Critical Infrastructure Committee
Toward Infrastructure Resilience: An Industry Perspective
Grid Resiliency
Ongoing R&D

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Three Dimensions of EPRI’s Value

- Thought Leadership
- Industry Expertise
- Collaborative Model

To provide value to the public, our members, and the electricity sector
Transmission Grid Resiliency – Externalties

Physical Security
GMD
EMP
Seismic

**High Impact Low Frequency (HILF)**

Floors
Straight Line Winds
Hurricane/Ice Storms
Tornados
Fires
High-altitude Electromagnetic Pulse (HEMP)

Detonation of a Nuclear Weapon in Space

E1 – Fast Pulse (50 kV/m - 2.5 nsec rise time)

E2 – Similar to lightning, but different coupling mechanism (100V/m)

E3 – Slow Pulse (10’s V/km, mHz)
EMP: Completed and Ongoing

Transformer Overheating

Wide Area Blackout

Voltage Stress Modelling & Testing

Relay & IED Testing

Component Strength Testing

E3

E1

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

Order No. 830
GMD Research Work Plan
Addressing Geomagnetic Disturbance Events and Impacts on Reliability
PRELIMINARY PLAN
May 2017

Improved Earth Conductivity Models

Improved Harmonic Analysis Capability

Harmonic Impacts

Transformer Thermal Impacts

Spatial Averaging

\[ E_{\text{peak}} = 8 \times \alpha \times \beta \text{ (V/km)} \]

\[ \sigma = \text{Geomagnetic Latitude Scaling Factors} \]

\[ \beta = \text{Conductivity Scaling Factor} \]

GeoElectric Field Evaluation and Tool

Latitude Scaling Factor

Highest Priority

Lowest Priority
Self Cleaning

Icephobicity

Fig. 4
Surface roughness and self-cleaning by rinsing with water.
Opportunities for Coatings in High Voltage Applications

- Contaminated Insulators
- Iced Insulation
- Iced Conductors
- Iced Structures
Role of R&D in T&D Resiliency

Risk Assessment

Mitigation

Technical Basis for Informed Decision Making

Avoid Unintended Consequences

Coordinate with Reliability

Optimize Investment

Acquire

Maintain

Operate

Dispose
Together…Shaping the Future of Electricity
Planning Restoration Absent SCADA or EMS  
FERC-NERC-Regional Entity Joint Study Report (June 2017)  
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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.
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


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