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NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

The 10th Annual Monitoring and Situational Awareness Technical Conference – Session 1

Post Pandemic --- New Normal in Energy Management Systems

NERC EMS Working Group
September 22, 2022

Today's Agenda

- Welcome and Introduction
  - Phil Hoffer, Chair of NERC EMS Working Group, AEP
- Analysis of EMS Event Outages
  - Wei Qiu, NERC
- NERC BPSA 2022 Physical Security Overview
  - Tony Burt, NERC
- **10-minute Break**
- Lessons Leaned and Best Practices
  - Wei Qiu, NERC
  - Kyle Rogers and Adam Wortz, OSI
- Session Summary
  - Matt Lewis, NERC

Phil Hoffer

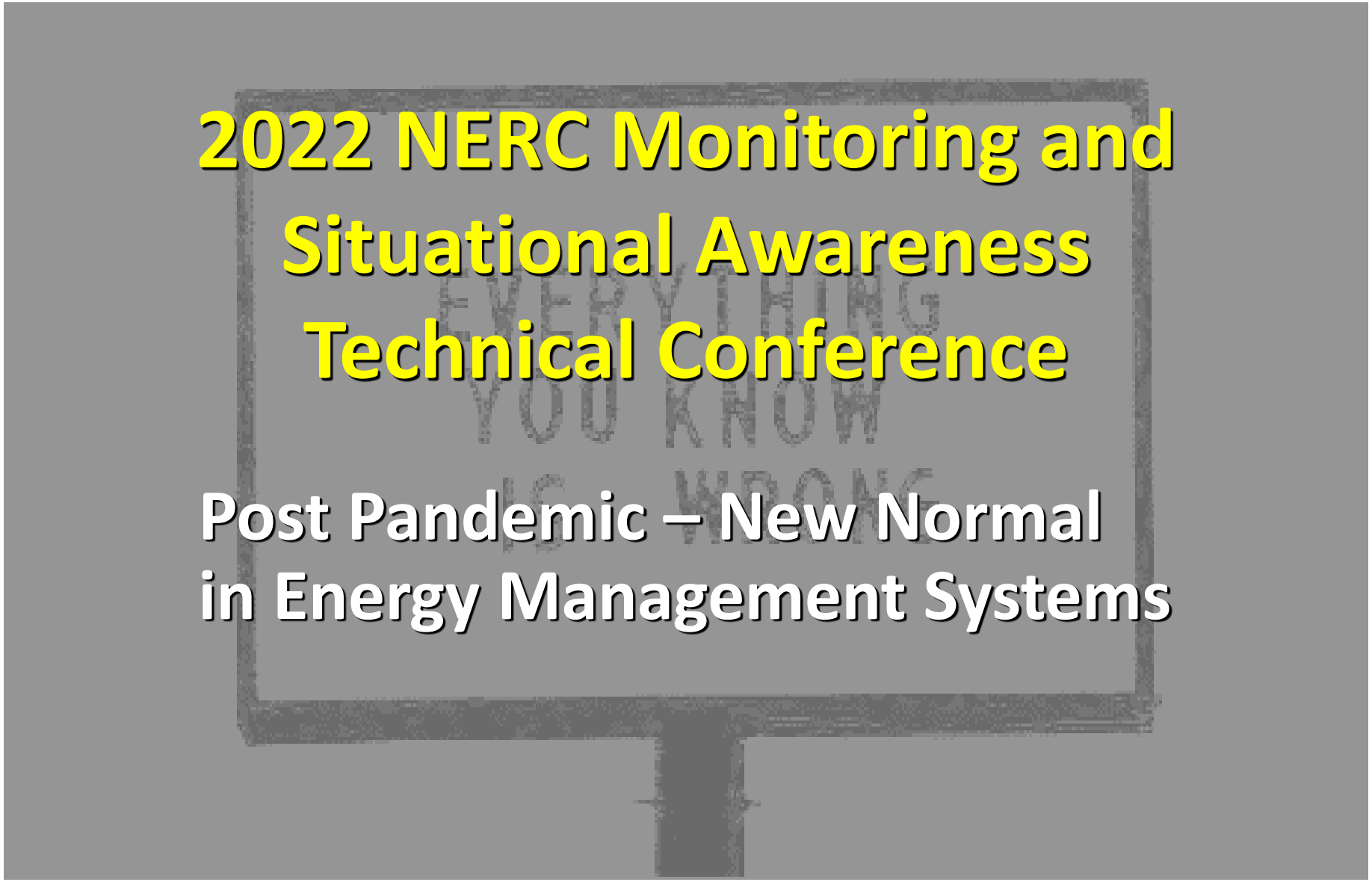
Phil Hoffer is currently the manager of EMS Applications at AEP. He has been with AEP Transmission Operations since 1986. His group is responsible for the state estimator and contingency analysis systems and maintaining the operational model of the transmission system network.

He has a BSEE from The Ohio State University and is a registered Professional Engineer in the state of Ohio.


EVERYTHING
YOU KNOW
IS WRONG

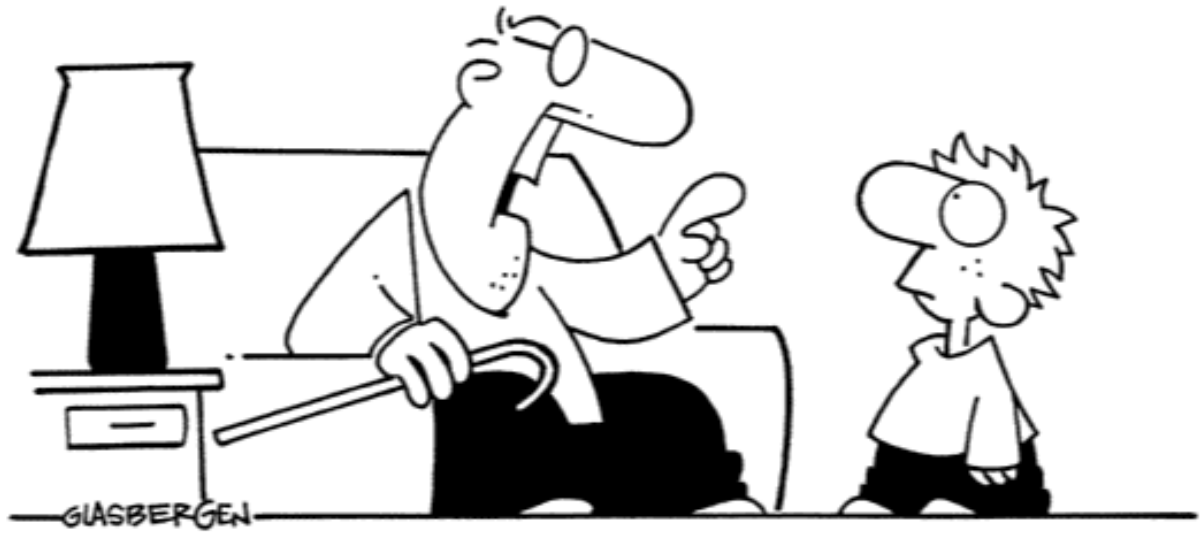
AMERICAN ELECTRIC POWER

BOUNDLESS ENERGY



2022 NERC Monitoring and Situational Awareness Technical Conference

Post Pandemic – New Normal in Energy Management Systems



"You can live a perfectly normal life if you accept the fact that your life will never be perfectly normal."

EMS Working Group

- Since 2013
- 40+ members
- Rob Adams - *Rob.Adams@fpl.com*
- Phil Hoffer - *pehoffer@aep.com*
- Wei Qiu - *Wei.Qiu@nerc.net*

NEW

THE FUTURE IS^~~NOW~~

EMS & Real Time Analysis:

- **New employees**
- **New analysis tools**
- **New generation types**
- **New load types**
- **New security challenges**

What will you do?

Conference Topics

1. Overview - 9/22 13:00-15:00

   Analysis of EMS outages, physical security overview, lessons learned

2. System Operations – 10/6 13:00-15:00

   Real-time stability analysis, real-time assessment summary, cloud computing

3. Vendor Discussion Panel – 10/20 13:00-15:00

Thank You & Enjoy !

Wei Qiu

Wei Qiu is a Lead Engineer of Event Analysis at NERC. As an EMS SME, Wei is responsible for analyzing the EMS events reported, understanding the causes, and working with the industry to develop remediation strategies.

Wei earned his Ph.D in Electrical Engineering from Illinois Institute of Technology, Chicago. He is an IEEE senior member.

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Analysis of EMS Outages

Wei Qiu, NERC

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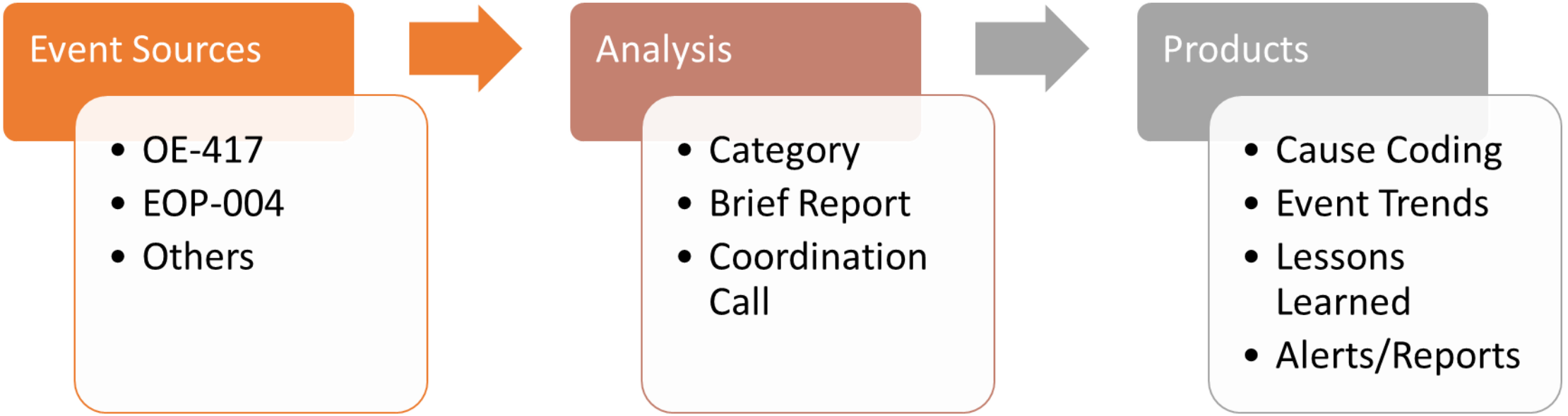
Agenda

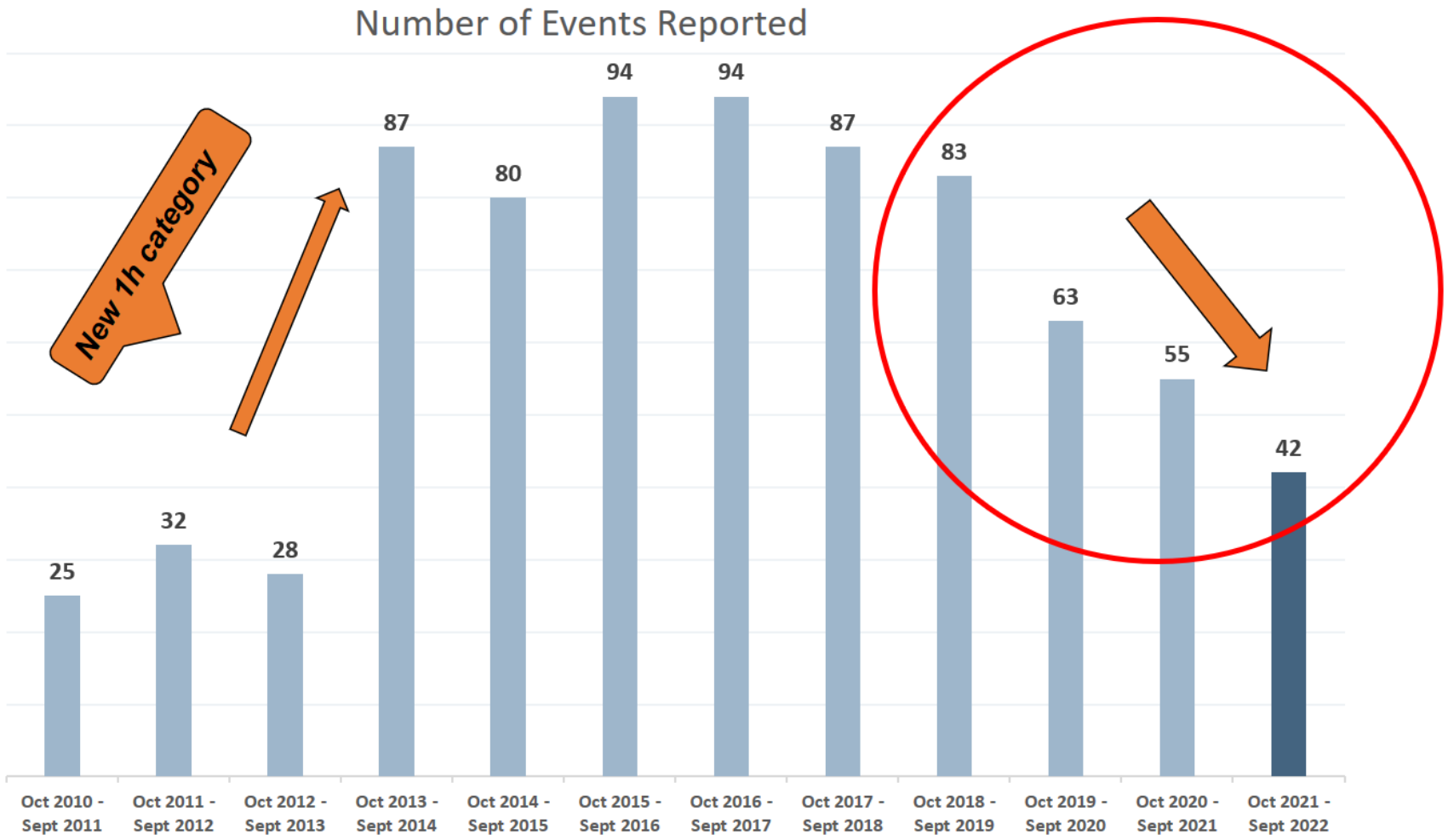
- ERO Event Analysis Process
- Data, Analysis, and Trends
- Key Takeaways
- Q&A

ERO Event Analysis Process

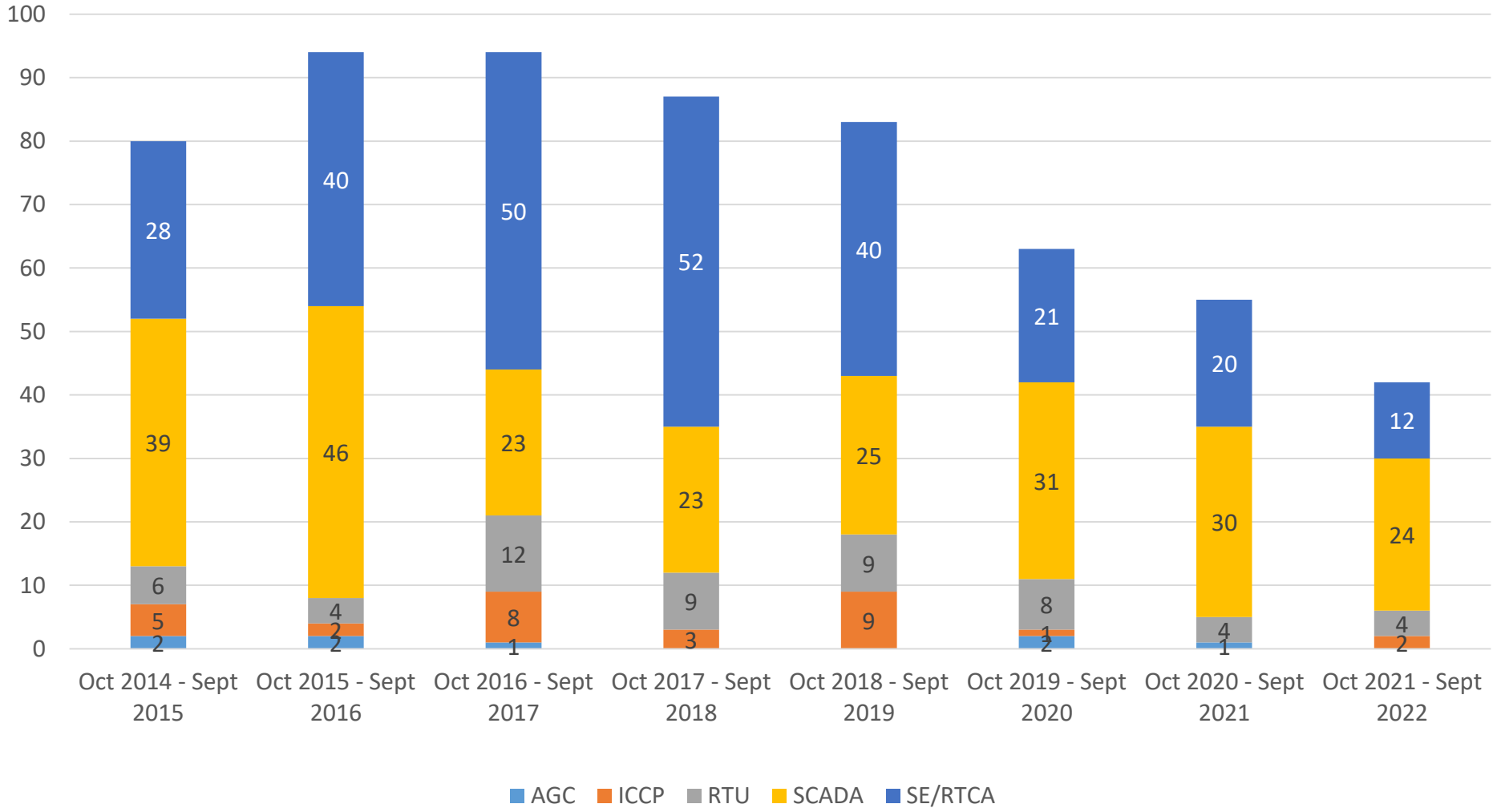
- Promote a structured and consistent approach to performing event analysis
- Learn from events and share information with industry
  - Not every event results in a succinct lesson learned, but we learn from every event
- Collaborate between registered entities, Regional Entities, and NERC



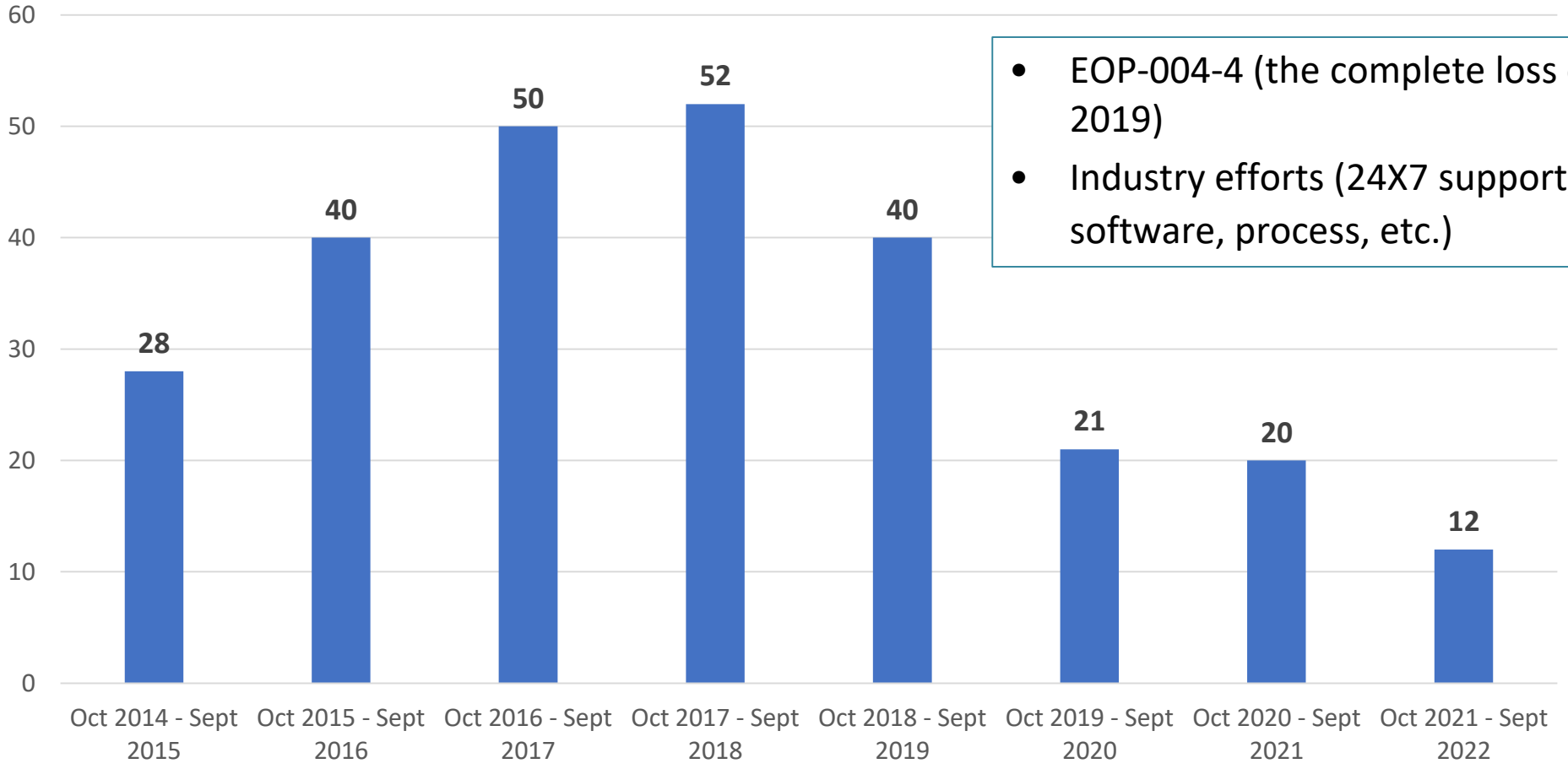
EMS Event Counts Trend



EMS Functions Trend

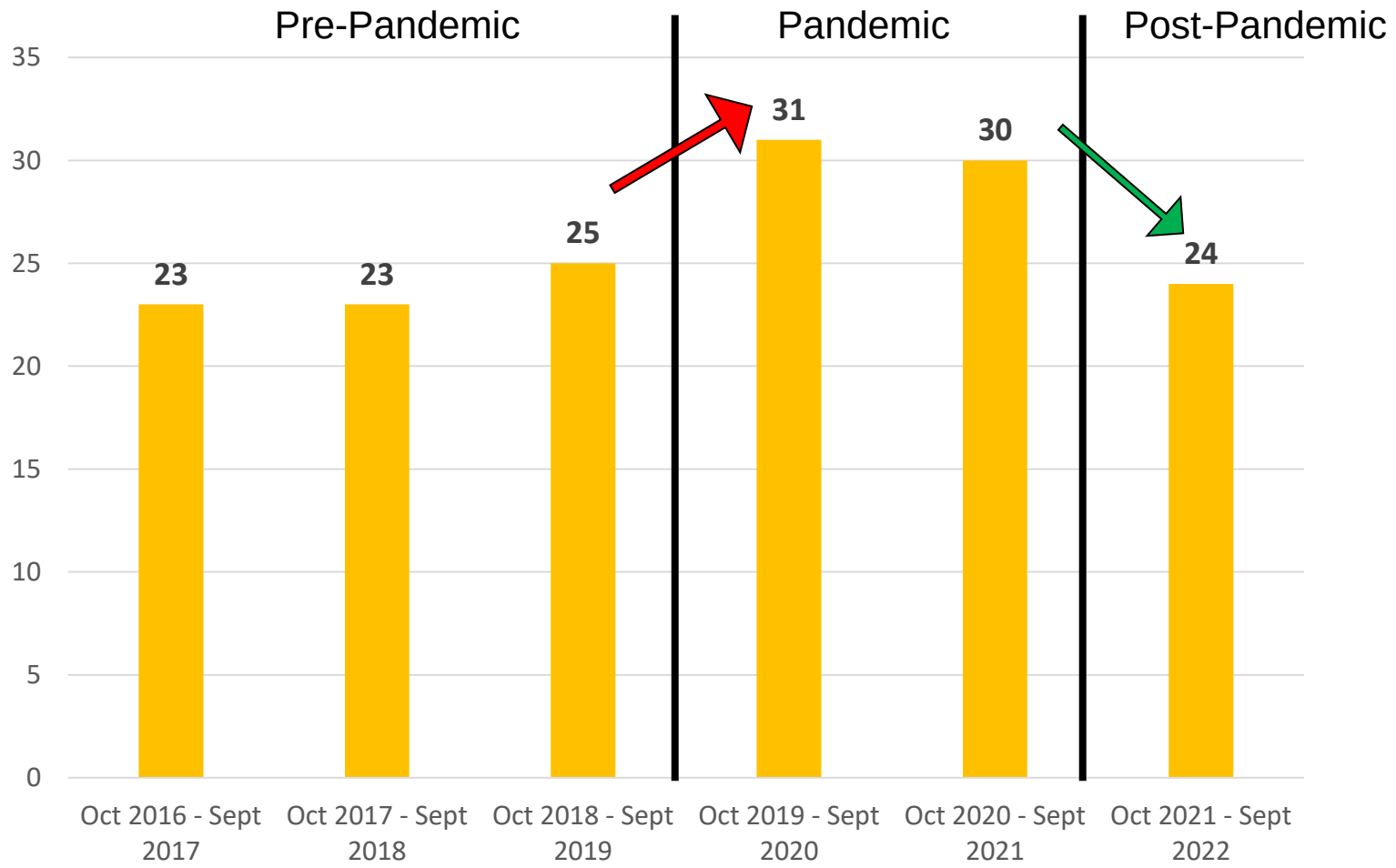


Trend of Loss of SE/CA



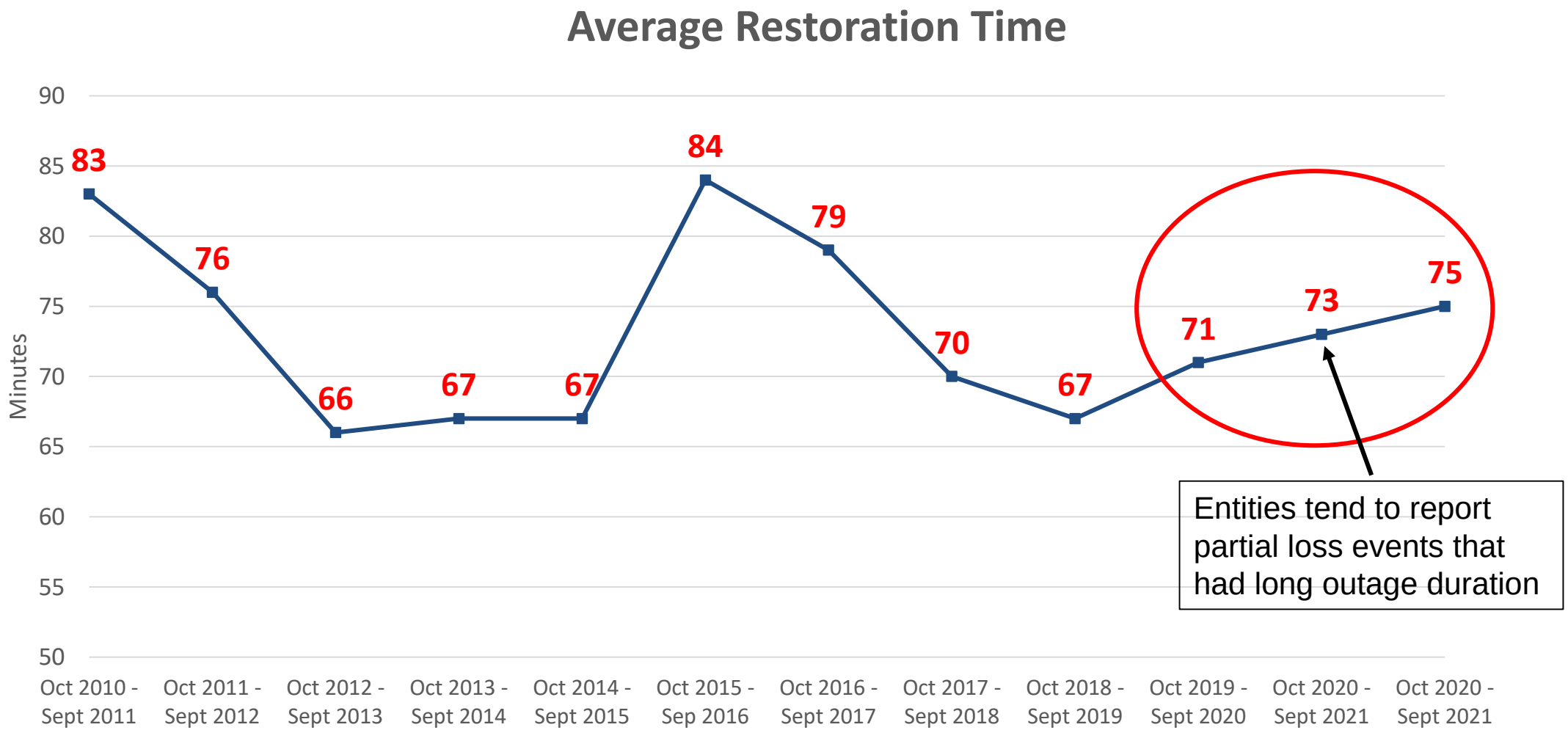
- EOP-004-4 (the complete loss only since April 2019)
- Industry efforts (24X7 support, training, software, process, etc.)

Trend of Loss of SCADA



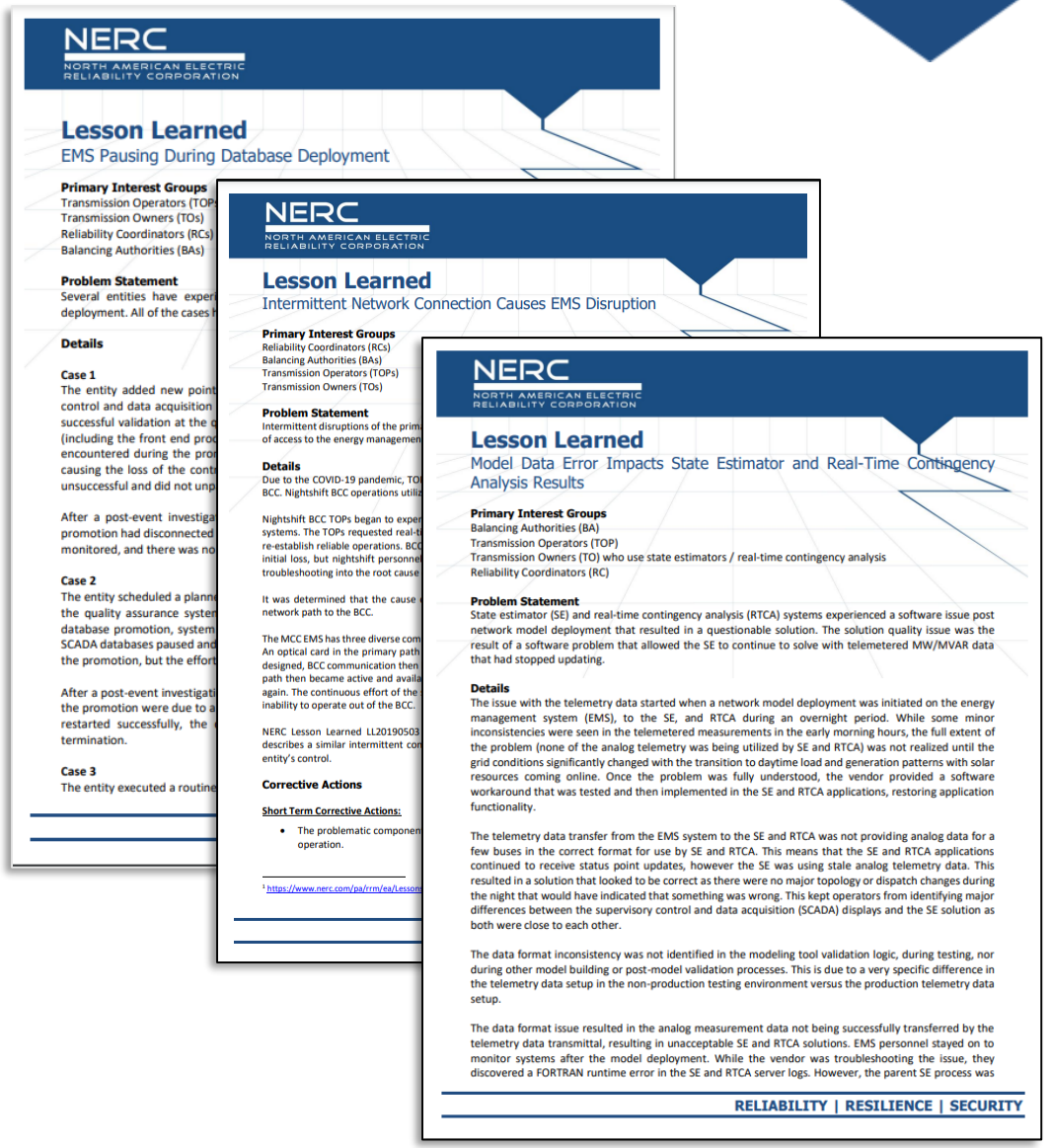
- New Normal Working Environment
  - Work from home: Onsite -> Remote fashion
  - Working split shifts

Average Restoration Time Trend



Things we all can improve

- Database Deployment
- Failover Configurations on Communications
  - Failed failover
  - Intermittent Network Connection
  - Fighting for “Host” (primary vs. backup)
- Modeling
  - Format in CIM
- Race conditions & dead lock
  - Monitor resource usage on servers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Lesson Learned
EMS Pausing During Database Deployment

Primary Interest Groups
Transmission Operators (TOPs)
Transmission Owners (TOs)
Reliability Coordinators (RCs)
Balancing Authorities (BAs)

Problem Statement

Details

Case 1

Case 2

Case 3

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Lesson Learned
Intermittent Network Connection Causes EMS Disruption

Primary Interest Groups
Reliability Coordinators (RCs)
Balancing Authorities (BAs)
Transmission Operators (TOPs)
Transmission Owners (TOs)

Problem Statement

Details

Corrective Actions

Short Term Corrective Actions:

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Lesson Learned
Model Data Error Impacts State Estimator and Real-Time Contingency Analysis Results

Primary Interest Groups
Balancing Authorities (BA)
Transmission Operators (TOP)
Transmission Owners (TO) who use state estimators / real-time contingency analysis
Reliability Coordinators (RC)

Problem Statement
State estimator (SE) and real-time contingency analysis (RTCA) systems experienced a software issue post network model deployment that resulted in a questionable solution. The solution quality issue was the result of a software problem that allowed the SE to continue to solve with telemetered MW/MVAR data that had stopped updating.

Details
The issue with the telemetry data started when a network model deployment was initiated on the energy management system (EMS), to the SE, and RTCA during an overnight period. While some minor inconsistencies were seen in the telemetered measurements in the early morning hours, the full extent of the problem (none of the analog telemetry was being utilized by SE and RTCA) was not realized until the grid conditions significantly changed with the transition to daytime load and generation patterns with solar resources coming online. Once the problem was fully understood, the vendor provided a software workaround that was tested and then implemented in the SE and RTCA applications, restoring application functionality.

The telemetry data transfer from the EMS system to the SE and RTCA was not providing analog data for a few buses in the correct format for use by SE and RTCA. This means that the SE and RTCA applications continued to receive status point updates, however the SE was using stale analog telemetry data. This resulted in a solution that looked to be correct as there were no major topology or dispatch changes during the night that would have indicated that something was wrong. This kept operators from identifying major differences between the supervisory control and data acquisition (SCADA) displays and the SE solution as both were close to each other.

The data format inconsistency was not identified in the modeling tool validation logic, during testing, nor during other model building or post-model validation processes. This is due to a very specific difference in the telemetry data setup in the non-production testing environment versus the production telemetry data setup.

The data format issue resulted in the analog measurement data not being successfully transferred by the telemetry data transmittal, resulting in unacceptable SE and RTCA solutions. EMS personnel stayed on to monitor systems after the model deployment. While the vendor was troubleshooting the issue, they discovered a FORTRAN runtime error in the SE and RTCA server logs. However, the parent SE process was

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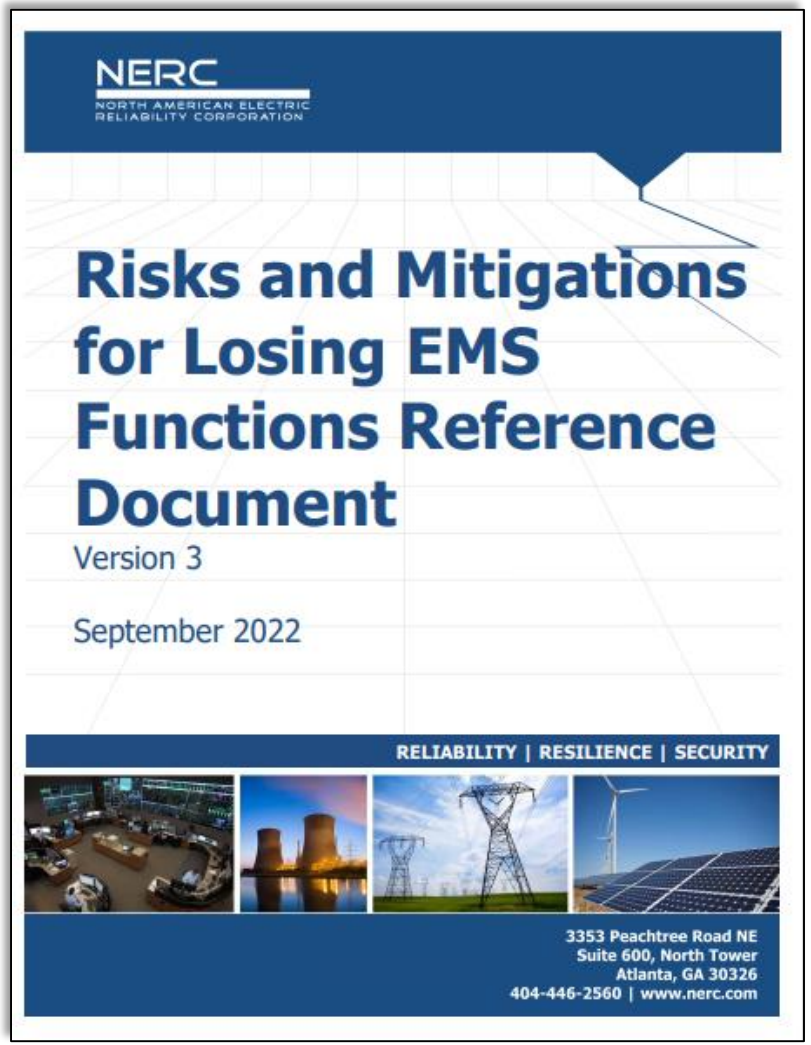
Risks and Mitigations for Losing EMS Functions Reference Document V3.0



- The reference document was endorsed by the RTSC in September 2022
  - 371 EMS Events (2017-2021)
  - Identification and discussion of reliability and security risks
  - Risk mitigation strategies used by industry
  - EMS Availability 99.99%

Key Takeaways

- EMS reliability and resilience is continuously improving
- Loss of SCADA events became the most prevailing failure for the third year in a row
- Number of loss of SCADA decreased in the 2021-2022 period
- Things we all can improve
  - Database Deployment
  - Failover Configurations on Communications
  - Model
  - Race Conditions & dead lock

Questions and Answers

Contact Information:
wei.qiu@nerc.net

Tony Burt

- BPSA Physical Security Analyst
- 25 Years in Industry
- 18 Years in System Operations related roles (Operator, Operator Trainer, Operations Manager)
- 5 Years as Operations Manager for PEAK Reliability
- Joined NERC in 2019
- Commissioned Law Enforcement Officer in Washington State since 1998

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2022 Physical Security Overview

NERC Bulk Power System Awareness (BPSA)

Tony Burt, BPSA Physical Security Analyst

NERC 10th Annual Monitoring and Situational Awareness Technical Conference

September 22, 2022

BPSA Team

- Average 25 years industry experience per employee
- NERC Certified Operators
- Excellent communicators, maintain and strengthening relationships
- Diverse bulk power system regional knowledge and related experiences outside the electric industry

Mission

- NERC's BPSA group acquires and disseminates timely, accurate and complete information regarding the current status of the bulk power system (BPS) and threats to its reliable operation, to enable the ERO to effectively assure the reliability of the BPS. During major system disturbances, facilitate effective communications between industry and government stakeholders.
- NERC's BPSA team also collects and analyzes information on system disturbances and other incidents that could have impact to the North American BPS

What We Do

- Front end of the ERO Event Analysis Process (Receive and enter reports)
- Participate in cause coding
- Prepare and publish regular reports
- Prepare and publish special reports for NERC senior leadership, ERO, and government stakeholders
- Receive EOP-004 and OE-417 reports
- Confirm large unit trips for Resources Subcommittee (RS) and NERC frequency response analysis
- Provide NERC staff support to the North American Generator Forum (NAGF)

What We Do (cont'd)

- Assist in the acquisition, maintenance, and divestiture of reliability tools
- Work closely with other NERC departments and the Electric Reliability Organization (ERO) to support each other as needed for technical initiatives and analyses
- Build and strengthen relationships with technically oriented government agencies (United States and Canada)
- Administer the NERC Alert programs
  - Administrative support, staffing and revision, publication and user assistance
  - Published three alerts to date this year
- Provide information, perspective and technical support for E-ISAC, government, and sector

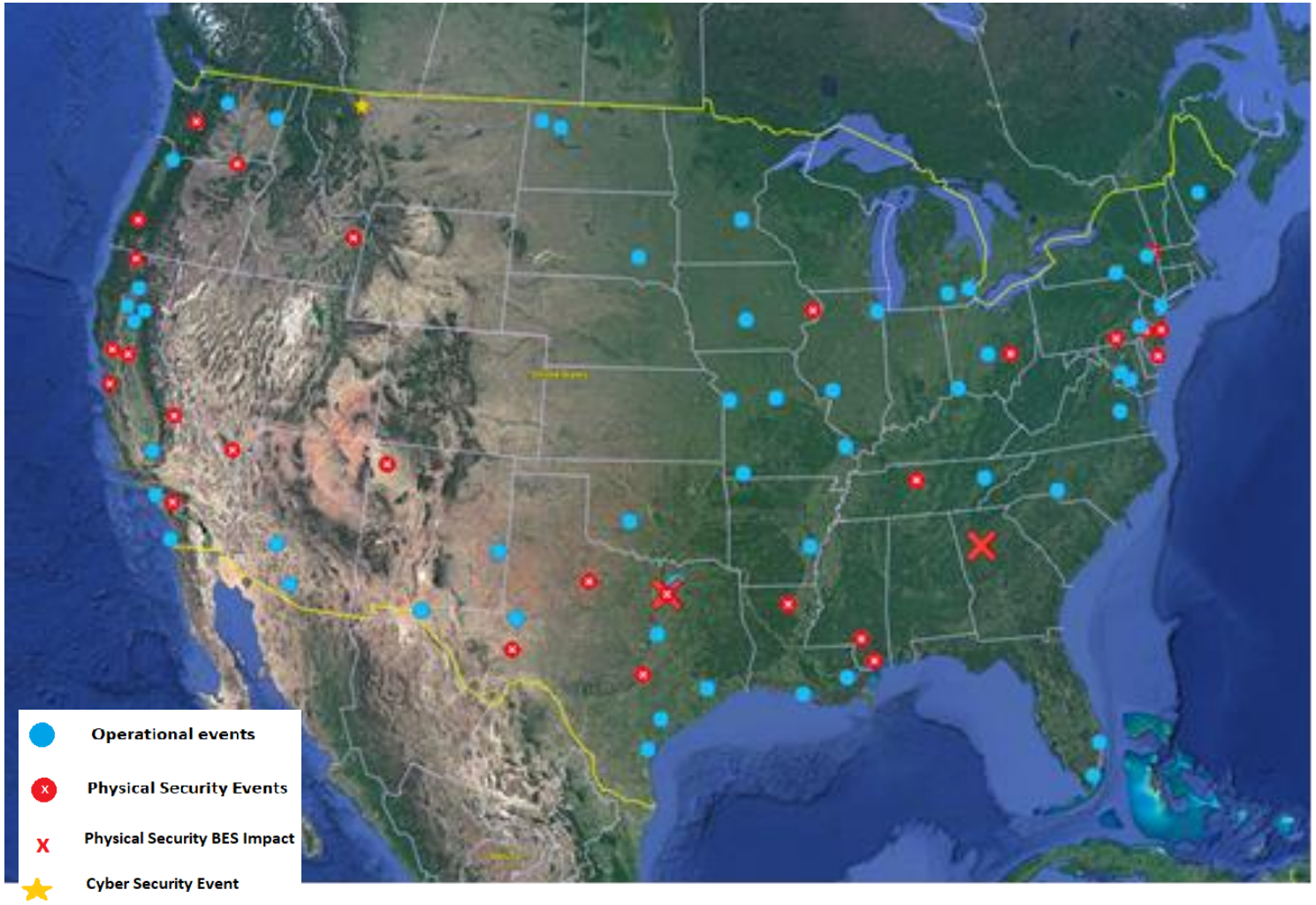
Physical Security Data EOP-004

EOP-004	2019	2020	2021	2022
Damage or destruction of a facility	50	48	35	34
Physical threat to its facility	26	38	37	12
Physical threat to its BES control center	0	3	1	0
	76	89	73	46

Physical Security Data OE-417

OE-417	2019	2020	2021	2022
Physical attack that causes major interruptions or impacts to critical infrastructure facilities or to operations	2	0	1	0
Physical attack that could potentially impact electric power system adequacy or reliability; or vandalism which targets components of any security systems.	17	8	15	15
Damage or destruction of a facility within its Reliability Coordinator Area, Balancing Authority Area or Transmission operator Area that results in action(s) to avoid a Bulk Electric System Emergency	1	5	5	3
Damage or destruction to its facility that reslults from actual or suspected human action	48	48	43	57
Physical threat to its facility excluding weather or natural disaster related threats; which has the potential to degrade the normal operation of the facility. Or suspicious device or activity at its facility	23	30	29	29
Physical threat to its BES Control Center excluding weather or natural disaster related threats; which has the potential to degrade the normal operation of the control center. Or suspicious device or activity at its BES control center	2	7	8	2
	93	98	101	106

SAFNR View of Physical Security and Reliability Events



Questions and Answers

Kyle Rogers

Kyle Rogers is Senior Director of Power Systems and Applications Engineering. He has a Masters Degree of Science in Electrical Engineering from the Michigan Technological University. He has been with OSI for 7 years. Kyle is formally Transmission Operations Engineer, working at Minnesota Power prior to joining OSI.

Adam Wortz

Adam Wortz is Senior Director of Product Management at OSI. He has a Bachelor's of Science in Electrical and Computer Engineering from University of Minnesota Duluth. He has been with OSI for 20 years.

Wei Qiu

Wei Qiu is a Lead Engineer of Event Analysis at NERC. As an EMS SME, Wei is responsible for analyzing the EMS events reported, understanding the causes, and working with the industry to develop remediation strategies.

Wei earned his Ph.D in Electrical Engineering from Illinois Institute of Technology, Chicago. He is an IEEE senior member.

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Lessons Learned and Best Practices

EMS Pausing During Database Deployment

Wei Qiu, NERC
Kyle Rogers and Adam Wortz, OSI
NERC 10th Annual Monitoring and Situational Awareness Conference
September 22, 2022

Agenda

- Details, Corrective Actions, and Lessons Learned (Wei)
- Best Practices (Kyle and Adam)
- Q&A (Kyle, Adam, and Wei)

EMS Pausing during Database Deployment

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Lesson Learned

EMS Pausing During Database Deployment

Primary Interest Groups
Transmission Operators (TOPs)
Transmission Owners (TOs)
Reliability Coordinators (RCs)
Balancing Authorities (BAs)

Problem Statement
Several entities have experienced energy management system (EMS) outages during EMS database deployment. All of the cases had the same EMS vendor.

Details

Case 1
The entity added new points for inter-control center communications protocol (ICCP) and supervisory control and data acquisition (SCADA). The entity pushed changes to the production environment after a successful validation at the quality assurance system. During the database promotion, several databases (including the front end processor (FEP) and SCADA databases) were paused as expected. Due to issues encountered during the promotion, the databases were not unpaused at the completion of the effort, causing the loss of the control center visibility. The entity attempted to revert the changes, but it was unsuccessful and did not unpause the databases.

After a post-event investigation, it was discovered that a critical process that manages the database promotion had disconnected before the task was executed. The critical process connection was not readily monitored, and there was no obvious alarm or indication when it had disconnected.

Case 2
The entity scheduled a planned database promotion, including changes to FEP and SCADA databases, from the quality assurance system to the production environment. When errors were reported during the database promotion, system staff manually terminated the effort midway. The termination left FEP and SCADA databases paused and caused the loss of the control center visibility. The entity attempted to revert the promotion, but the effort failed.

After a post-event investigation, it was discovered that the errors observed that caused staff to terminate the promotion were due to a critical process restarting on the production environment. While the process restarted successfully, the databases were left in a paused state due to the database promotion termination.

Case 3
The entity executed a routine database promotion. After successfully updating four remote FEP databases,

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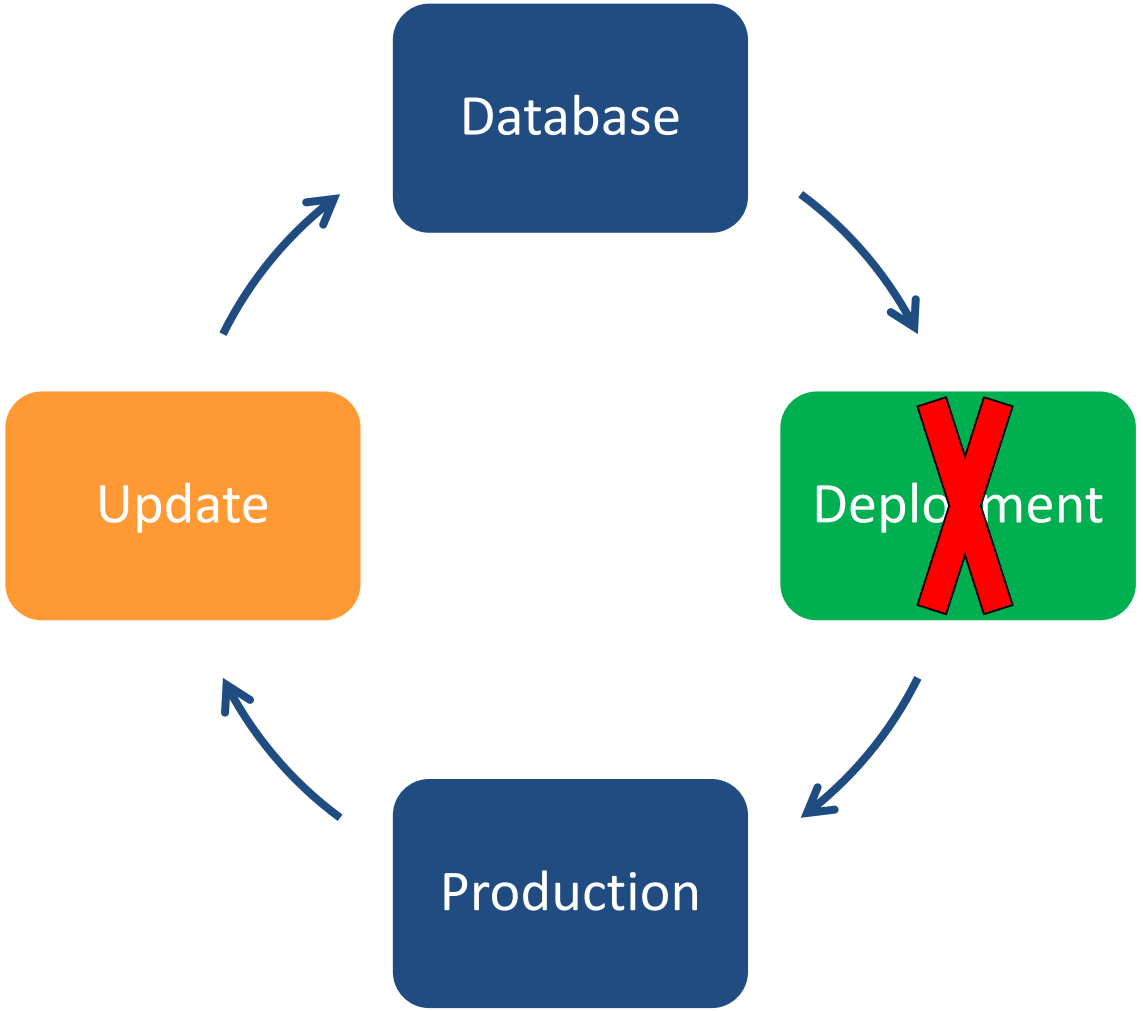
Please scan:

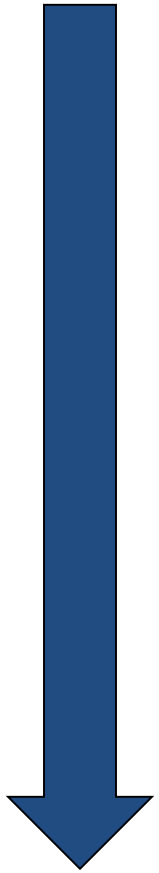
Please click:

https://www.nerc.com/pa/rrm/ea/Lessons%20Learned%20Document%20Library/LL20220801_EMS_pausing_during_database_deployment.pdf

Problem Statement



Case Description



Case 1

- FEP, ICCP, and SCADA
- Validation at QAS
- Paused (as expected)
- Hung…
- Failover Attempted

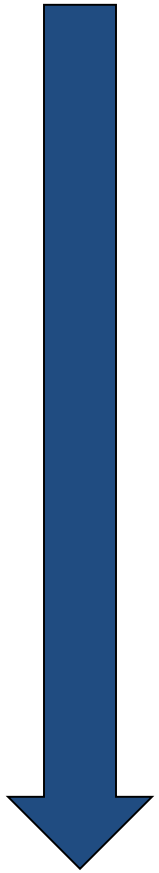
Case 2

- FEP, ICCP, and SCADA
- Validation at QAS
- Errors were reported
- System staff manually terminated the process
- Hung…
- Failover Attempted

Case 3

- FEP, ICCP, and SCADA
- Validation at QAS
- Paused (as expected)
- Hung…
- Failover Attempted

Corrective Actions



Case 1

- Contacted the vendor
- Synced the SCADA databases
- Restarted an FEP service
- Rebuilt the FEP database

Case 2

- Contacted the vendor
- Reverted to the pre-updated conditions
- Rebuilt the FEP database

Case 3

- Contacted the vendor
- Un-paused the databases

Lessons Learned

Pre Deployment	• Test pre-effort checks, promotion steps and post-effort checks in a non-production environment(s) • Build and implement a list of checks to ensure all processes
During Deployment	• Develop and implement alarming/indications to monitor the process
Restoration	• Build detailed documents that institute an effective process for troubleshooting and rolling back to previous system conditions • Consider prioritizing the restoration of the FEP and ICCP links
Post Deployment	• Build and implement a list of checks to review functionality to ensure all critical functionality is confirmed or issues identified quickly

In-house expertise !!!

Best Practices

Operations Monitoring & Pre-Checklist

- FEP is bringing RTU telemetry inbound
- ICCP is communicating both inbound and outbound data
- SCADA is updating with real-time data values
- Calculations are running
- Advanced applications are running and producing valid results
- Sites & servers are online and available
- No Process failure or restart alarms

Maintenance Review Dashboard

- Database Monitoring
- Trend windows for showing real-time data flow (via FEP or ICCP)
- Test calculation outputs
- Alarm points - triggered by exceedance of maintenance time limits to alert operator users to maintenance issues

Improvement Initiatives

Plan ahead – Recovery Plan	• Understand the tools available for recovery • Prepare for primary and contingency scenarios
Practice the plan	• Routine Training • Schedule drills / events (i.e. like a Site failover) • Refine recovery strategy through rehearsal
Assess and Execute	• Establish criteria to initiate database rollback or recovery • Execute the plan • Contact Customer Support

Questions and Answers

Contact Information:
wei.qiu@nerc.net

Future Sessions

- Session 2
  - Theme: System Operation
  - Time: 1:00 PM – 3:00 PM ET
  - Date: Thursday, 10/06/2022
  - Presentations:
    - RC West: Frequency Response Monitoring and Mitigation
    - ERCOT: Real-time Assessment
    - NERC/AMZON AWS: Cloud Computing
- Session 3
  - Theme: Vendor Discussion Panel
  - Time: 1:00 PM – 3:00 PM ET
  - Date: Thursday, 10/20/2022
  - Panelist: GE, Hitachi Energy, OSI, and Siemens

Please scan: