

*Exceptional service in the national interest*



*Gigahertz Transverse ElectroMagnetic (GTEM) test chamber is rated for continuous operation from direct current to more than 1 gigahertz and short duration operation up to electrical fields of 125,000 volts per meter for simulation of nuclear electromagnetic pulse.*

## ElectroMagnetic (EM) Radiation Effects Sciences

*Securing our Nation from the threat of hostile EM radiation environments*

Triggering a threat to our nation's electricity grid, an ElectroMagnetic Pulse (EMP) could cause catastrophic damage, resulting in long-term, national power outages. This sudden burst of electromagnetic radiation, from a natural or man-made event, is likely to intensify as we enter into a period of vast solar activity – resulting in an increase in geomagnetic events on earth. Because survivability of our nuclear weapons stockpile in hostile radiation and EMP environments has been a national security concern at Sandia since the 1950's, the synergy between this nuclear deterrence mission and broader national security missions forge a robust capability base that empowers us to solve other complex national security problems including the safety, security and resilience of national energy infrastructure and assets.

Sandia National Laboratories accelerates its research by focusing on understanding the physics and effects of neutron, X-ray, gamma ray and non-ionizing EM radiation on systems, circuits, solid-state devices and materials. Using advanced research technology to return high quality results, Sandia's exploration includes expertise in radiation induced System Generated EMP (SGEMP) and Source Region EMP (SREMP). Sandia has developed state-of-the-art computer simulation capabilities and models to understand the underlying physics of these hostile environments into complex systems. A suite of large-scale pulsed radiation sources (Hermes III, Saturn, Z) and electromagnetic test facilities, including full threat-level EMP simulators, enable code validation and realistic testing of complex systems to understand their susceptibility to these environments. The availability of these tests demonstrates Sandia's industry leading position EM testing.

### 3 General Properties of all Electromagnetic Radiation

- Electromagnetic radiation can travel through empty space. Most other types of waves must travel through some sort of substance.
- The speed of light is always a constant. (Speed of light :  $2.99792458 \times 10^8$  m s<sup>-1</sup>).
- Wavelengths are measured between the distances of either crests or troughs.

### Research & Accomplishments

Sandia has a long history of contributions in modeling, analysis and testing related to electrical grid infrastructure. The Lab pushes the boundaries to research & address current and anticipated grid (or microgrid) challenges;

- EMP/EM penetration into enclosures and through electrical cable shielding. (1994-present)
- EMP effects on SCADA and electronics equipment for the Congressional EMP Commission. (2002)
- EMP propagation into facility electrical service-entrances. (2003)
- EMP coupling and propagation on long transmission lines. (2004)
- EMP/HPM effects on the Watts Bar and Fermi-II nuclear power plants for the NRC. (2008-10)
- EMP effects on urban infrastructure for the DOD. (2012-2016)
- Fast simulation tool suite for EMP coupling to above ground and buried cable systems for the DOE. (2013-present)
- DOD-DOE collaboration on EMP and SREMP modeling capabilities for electrical grids and high voltage distribution equipment. (2015-ongoing)

### Research Funding Base

Funding for studies, experimental investigations and reports represent a significant step in addressing the continued challenges facing the industry. Sandia influencers include DOE/NNSA NA-10 Engineering/Science Campaigns & Stockpile and Weapons Product Realization Program, Laboratory Directed Research and Development, other Government Agencies and International Partners.