

# Assessment and Mitigation of Intentional Electromagnetic Interference (IEMI)



Figure 1. Illustration of IEMI attack on a server rack using a portable weapon

## Background, Objectives, and New Learnings

Intentional electromagnetic interference (IEMI) refers to a manmade electromagnetic attack where the target, for example, protection and control systems inside a substation control building, are intentionally subjected to intense electromagnetic (EM) and/or electrical signals. Like the threat posed by early-time high-altitude electromagnetic pulse (E1 HEMP), IEMI threats can be categorized as either radiated or conducted. In the case of a radiated attack, a high-voltage source is connected to an antenna and is used to generate an intense electromagnetic field that propagates through the air and unshielded infrastructure and interacts with electronic systems directly or through coupling to cables that are connected to the device(s). Conducted attacks use exposed physical wiring to inject high-frequency signals directly into the targeted systems with the intent of disrupting or damaging connected equipment. Both attack vectors require some level of sophistication and physical access to the target location.

## Benefits

Public benefits can include increased reliability, increased safety, lower environmental impact including carbon reduction, affordable electricity price, etc.

Funder benefits can include increased understanding of options and risks, helping to define the research question, helping to manage institutional knowledge, increasing operational efficiency, reducing costs, and complying with regulations and laws.

This project can potentially provide the following benefits:

- Technical guidance and tools for assessing the potential impacts of IEMI on electric utility systems
- Options for mitigating the potential impacts of IEMI on electric utility systems
- Improved understanding of the costs and potential unintended consequences associated with employing IEMI mitigation

IEMI sources vary in technology, capabilities, and mobility. Radiated and conducted IEMI signals can be broadband or narrow band and delivery systems can be small portable devices that fit inside of a suitcase or larger devices that require a vehicle to transport. Radiated field amplitudes can reach 150 kV/m or higher with frequency content up to 20+ GHz as shown in Figure 2.

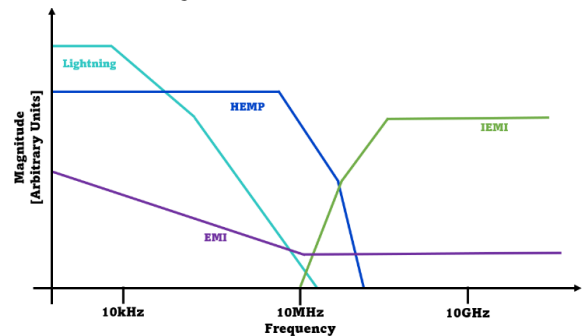


Figure 2. IEMI frequency spectrum compared to E1 HEMP and lightning

Given the recent emergence of substation physical attacks, IEMI has begun to receive attention as another method by which an attacker could assault critical infrastructure. IEMI may represent an attractive attack vector for the following reasons<sup>1</sup>:

- Radiated electromagnetic fields generated by IEMI weapons can penetrate physical boundaries such as fences and building walls.
- IEMI attacks can be undertaken covertly and anonymously by state actors or criminals with minimal obvious evidence left after a failed attempt.

<sup>1</sup> F. Sabath and H. Garbe, "Risk potential of radiated HPEM environments", 2009 IEEE International Symposium on Electromagnetic Compatibility, Austin, TX, USA, pp. 226-231

- There is significant potential to disable or disrupt functionality of critical systems and infrastructure.
- IEMI sources and their components are available on the open market; many are small and highly mobile, for example the suitcase weapon shown in Figure 1.

While EPRI and the electric utility industry have made significant strides in understanding the potential impacts and mitigation methods related to E1 HEMP, little information is available regarding the potential threat, impacts and mitigation of IEMI attacks on critical energy infrastructure. The primary objective of this research is to improve understanding of IEMI threats (radiated and conducted) and mitigation leveraging EPRI's vast body of knowledge and resources related to E1 HEMP impacts and mitigation.

### Benefits

This project can potentially provide the following benefits:

- Technical guidance and tools for assessing the potential impacts of IEMI attacks on critical electrical infrastructure and electronics
- Options for mitigating the potential impacts of IEMI on electric utility systems
- Improved understanding of the costs and potential unintended consequences associated with IEMI hardening of systems.

### Project Approach and Summary

This project will leverage prior and ongoing R&D in high-altitude electromagnetic pulse (HEMP). Specific tasks planned for this project include:

**Task 1:** Literature review of available public documents describing IEMI technologies and threats to help determine characteristics of attacks that are most likely to occur to critical electrical infrastructure.

**Task 2:** Survey of available commercial IEMI test equipment and its relevance to IEMI threats identified in literature review.

**Task 3:** Modeling and simulation of representative systems exposed to various IEMI sources to determine electromagnetic and electrical stresses expected to critical devices.

**Task 4:** Laboratory testing of critical substation electronics (digital protective relays, SCADA, telecom, etc.) against IEMI radiated source(s). Specific equipment tested will be defined by donations from project members.

**Task 5:** Laboratory testing of E1 HEMP hardened structures against IEMI radiated test sources to determine how effective E1 HEMP hardening is against IEMI.

**Task 6:** Determination of mitigation options including rough costs and laboratory testing of solutions, as appropriate.

### Deliverables

- A technical guidebook which enables the reader to assess the potential impacts of IEMI on substations and control centers as well as providing step-by-step guidance to develop engineering solutions to mitigate the potential impacts.
- A software tool to aid practitioners in assessing potential IEMI vulnerabilities of critical power system components.
- Annual Workshop and periodic update WebEx meetings.

### Price of Project

The price of this project is \$60k per year for two years (\$120k total) for utilities with > 10,000 MW of peak transmission capacity and \$30k per year for two years (\$60k total) for utilities with less than 10,000 MW of capacity. The project qualifies self-directed funding (SDF).

### Project Status and Schedule

This two-year project is expected to start in Q3 2023.

### Who Should Join

Asset owners responsible for the resiliency, reliability, and security of transmission, distribution, or associated systems.

### Contact Information

For more information, contact the EPRI Customer Assistance Center at 800.313.3774 ([askepri@epri.com](mailto:askepri@epri.com)).

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