ERO Event Analysis Process

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2019 EMMOS
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• Introduction to North American Electric Reliability Corporation (NERC)
• Overview of the Electric Reliability Organization (ERO) Event Analysis Process (EAP)
• Products of the ERO EAP
• A not-for-profit international regulatory authority
• The electric reliability organization (ERO) for North America, subject to oversight by the Federal Energy Regulatory Commission (FERC) and governmental authorities in Canada
• Assure the effective and efficient reduction of risks to the reliability and security of the grid
  ▪ Develop and enforce reliability standards
  ▪ Annually assess seasonal and long-term reliability
  ▪ Monitor the bulk power system through system awareness
  ▪ Educate, train, and certify industry personnel
NERC Regions

**Midwest Reliability Organization (MRO)**
**Northeast Power Coordinating Council (NPCC)**
**Reliability First (RF)**

**SERC Reliability Corporation (SERC)**
**Texas Reliability Entity (Texas RE)**
**Western Electricity Coordinating Council (WECC)**
• “An unwanted, undesirable change in the state of plants, systems, or components that leads to undesirable consequences to the safe and reliable operation of the plant or system”

• Often driven by Risk Clusters
  - Programmatic deficiencies
  - Deficiencies in barriers and defenses
  - Latent organizational weaknesses and conditions
  - Errors in human performance and contextual factors
  - Equipment design and/or maintenance issues
Come on in the water is fine!

Nothing to be afraid of just jump right in.
Not every event results in a succinct lesson learned, but we learn from every event.
Prior to the implementation of the event analysis (EA) field trial there was need for:

- A systematic, predictable and transparent event analysis process
- Review of bulk power system (BPS) events based on risk, significance and prioritization
- Consistent and timely reporting of event information
- Delivery and sharing of valuable lessons learned
• Promote reliability of the BPS
• Develop a culture of reliability excellence that promotes aggressive critical review and analysis of the event
• Collaboration between registered entities, Regional Entities, and NERC
• Being a learning organization by disseminating information from event to owners, operators, and users of the BPS
**Event Analysis Mapping**

**Event Analysis Process**

- **Step 1**: Assessment, event category determination, and RE notification.
- **Step 2**: Planning/coordination call between entity and region.
- **Step 3**: Brief report submitted by entity to region.
- **Step 4**: Event Analysis Report submitted by entity to region (if needed).
- **Step 5**: Lessons learned documents developed/published/shared (as appropriate).
- **Step 6**: The Event Analysis Process is closed.

Regional Entity working with industry.
Prioritizes EA based on risk and significance, response is systematic and the depth of analysis increases as the category rises.

**Cat 4/5**
- Loss of large amounts of load or generation (5,000-10,000+ MW); Large Unintended System Separations and Islanding

**Cat 2/3**
- Loss of a generation stations, loss of small to medium amounts of load (300MW+); Unintended System Separations; Islanding of 1000-10,000 MW

**Cat 1**
- Unintended Loss of multiple BPS elements; EMS outages; SPS/RAS misoperations
The Event Analysis Management System (TEAMS)
Products of the ERO EAP

- Cause Coding
- Event and Performance Trends
- Lessons Learned
- Alerts, Reports and Training
Cause Codes

NERC CCAP
Cause Code Quick Reference

A1 Design/Engineering
A2 Equipment/Material
A3 Individual Human Performance
A4 Management / Organization
A5 Communication
A6 Training
A7 Other
A8 (Open)

A1 Design Input LTA
B1 Calibration for Instruments LTA
B2 Rule Based Error
B3 Knowledge Based Error
B4 Work Practices LTA
B5 PROCUREMENT CONTROL LTA
B6 DEFECTIVE, FAILED, OR CONTAMINATED
B7 Equipment Interactions LTA

A2 Design Output LTA
B2 Periodic/Corrective Maintenance LTA
B3 Inspections/Testing LTA
B4 Material Control LTA
B5 OPERABILITY OF DESIGN/ENVIRONMENT LTA

A3 Design Documentation LTA
B3 KNOWLEDGE BASED ERROR

A4 Design Installation Verification LTA
B4 WORK PRACTICES LTA
B4 SUPERVISORY METHODS LTA
B4 VERBAL COMMUNICATION LTA

A5 Individual Human Performance
B1 SKILL BASED ERROR
B2 RULE BASED ERROR
B3 KNOWLEDGE BASED ERROR
B4 WORK PRACTICES LTA
B5 CHANGE MANAGEMENT LTA

A6 Communication
B1 WRITTEN COMMUNICATIONS METHOD OR PRESENTATION LTA
B2 WRITTEN COMMUNICATION CONTENT LTA
B3 WRITTEN COMMUNICATION NOT USED
B4 VERBAL COMMUNICATION LTA

A7 Other
B1 NO TRAINING PROVIDED
B2 TRAINING METHODS LTA
B3 TRAINING MATERIAL LTA
B4 SUPERVISORY METHODS LTA

A8 Overall Configuration
B1 INSTALLATION/DESIGN CONFIGURATION LTA
B2 MAINTENANCE/MODIFICATION CONFIGURATION LTA

AZ - Information to determine cause LTA

B1 UNABLE TO IDENTIFY SPECIFIC ROOT CAUSE
B2 REPORT STOPS AT FAILURE ERROR MODE (WHAT HAPPENED, NOT WHY IT HAPPENED)
B3 OTHER PARTIES INVOLVED IN EVENT
B4 CROSS-REFERENCE REQUIRED FOR OTHER SOURCES OF INFORMATION

NERC REGIONS

Disclaimer: This NERC Event Analysis document is a working document used for analyzing events in order to identify reliability risk to the North American Bulk Power System, to ensure and continuously improve reliability. This document cannot be used for compliance monitoring or enforcement purposes. Any statements or conclusions on this document will not prejudice the outcome of an event analysis or a potential compliance review associated with the same facts or circumstances. This document makes no findings regarding compliance with Reliability Standards.
## Characteristics and Attributes (also known as Flags)

### Controls/Communications
- EMS
- EMS-Comms-Routable (IP)
- EMS-Comms-Non-Routable (non IP)
- EMS-Comms-License
- IEC 61850 Data
- ISN Data
- SCADA
- Verbal Communications

### Entity Operations
- Autoreclosing Relay Problem
- Construction
- Evacuation
- Maintenance – Computer Systems
- Maintenance – Equipment, Facilities
- Outage Coordination
- Planning Problem
- Restoration Problem
- Switching
- Testing

### Failed Equipment
- Auxiliary Support Systems
- Capacitor/Condenser Bank
- Circuit Breaker
- Circuit Breaker (100-159KV)
- Circuit Breaker (200-299KV)
- Circuit Breaker (300-399KV)
- Circuit Breaker (400-599KV)
- Circuit Breaker (600KV or greater)
- Circuit Breaker (less than 100KV)
- Circuit Switcher
- Communications Controls
- Controls – Network
- Controls - Power System
- Grounding System
- Insulator/Insulation
- Lightning/Burge Arrestor
- Other Failed Equipment
- Reactor
- Relays
- Shield Wire/Static Wire
- Splice
- Structure
- Switch (Disconnect/Ground)
- Transformer - Instrument Transformer
- Transformer - Power Transformer
- UPG
- UPS Switchgear

### Industry Alerts
- EEA
- Other BES Alerts
- Public Appeals

### Infrastructure Security
- Copper Theft
- Facility Threat
- Sabotage
- Suspicious Activity
- Vandalism

### Miscellaneous
- Breaker Failure Operation - failed to operate breaker
- Breaker Failure Operation - slow to operate breaker
- Common Tower/ROW
- Computer/Software Problem
- Contractor Work Problem
- Control System Misoperation
- Human Performance Error
- Incorrect Protection System Settings
- Other
- Protection System Misoperation
- SPS RAS Misoperation
- SPS RAS Unintended Operation
- Vendor Problem

### Natural Phenomena
- Drought
- Dust Storm
- Earthquake
- Fire
- Flooding
- Geomagnetic Disturbance
- High Winds
- Hurricane
- Ice
- Lightning
- Natural Phenomena – Other
- Pandemic
- Snow
- Storms
- Tsunami
- Volcano

### System Conditions
- Frequency Excursions
- Generation Outage
- IRO/NOR Violations
- Islanding
- Loss of Firm Load
- Loss of Interchange Load
- Loss of Offsite Power
- Scheduled Equipment Outage
- Solar System Impact or Impacted
- Transmission Outage
- Wind Farm Impact or Impacted

### System Tools
- Automatic Generation Control (AGC)
- Diagnostic Tools
- Loss
- Failure to Converge - Contingency Analysis
- Failure to Converge - State Estimator
- Load Forecasting Tools
- Load Management System
- Market Tools
- Modeling Error
- Other System Tools
- Real Time Contingency Analysis (RTCA)
- State Estimator
- Time Error Correction

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As of 20170823
A-Level Cause Code

(242 events: excluding AZ & AN)
Region = (Multiple Items); Year = (All)

- A1 Design/Engineering: 61 (25%)
- A2 Equipment/Material: 16 (7%)
- A3 Individual Human Performance: 45 (19%)
- A4 Management/Organization: 11 (4%)
- A5 Communication: 95 (39%)
- A7 Other: 10 (4%)
- AX Overall Configuration: 4 (2%)

Total: 242
Tracking and Trending

Number of EMS Events

Average Restoration Time

EMS Event during Planned Work
Analysis on common themes

Total: 97 EMS Events (10/2017 – 09/2018)
- SCADA, 23, 24%
- RTU, 8, 8%
- ICCP, 3, 3%
- AGC, 0

Total: 63 EMS SE/CA Events (10/2017 – 09/2018)
- Vendor, 14, 22%
- Modeling, 36, 57%
- Software C/I/M, 6, 9%
- Human Performance, 1, 2%
- Communications, 5, 8%
- Hardware, 1, 2%
Outreach and Collaboration

- NERC Monitoring and Situational Awareness Technical Conference

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<th>Theme</th>
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<td>2015</td>
<td>Confidence in Tools (a System Operators View)</td>
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<td>2016</td>
<td>EMS Resiliency (The Capacity to Recover Quickly from Difficulties)</td>
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<td>2017</td>
<td>EMS Solution Quality (Modeling and Real-Time Assessment)</td>
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<td>2018</td>
<td>The Evolution of EMS Systems</td>
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## Lessons Learned Metrics

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*“ERO Team” means multiple Regions contributed*
Lesson Learned
Incorrect Field Modification and RAS Operation Lead to Partial System Collapse

Primary Interest Groups
Balancing Authorities (BAs)
Reliability Coordinators (RCs)
Transmission Operators (TOPs)
Transmission Owners (TOS)
Generator Operators (GOPs)
Generator Owners (GOS)

Problem Statement
During an outage to isolate a 500 kV line disconnect switch and install a temporary bypass to facilitate its replacement, the position of an auxiliary contact multiplier relay was incorrectly modified by field staff. This incorrect multiplier position enabled line stub bus protection, which misoperated due to the increase in flow despite there being no actual line fault. This incorrect multiplier position also prevented the remedial action scheme (RAS) from operating as designed for the loss of the respective 500 kV circuit. The actions resulted in separation of a large portion of the entity’s system, load losses, generator trips, and an islanding of a small pocket sustained by local generation.

Details
On August 9, 2017, planned work was underway to replace the 500 kV Line A disconnect switch at Station A. As part of this project, a temporary bypass was installed to keep the circuit in-service during the replacement (see Figure 1).

Figure 1: Schematic of Disconnect Switch and Bypass at Station A
Level 2 NERC Alert – Industry Recommendation

Industry Recommendation
Loss of Solar Resources during Transmission Disturbances due to Inverter Settings

Initial Distribution: June 20, 2017

NERC identified a potential characteristic exhibited by some inverter-based resources, particularly utility-scale solar photovoltaic (PV) generation, which reduces power output during fault conditions on the transmission system. An example of this behavior has been observed during recent BPS disturbances, highlighting potential risks to BPS reliability. With the recent and expected increases of utility-scale solar resources, the causes of this reduction in power output from utility-scale power inverters needs to be widely communicated and addressed by the industry. The industry should identify reliability preserving actions in the areas of power system planning and operations to reduce the system reliability impact in the event of widespread loss of solar-resources during faults on the power system.

For more information, see the 1,200 MW Fault Induced Solar Photovoltaic Resource Interruption Disturbance Report

About NERC Alerts >>
Training Modules

Contents of Instructor’s Manual
- Introduction
- Course Overview
- Training Coordination tips
- Course Goals and Outcomes
- Trainer Tools and Tips
- Presentation Deck with Key Messages
• ERO Event Analysis Program
  (https://www.nerc.com/pa/rrm/ea/Pages/EA-Program.aspx)

• NERC Lessons Learned
  (https://www.nerc.com/pa/rrm/ea/Pages/Lessons-Learned.aspx)

• NERC EMS conference presentations
  (https://www.nerc.com/pa/rrm/Resources/Pages/Conferences-and-Workshops.aspx)
Questions and Answers