

# Electric Power Research Institute Power Delivery and Utilization Laboratories

## Capabilities and Facilities Overview



# A Tradition of Leading-Edge Research

## Capabilities of the Power Delivery & Utilization Laboratories

For more than three decades, the Electric Power Research Institute, Inc. (EPRI) has been a source of leading-edge research for the electric energy industry. Over that time EPRI's laboratories have provided an environment where experiments and technology-application research in energy utilization, power distribution and high-voltage transmission are conducted and proven. Those experiences help accelerate the pace of research it performs today. For example, EPRI is able to apply wisdom from its experience in high voltage transmission to lower voltage distribution applications.

EPRI has laboratories in Charlotte, North Carolina; Knoxville, Tennessee; and Lenox, Massachusetts and these facilities engage in testing for transmission and distribution companies, end users as well as industrial customers. In many instances, EPRI's labs serve companies whose primary goal is maintaining a high level of power quality.

## Distinct Capabilities

The EPRI laboratories offer specific capabilities that few electric power research labs can offer.

**Non-Ceramic Insulators.** A world renowned expert on non-ceramic insulators is part of the EPRI team. Additionally, the company has the capability to do testing and analysis that few companies can do, such as aging tests on polymer insulators.

**SEMI F47.** EPRI manages a comprehensive program around the SEMI F47 voltage sag standard. With its unique portable test equipment, EPRI engineers can evaluate the ability of semiconductor tooling equipment to meet voltage sag performance requirements and comply with the standard. The company can also consult, train, execute onsite testing, as well as carry out onsite power quality audits. EPRI has a PQ Star certification program to test manufacturer equipment per established power quality standards such as SEMI F47-0706 and IEC 61000-4-11 and IEC 61000-4-34. With the PQ Star certification, EPRI offers a third party verification that the equipment tested meets these important power quality standards.

**Training - EPRI AC Transmission Line Reference Book—200 kV and Above (Red Book Reference Guide)** This publication is recognized as a comprehensive reference material on the cost-effective design of safe, reliable, and high-performance transmission lines. Industry experts are the authors of this guide and the company conducts the testing that leads to the acquired knowledge. EPRI also performs the training for its application, including hands-on demonstrations at the high-voltage facility that can conduct tests at over one million volts.



EPRI manages the laboratories in a collaborative way to efficiently use their capabilities and to maximize the use of the data uncovered for any program. For example, sensor and relay testing is conducted at all three locations and results are fed into a common data center for analysis. This allows EPRI to develop algorithms to manage all of the data centrally, rather than individually at each site.

## General Capabilities

The three laboratories offer an assortment of testing and research services, which can be augmented by custom test fixtures, protocols and methods.

**Energy Efficiency and Demand Response.** Develop test protocols, test energy-saving devices and test lighting technologies or conduct field demonstrations of emerging technologies.

**Distributed Resources.** Test inter-connection hardware as well as test and evaluate energy-storage technologies, from batteries to superconductors.

**System Compatibility.** Evaluate the capabilities of devices in electrical environments, provide design expertise and conduct voltage-sag testing with the industry-leading Porto Sag<sup>SM</sup> portable voltage-sag test equipment.

**Intelligent Electronic Device Testing.** Test revenue meters, protective relays and controls for distribution and transmission equipment. Also perform data integration, system compatibility, accuracy and communication testing.

**Electromagnetic Compatibility (EMC) Testing.** Perform emissions tests, evaluate compatibility, provide field audits and provide design assistance.

**Custom Metering and Monitoring.** Design and test custom metering systems measuring energy usage, power quality, electromagnetic emissions and environmental conditions. Provide data integration and analysis, using tools such as EPRI's PQView®.

**Line Design and Performance.** Conduct simulation of line voltage, geometry and phase spacing. Also conduct hybrid transmission studies.

**Insulator Performance.** Conduct simulations of insulator contamination and contamination flashover testing.

**Insulator Aging.** Perform accelerated aging of insulators and line components, including analysis in a variety of service environments.

**Lightning Performance.** Simulate lightning and switching overvoltages and impulse surges for low-voltage, medium-voltage and high-voltage equipment.

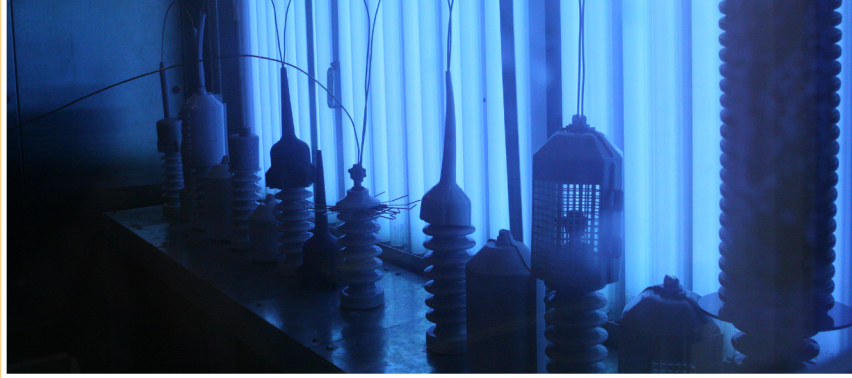
**Corona.** Investigate corona phenomena, including measurement of corona loss, audible noise and radio and television interference. Line compaction also studied.

**Manhole Design and Performance.** Simulate manhole events and test mitigation methods.

**H.V. and M.V. Inspections and Failure Analysis.** Inspect transmission and distribution lines and substation components, including infrared, corona, splice resistance, and electric and magnetic fields. We monitor for leakage current and watts loss, as well as determine and analyze the root cause of arrester failure.

**Tech Transfer and Training.** EPRI publishes reports and findings documents on topics such as power quality, wiring and grounding, video sagometer, TLWorkstation™, TFlash lightning performance software, and live line maintenance. EPRI engineers also conduct training on the same topics.

"PQView" is a registered trademark of Electrotek Concepts, Inc. and is part of the EPRI Power Quality Diagnostic System."



## Facilities

In combination, the three PDU laboratories have a wide array of testing equipment.

### HVAC Power Supplies

- Full three-phase source in specific voltage ranges up to 1500-kV rms phase-to-phase
- 500-kV rms (continuously variable)
- 3000-kV rms single phase
- High-current, low-voltage transformers to 8000 A

### HVDC Power Supplies

- Two 1500-kV DC power supplies, providing bipolar voltages up to  $\pm 1500$  kV
- 1500-kV DC symmetrical cascade rectifier set, rated at 250 mA

### AC-DC Converter

- Operation in bipolar mode up to  $\pm 750$  kV, or in monopolar mode up to  $\pm 1500$  kV
- Auxiliary  $\pm 375$  kV converter

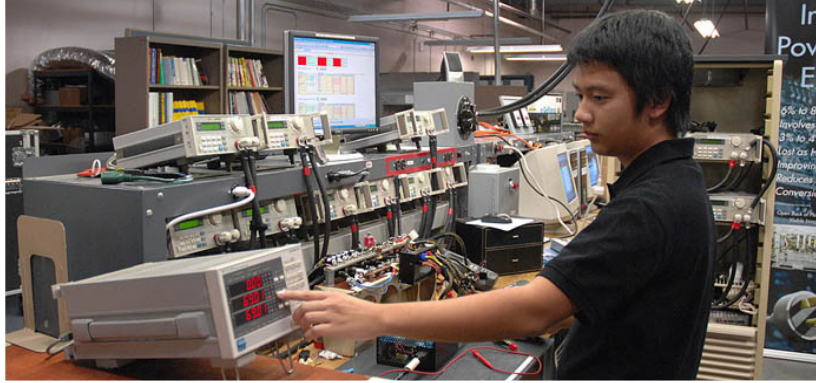
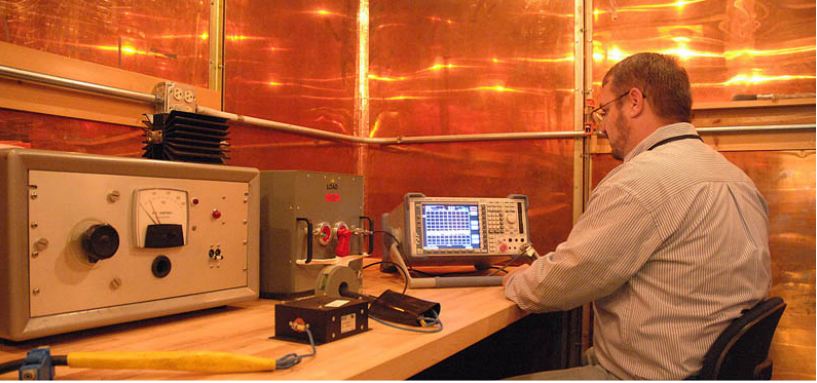
### Full-Scale Test Lines

- Both AC and DC
- Full-scale 340-m main span line
- Capable of being energized at voltages up to  $\pm 1500$ -kV rms phase-to-phase or  $\pm 1500$ -kV DC.
- For DC, configurations include monopolar, bipolar horizontal pole configuration, and bipolar vertical pole configuration.

### Insulator Testing Facilities

- Fog chamber (24-m high, 24-m diameter), available voltage to 866-kV AC, 1100-kV DC or 1200-kV impulse.
- Nonceramic insulator aging chamber, for 230- and 500-kV assemblies, with mechanical loading capabilities, temperature control, UV radiation, clean rain, and salt spray





### Corona Test Cage

- Inner isolated framework, microphones, and rain spray

### Impulse Generator

- Outdoor bipolar multistage Marx-circuit impulse generator, rated at 5600 kV 280 kJ
- Compensated resistive-capacitive impulse voltage divider

### Manhole Testing Facility

- Two full-scale manholes, with transformer vault and three service boxes interconnected with an array of conduits

### Arrester Testing Facility

- Full-scale arrester characterizations up to 765 kV

### Mechanical Stress Lab

- Multiple test fixtures able to apply strain and torsion stress to insulators, conductors, and splices
- Fixtures able to test to failure

### Medium-Voltage Multi-Stress Chamber

- One 80-square-foot chamber capable of providing the following stresses to medium-voltage equipment: voltage, temperature, rain, salt spray, and ultraviolet light (UV)

### EMC Shielded Rooms

- One 96-square-foot double shielded (electric and magnetic fields) with an electric-field-shielded vestibule and one 128-square-foot electric-field shielded room

### Distributed Resources Park

- Covered area with concrete trendways designed for easy installation of generators and energy-storage devices up to 250 kVA at 480 V
- Loads of various types, utility interconnection switchgear, and state-of-the-art test equipment to evaluate the performance and interconnection of distributed resources

### Power Quality Test Facility

- One indoor area capable of testing the performance of devices at voltages up to 600 V and at 50 or 60 Hz with state-of-the-art surge generators and monitoring equipment

### Motor and Drive Test Stand

- Motor test stand with 400-hp DC eddy-current brake

### Energy Efficiency and

### Demand Response Facility

- EPRI's Living Laboratory is a state-of-the-art facility for evaluation and demonstration of emerging energy efficiency and demand response hardware and software

### Lighting Lab

- State-of-the-art photometric measurement equipment and customized power quality measurement and diagnostic equipment



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