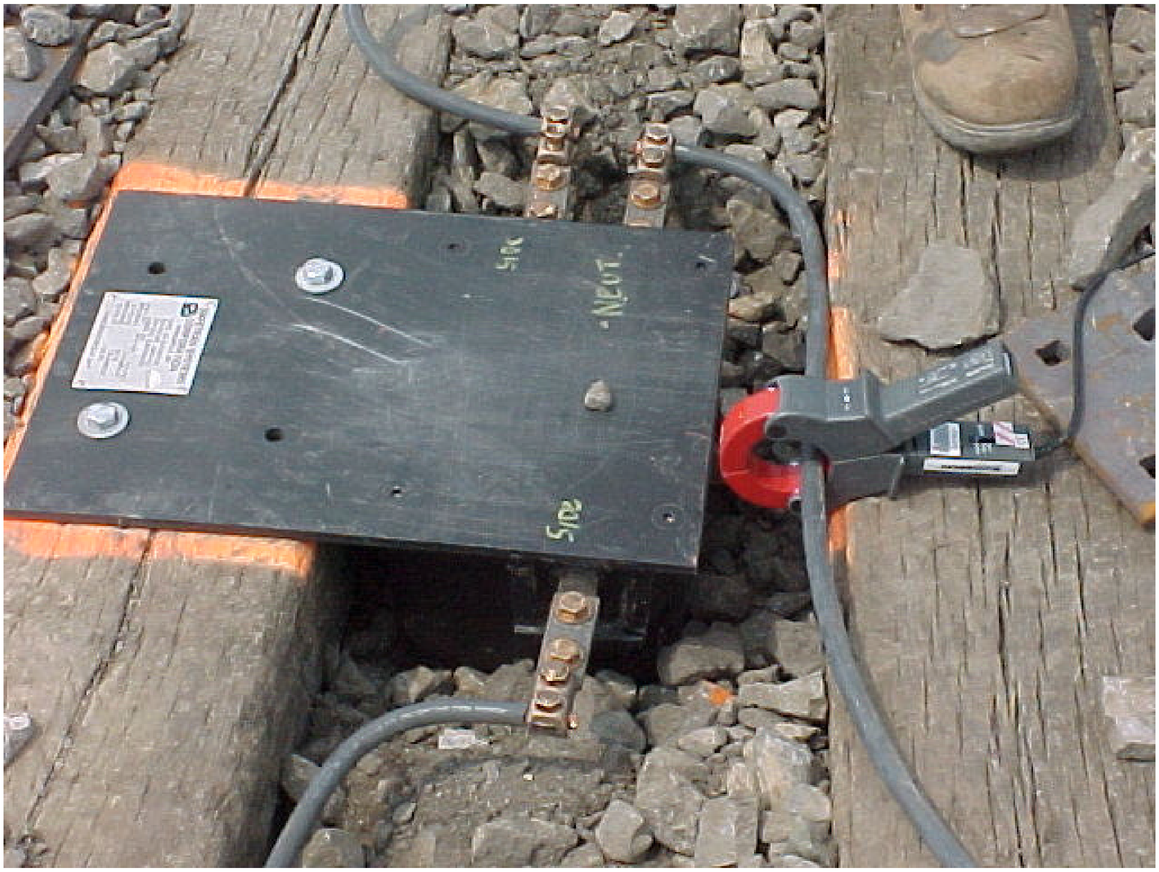


An example of induction measurement results on a complex portion of shared corridor



A novel approach for measurement of leakage currents in large steel transmission line towers

Implementation of impedance bond induction mitigation



Implementation and measurements of impedance bond induction mitigation