Critical Infrastructure Committee

Toward Infrastructure Resilience: An Industry Perspective

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Grid Resiliency

Ongoing R&D

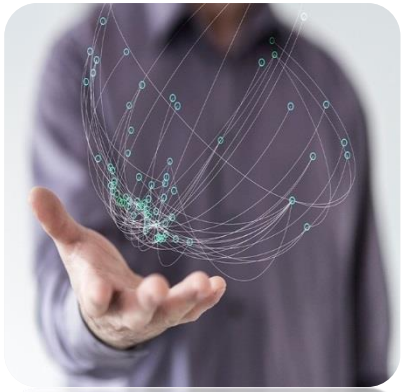
Dr. Andrew Phillips
Director: Transmission, Distribution & Substation

November 2017

Three Dimensions of EPRI's Value

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Thought Leadership



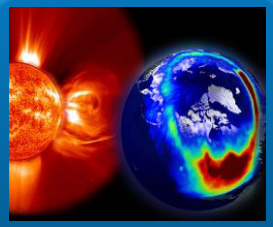
Industry Expertise

Collaborative Model

To provide value to the public, our members, and the electricity sector

Transmission Grid Resiliency – Externalities


Physical Security


GMD


EMP


Seismic

High Impact Low Frequency (HILF)


Floods

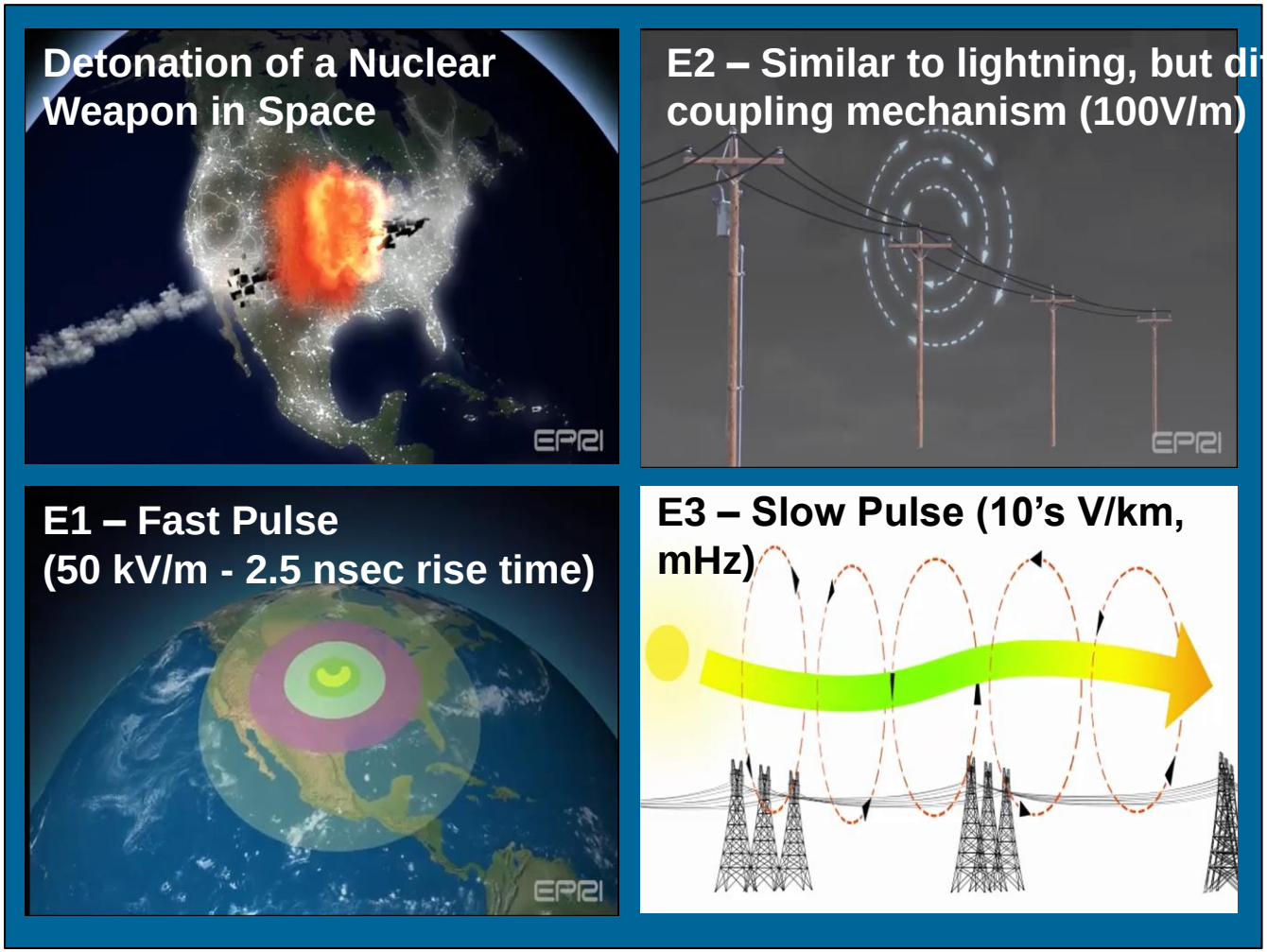

Straight Line Winds


Hurricane/ Ice Storms

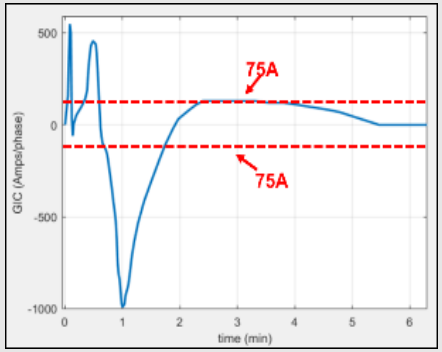

Tornados


Fires

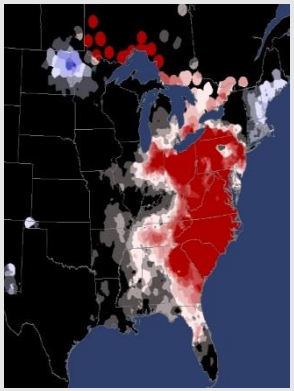
High-altitude Electromagnetic Pulse (HEMP)



EMP: Completed and Ongoing

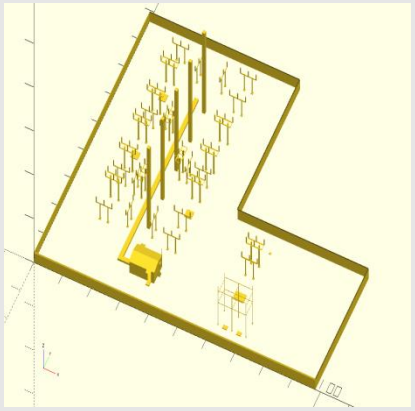


Transformer Overheating



Wide Area Blackout

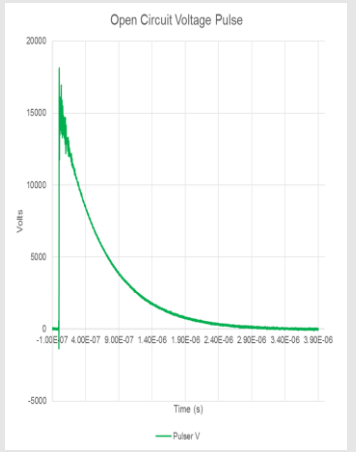
E3



Voltage Stress Modelling & Testing

Relay & IED Testing

E1



Component Strength Testing

E2

Black Sky Communications Solution Evaluation Project

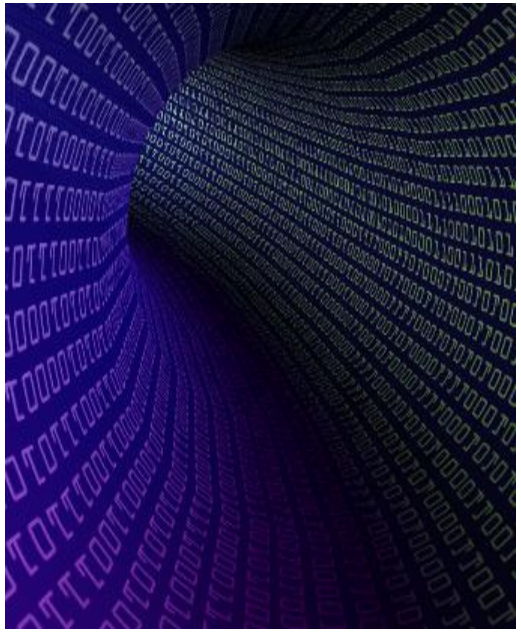
- **Catastrophic loss of electricity and *communications* creates a vulnerability that places our grid at risk**

Research Question: Is there an emergency communication system, deployable to multiple critical sectors, hardened against the full set of Black Sky hazards, designed for at least a month of operation with no access to grid electricity?

Black Sky Communications Assessment

Objectives and Scope

- Emergency communications network Evaluation:
  - Requirements to recover from a Black Sky event
  - Existing and emerging technologies for network resiliency
  - Interoperable standards to support communication requirements and an eco-system for multi-vendor support
  - Basic cost analysis – Interpolation at Scale
  - Basic Technology Evaluation of BSX Technology and possibly other technologies
  - Evaluate potential Next Steps



Value

- Improve clarity about Black Sky communications event resiliency requirements and solutions Critical Infrastructure
- Understand State of Industry and potential next steps for nationwide collaboration with multiple critical infrastructures

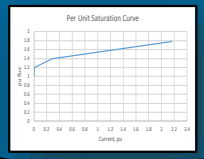
GMD:R&D in Response to FERC Order 830 & Support TPL-007

Highest Priority

Lowest Priority

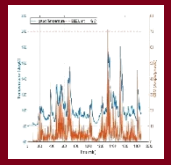
Improved Earth Conductivity Models

Improved Harmonic Analysis Capability



Harmonic Impacts

Transformer Thermal Impacts



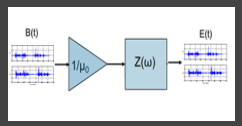
Spatial Averaging

$E_{peak} = 8 \times \alpha \times \beta$ (V/km)

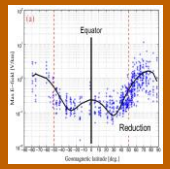
α= Geomagnetic Latitude Scaling Factors

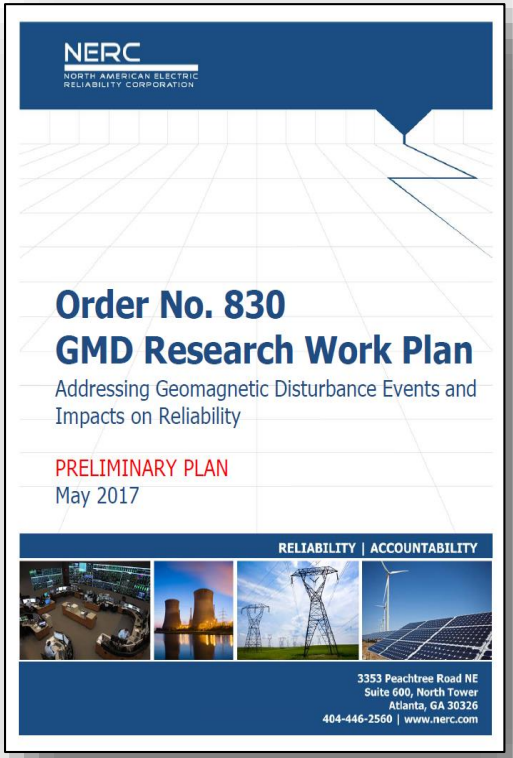
β= Conductivity Scaling Factor

Geoelectric Field Evaluation and Tool



Latitude Scaling Factor





EPRI ELECTRIC POWER RESEARCH INSTITUTE

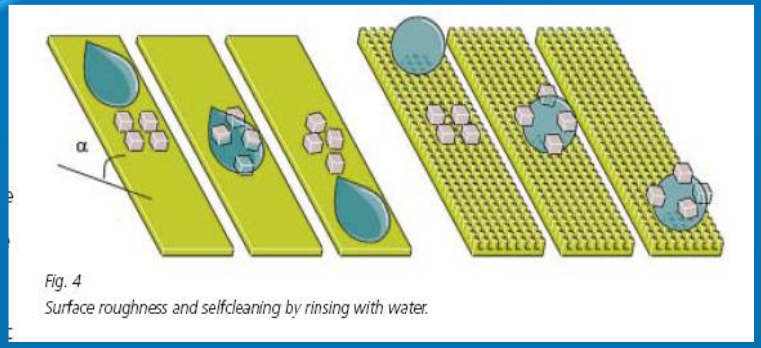
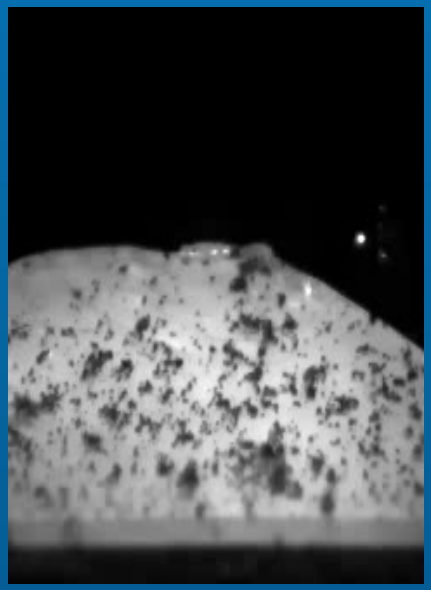
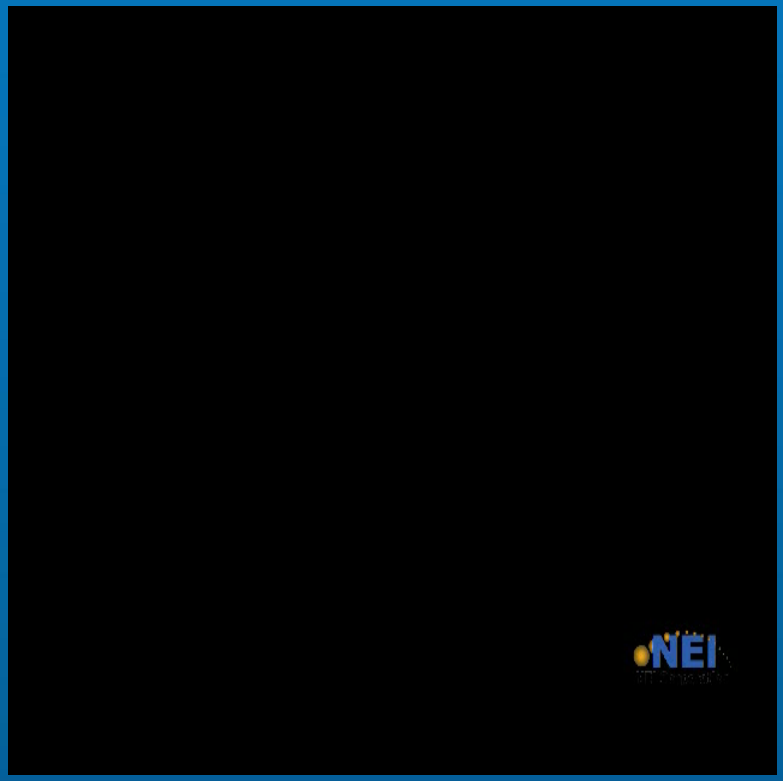


Fig. 4
Surface roughness and selfcleaning by rinsing with water.





Self Cleaning

Icephobicity

Opportunities for Coatings in High Voltage Applications

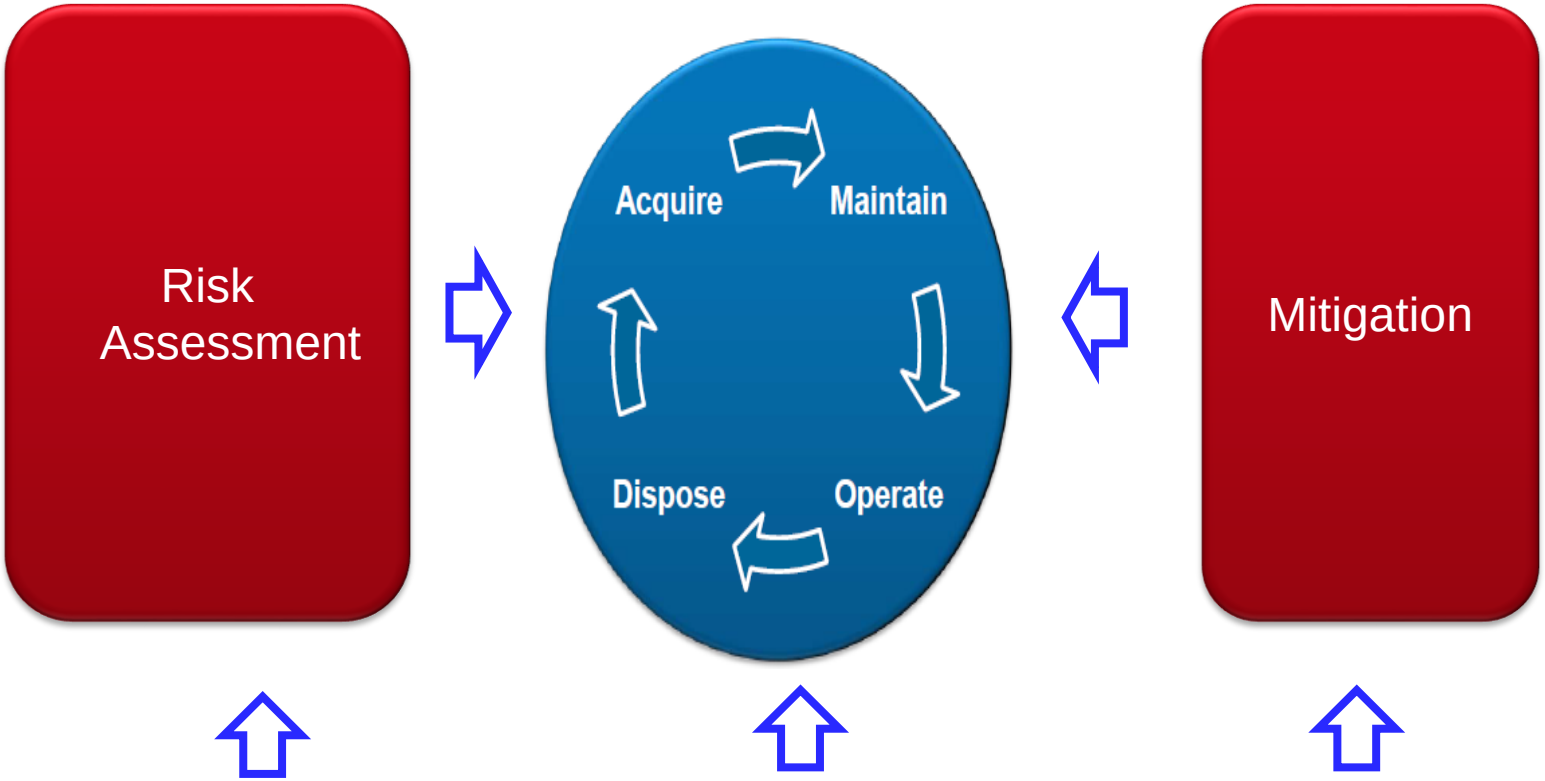
Contaminated Insulators

Iced Insulation

Iced Conductors

Iced Structures

Role of R&D in T&D Resiliency



Technical Basis for Informed Decision Making

Avoid Unintended Consequences

Coordinate with Reliability

Optimize Investment

Together…Shaping the Future of Electricity

Federal Energy Regulatory Commission | Washington D.C.

Planning Restoration Absent SCADA or EMS

FERC-NERC-Regional Entity Joint Study Report (June 2017)

David Huff
Office of Electric Reliability

November 12, 2017

This report was prepared by the staff of the Federal Energy Regulatory Commission in consultation with staff from the North American Electric Reliability Corporation and its Regional Entities. This report does not necessarily reflect the views of the Commission or any Commissioner.

Objective

- Assess applicable entities' system restoration plan steps that may be difficult in the absence of SCADA or EMS.
- Identify viable resources, methods, or practices that would expedite system restoration despite the loss of SCADA or EMS, and identify where those could be incorporated into restoration training.

Joint Study Team Process

- Identified representative sample of eight registered entities with significant bulk power system responsibilities.
- Reviewed their plans and identified viable approaches that would expedite system restoration despite the loss of SCADA or EMS.
- Formed recommendations to improve reliability.

Findings Overview

- All participants would remain capable of executing their restoration plan without SCADA or EMS availability.
- Completion of all restoration steps would be more time consuming and more involved under such conditions, especially those steps requiring a larger degree of coordination.

Recommendations

1. Backup communications: Planning for backup communications measures to provide effective means of communications in the event of the loss of normal communication means during system restoration absent SCADA or EMS.
2. Personnel support: Planning for personnel support during system restoration absent SCADA, to support the field and control room personnel.

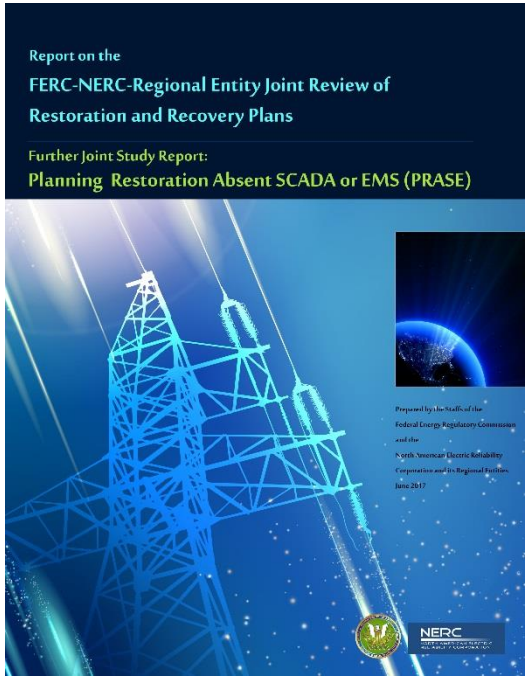
Recommendations (Cont'd.)

3. Backup power supplies: Planning backup power supplies to ensure they are available for an extended period of time beyond the normal expectation from battery backups.
4. Analysis tools: Analysis tools for system restoration, especially for use during the later stages of restoration in the absence of SCADA or EMS.

Recommendations (Cont'd.)

5. Training: Incorporating loss of SCADA or EMS scenarios in system restoration training, to practice implementation of restoration plan steps absent SCADA/EMS functionality.

FERC-NERC-Regional Entity Joint Study Report: Planning Restoration Absent SCADA or EMS



https://www.ferc.gov/legal/staff-reports/2017/06-09-17-FERC-NERC-Report.pdf

Contact: David Huff
FERC - Office of Electric Reliability
Division of Compliance
301-665-1603
david.huff@ferc.gov

Critical Infrastructure Committee