

EPRI EMP Testing and Design Support Applications

High-Altitude Electromagnetic Pulse (HEMP) has long been identified as a threat to power grids around the world and can disrupt unhardened power systems over large geographical areas. EPRI is here to help! With decades of power system and electric utility experience, coupled with advanced HEMP and electromagnetic analytical and testing capabilities, EPRI can perform comprehensive analysis of potential HEMP impacts, identify and design potential mitigation options, and provide engineering solutions to minimize unintended consequences that can result from improper implementation of mitigation. EPRI has extensive experience performing HEMP assessments and designing HEMP hardened power grids, and can offer the following services:

Technical Consulting and Design Support

Effective HEMP mitigation requires that project teams include HEMP subject matter experts. EPRI currently provides expertise to utilities and manufacturers and the U.S. government. Capabilities include:

- Analysis of electric power grids to determine system and component susceptibility to HEMP radiated and conducted threats
- Detailed design of HEMP mitigation systems
- Technical review of substation control building and/or HEMP shielded enclosure designs and bid packages
- Suggestion of mitigation solutions given various constraints (budget, desired hardening level, etc.)
- Validation of proposed designs through modeling and simulation and testing

Modeling and Simulation

System modeling provides an estimation of the electrical stresses equipment could be exposed to during a HEMP event. When used with testing data, modeling and simulation can predict HEMP impacts of large systems. EPRI has extensive experience using and developing computer-based HEMP modeling and simulation tools. Capabilities include:

- Estimation of the voltage and current surges that result from coupling of E1 and E2 HEMP into cables and overhead lines
- 3D electromagnetics (E/M) modeling and simulation using CST Studio to perform highly detailed E/M analyses of electromagnetic interactions in complex systems.

Component and System Testing

Effective hardening of electrical systems requires an understanding of the HEMP stress levels that equipment can withstand. At EPRI's HEMP laboratories in Knoxville, Tennessee and Charlotte, North Carolina, components and systems are exposed to threat-level insults (E-field, voltage, and current surges) to determine equipment susceptibility levels. These testing capabilities allow the following to be determined:

- Efficacy of conducted threat mitigation devices (low voltage surge protection devices/filters)
- HEMP conducted threat susceptibility testing of electronic devices via MIL-188-125-1 compliant direct voltage and current injection testing up to 300 kV and 1000 A, respectively with a 10 ns rise time, 500 nsec FWHM pulse width.
- HEMP radiated susceptibility of electronic devices and systems up to 50 kV/m with two ns rise time and 25 nsec FWHM pulse width via MIL-STD-461G/RS105 guided wave test facility
- E1 HEMP shielding effectiveness testing of shielded buildings and enclosures within RS105 facility

EPRI can also perform testing at a customer's site including:

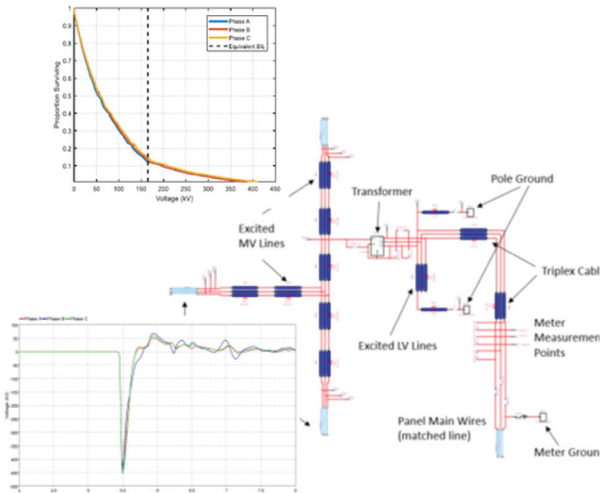
- MIL-188-125-1 Appendix A compliant shielding effectiveness testing of buildings and structures
- Direct voltage injection up to 300 kV

Training

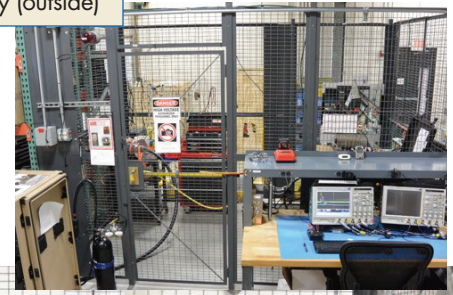
EPRI engineers are experienced at delivering training classes on a multitude of HEMP related topics. Training is offered either in-person at an EPRI or customer facility or can be performed via video teleconferencing. EPRI can provide custom tailored training classes to meet customers' specific needs.

Examples of EMP Testing and Design Support Services

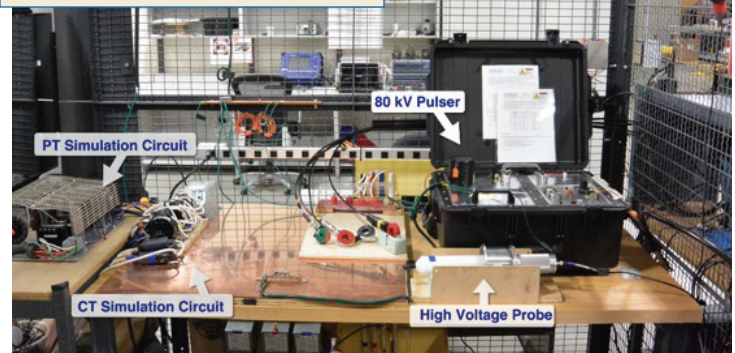
Example power system conducted threat model and results



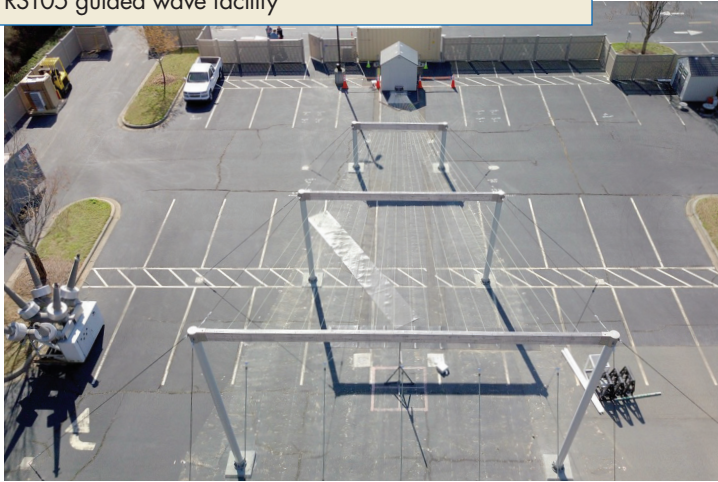
Direct-injection laboratory (outside)



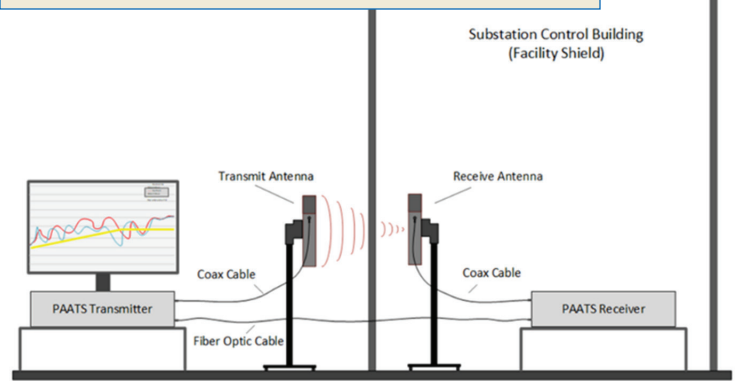
Direct-injection laboratory (inside)



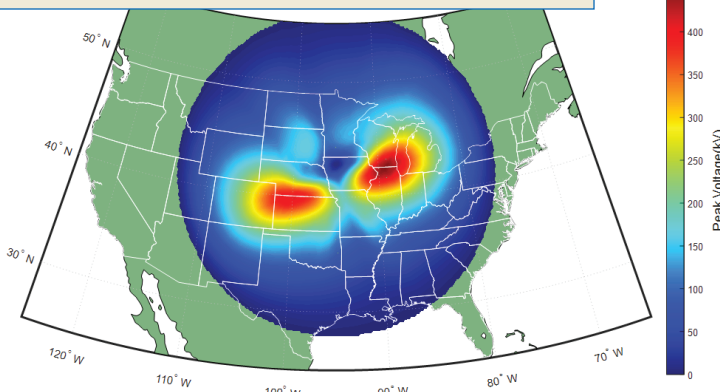
RS105 guided wave facility



Shielding effectiveness test illustration



Example geographical variance of impacts to equipment



Why EPRI?

EPRI has extensive experience performing HEMP-related services for electric utilities, OEMs and the U.S. government. EPRI combines decades of experience in power systems and the utility industry with advanced high frequency electromagnetics analysis and testing capabilities to ensure that HEMP mitigation solutions are optimized for electric utility applications. HEMP interaction with the power grid is commonly presented as "just another electromagnetic interference (EMI) problem". However, effective analysis and mitigation of HEMP threats to the grid require not only a deep understanding of high frequency electromagnetics, but also intimate knowledge of power systems and the utility industry. EPRI is an industry leader that can provide both.

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

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