Reliability 201: NERC Events Analysis

David Penney
Director, Reliability Services

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Upcoming Sessions

- June 3 – History and Introduction to Texas RE
- June 4 – Registration & Certification
- June 5 – Intro to Align
- June 6 – Risk-Based Approach to Reliability
- June 10 – Foundations of CIP Programs
- June 11 – Foundations of O&P Programs
- June 12 – Navigating Noncompliance Resolutions
- June 13 – NERC Data Collection, Events Analysis, and Guidelines
- June 17 – Reliability 201: CIP
- June 18 – Reliability 201: O&P
- June 24 – Reliability 201: CMEP Feedback Loop
- June 25 – Reliability 201: Compliance in Align Walkthrough
- June 25 – Reliability 201: Reliability Services

JUNE 2024

SUN	MON	TUE	WED	THU	FRI	SAT
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26 talk with TEXAS RE	27 talk with TEXAS RE	28	29
30						

Cyber and Physical Security Workshop
August 28, 2024

Upcoming ERO Enterprise Events

May - July, 2024

GADS Wind & Solar Template and Application Training

June 27, 2024

Regional Summer Assessment Webinar

July 16-18, 2024

Physical Security Workshop

August 13-15, 2024

Power Systems Security Conference

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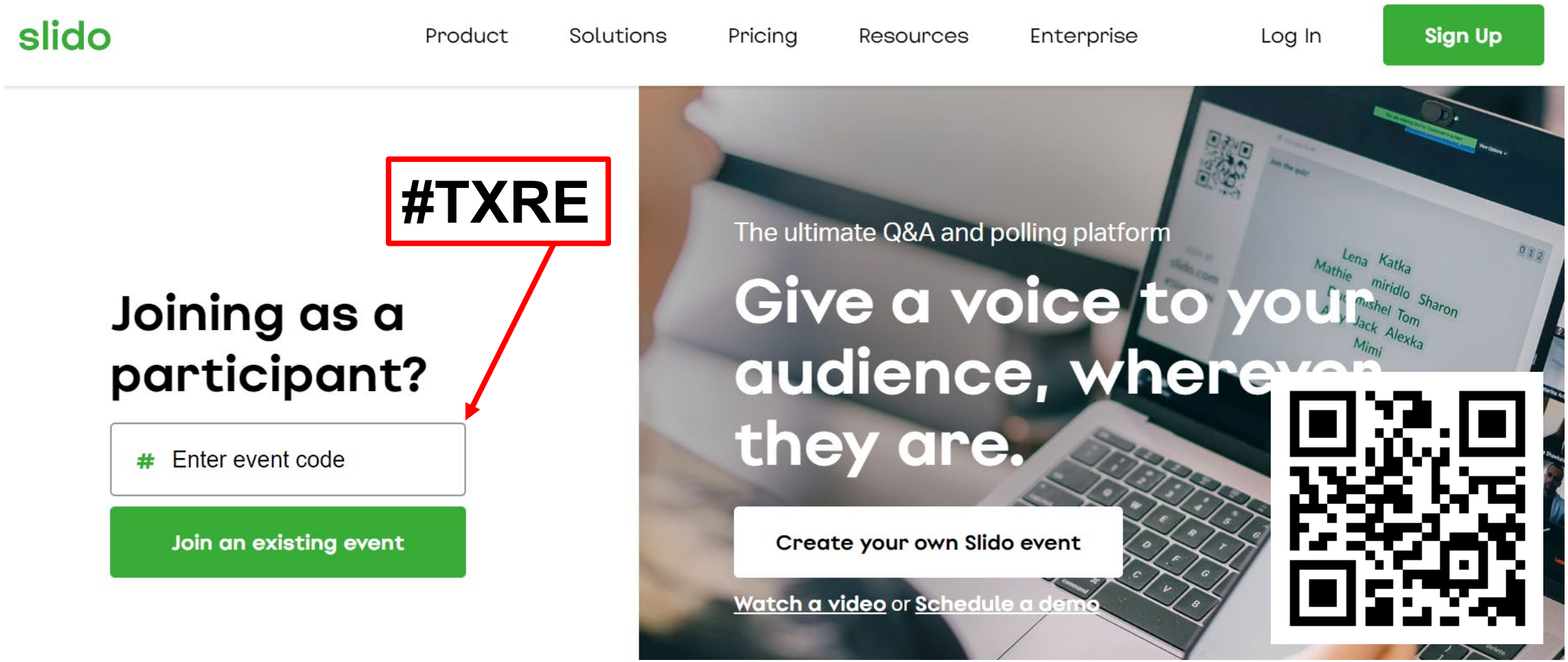
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Agenda

- Event Analysis Process
- Cause Coding
- Root Cause Analysis
- Event and Cause Code Examples
- Failure Modes and Mechanisms

Texas RE—Reliability Services 101 Recap

Regional Coordination for:

- Reliability Assessments
- Performance Analysis
- Event Analysis
- Situational Awareness (NERC Alerts)

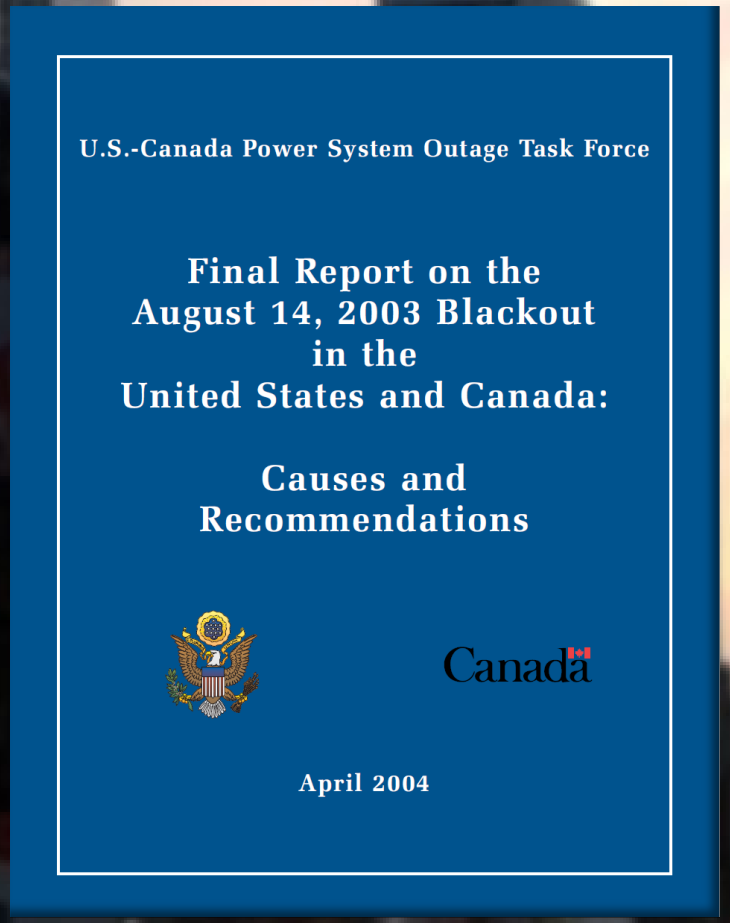
Guidelines, References, and Whitepapers

Data Collection

Event Analysis—What is an Event?

"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."

August 14, 2003
United States and Canada Blackout



Event Analysis Process (EAP)

The process, after notification of events through EOP-004, OE-417 or other means:

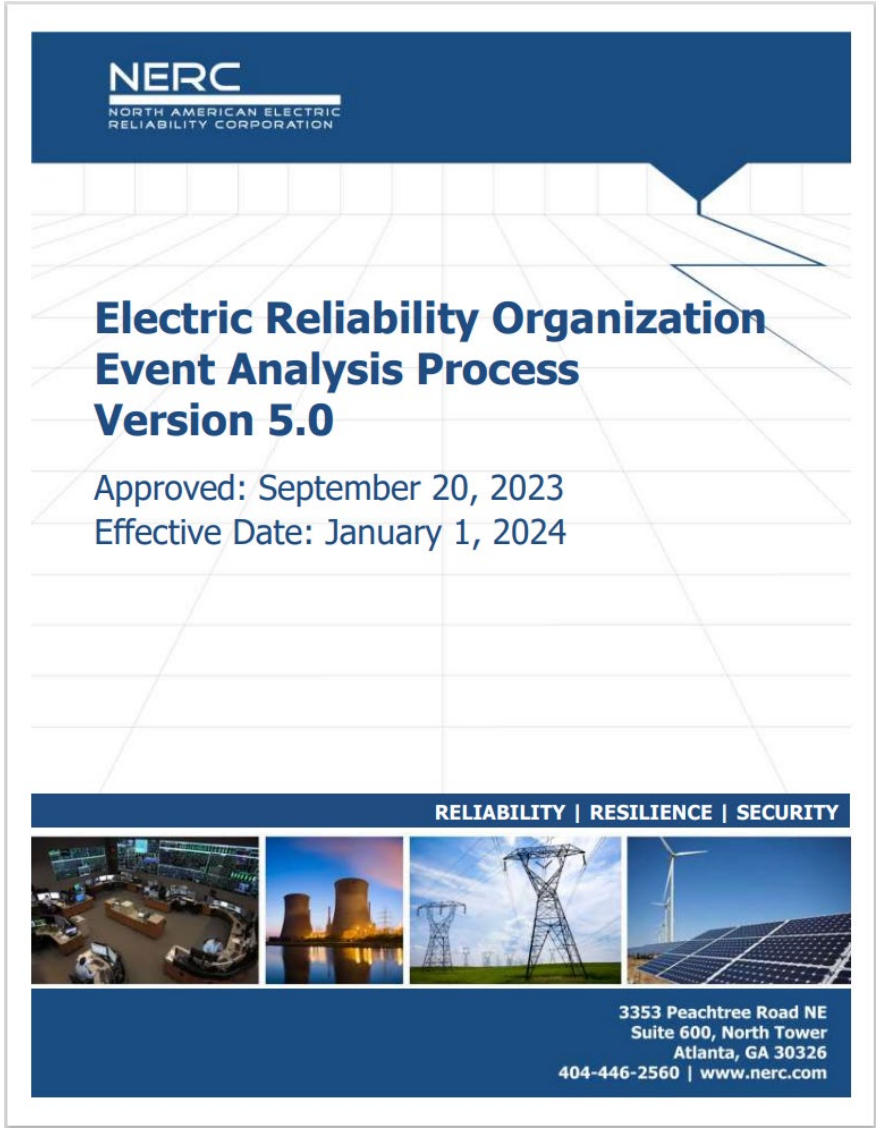
Step 1: Categorization

Step 2: Coordinate

Step 3 and 4: Brief Report and if needed, Event Analysis Report

Step 5: Lessons learned

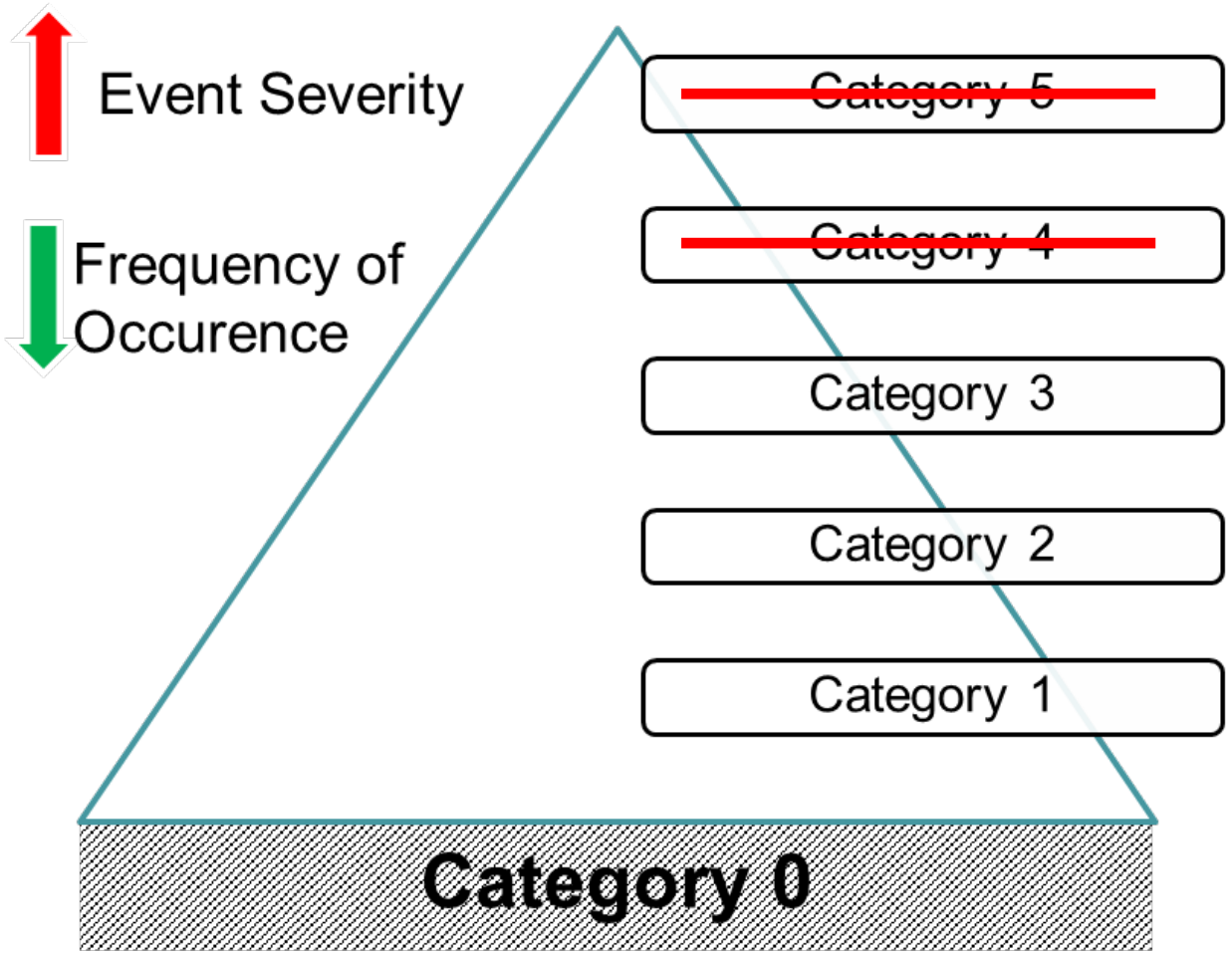
Step 6: EAP closure; cause coding initiated



Appendices:

A. Target Timeframes
B. Planning Meeting Scope Template
C. Brief Report Template
D. Event Analysis Report Template
E. Lessons Learned Template

Categorization—Hierarchy of Events



Handling of Minor Event Analysis

- Texas RE works cooperatively with ERCOT ISO to request information, often with jointly prepared Requests for Information
- ERCOT ISO prepares brief reports in most instances where multiple entities are involved
- Texas RE usually asks entities to incorporate data from Section 1600 applications (GADS, TADS, MIDAS)
- Reports are not posted publicly but findings are analyzed and trended with other events, and anonymous lessons learned sought

MOST COMMON EVENTS IN TEXAS RE
1.a.i. An outage contrary to design, of a combination of three or more BES Facilities. (excluding successful automatic reclosing)
1.h: Loss of monitoring and/or control at a Control Center such that it degrades the entity's ability to make Real-time operating decisions for 30 continuous minutes or more. (Complete loss is Cat 2.a.)
1.i: A non-consequential interruption of inverter type resources aggregated to 500MW or more not caused by a fault on its inverters, or its ac terminal equipment.

Significant Events

- Large events (Cat 3-5) or unusual situations (Cat 0)
- NERC and FERC lead the team
- Data holds issued, formal requests for information
- Formal reports
- Presentations, other outreach, and follow-up on recommendations

Lessons Learned

Resource for industry to identify problems, find what works, document the process, and share anonymously

Lessons Learned

Type	LL#	Title	Category	Date
Lessons Learned 2024 (1)				
	LL20240301	Protective Relay Solid-State Output Contact Voltage Leakage	Relaying and Protection Systems	3/4/2024
Lessons Learned 2023 (6)				
	LL20231102	Wind Turbine Generation Loss due to Unexpected and Insufficient Ride-through Performance	Generation Facilities	11/30/2023
	LL20231101	Loss of Communication to Transmission Substations	Communications	11/30/2023
	LL20230901	Abnormal Area Control Error due to a Model Translation Error	Communications	9/28/2023
	LL20230801	Loss of Monitoring due to a "Half Failed" High Availability Switch Pair	Communications	8/10/2023
	LL20230701	Weathering the Storm: System Hardening	Facilities Design, Commission, and Maintenance, Planning and Modeling, Generation Facilities, Transmission Facilities, Bulk-Power System Operations, Emergency Response	7/5/2023
	LL20230401	Combustion Turbine Anti-Icing Control Strategy	Generation Facilities	4/19/2023
Lessons Learned 2022 (13)				
	LL20221201	Air Breaker Cold Weather Operations	Transmission Facilities	12/15/2022
	LL20221101	Preventing Unwanted Operations during Relay Diagnostic Restarts	Relaying and Protection Systems	11/16/2022
	LL20220901	Loss of Energy Management System Functionality due to Server Resource Deadlock	Communications	9/28/2022
	LL20220801	EMS Pausing During Database Deployment	Communications	8/22/2022
	LL20220702	Tower Climber Incident	Transmission Facilities, Bulk-Power System Operations	7/20/2022
	LL20220701	Forecasted High Winds	Generation Facilities, Transmission Facilities, Bulk-Power System Operations	7/20/2022
	LL20220406	Intermittent Network Connection Causes EMS Disruption	Communications	4/13/2022
	LL20220405	Unintended Consequences of Altering Protection System Wiring to Accommodate Failing Equipment	Transmission Facilities	4/13/2022
	LL20220404	Substation Flooding Events Highlight Potential Design Deficiencies	Transmission Facilities	4/13/2022
	LL20220403	Model Data Error Impacts State Estimator and Real-Time Contingency Analysis Results	Communications	4/13/2022
	LL20220402	Islanding and Insufficient Primary Frequency Response Resulted in Unintended UFLS	Generation Facilities, Bulk-Power System Operations	4/13/2022
	LL20220401	Distributed Energy Resource Performance Characteristics during a Disturbance	Generation Facilities, Transmission Facilities, Bulk-Power System Operations	4/13/2022
	LL20220301	Managing UFLS Obligations and Service to Critical Loads during an Energy Emergency	Bulk-Power System Operations	3/9/2022
Lessons Learned 2021 (12)				
Lessons Learned 2020 (11)				

Example Content of Lesson Learned Document

Title: Combustion Turbine Anti-Icing Control Strategy

Primary Interest Groups: Generator Owners (GOs) Generator Operators (GOPs)

Problem Statement: Unexpected icing due to intermittent interference from outside sources may present operating challenges

Details: After an entity's investigation of an icing-over of a combustion turbine air inlet, it was determined…

Corrective Actions: As a result of these occurrences, the entity instituted a more aggressive combustion turbine anti-icing strategy to prevent…

Lesson Learned: Ensure that manual corrective actions are proactively taken when unexpected icing may occur due to…

Cause Coding—After Event Reports

NERC CCAP
North American Electric Reliability Corporation
Causal Code Assignment Process
An event and data analysis tool

The Reliability Risk Management Group (RRM) has designed, developed, and implemented the North American Energy Reliability Corporation (NERC) Causal Code Assignment Process to allow accurate, efficient trending and subsequent analysis of events for sharing and providing a cooperative forum focused on improving the reliability of the Bulk Power System (BPS).

Seven Digit NERC Cause Code Structure

First Level

- A1 Design/Engineering Problem
- A2 Equipment/Material Problem
- A3 Human Performance Less Than Adequate (LTA)
- A4 Management Problem
- A5 Communication LTA
- A6 Training Deficiency
- A7 Other Problem

Second Level

Third Level

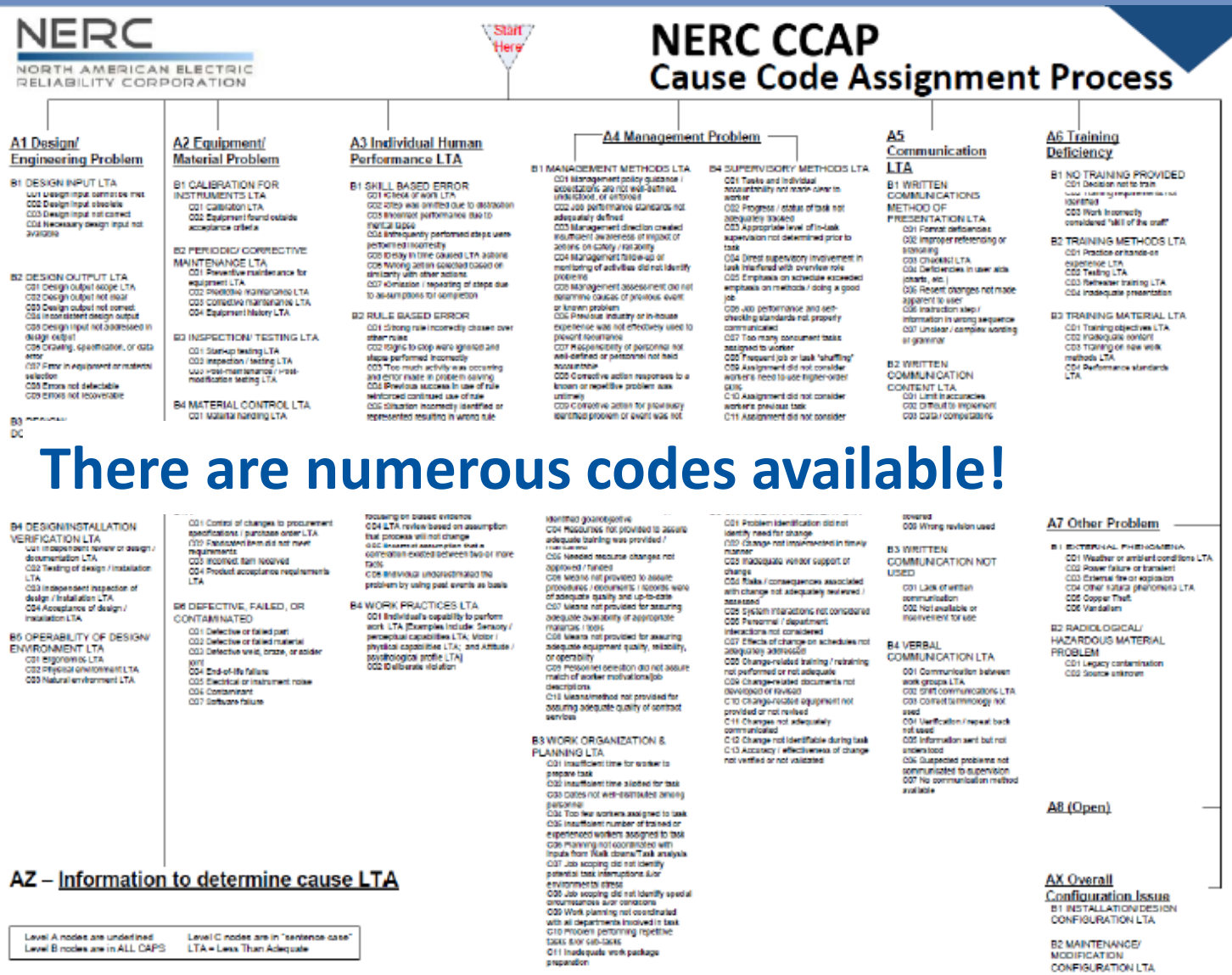
Example

A2B6C04

A2 = Equipment/material problem
B6 = Defective, failed, or contaminated
C04 = End of life failure

Meaning: The failure resulted from equipment or material having reached the end of its expected / normal service life. The failure was a result of the normal aging process for this component.

Cause Code Listing



Root Cause Analysis (RCA)—Basis for Cause Coding

A process used to identify, analyze, correct, and prevent recurrence of performance problems to determine the most basic reason for an undesirable condition or problem which, if eliminated or corrected, would have prevented it from existing or occurring

DOE GUIDELINE ROOT CAUSE ANALYSIS GUIDANCE DOCUMENT - DOE-NE-STD-1004-92

February 1992

The basic reason for investigating and reporting the causes of occurrences is to enable the identification of corrective actions adequate to prevent recurrence and thereby protect the health and safety of the public, workers, and the environment.

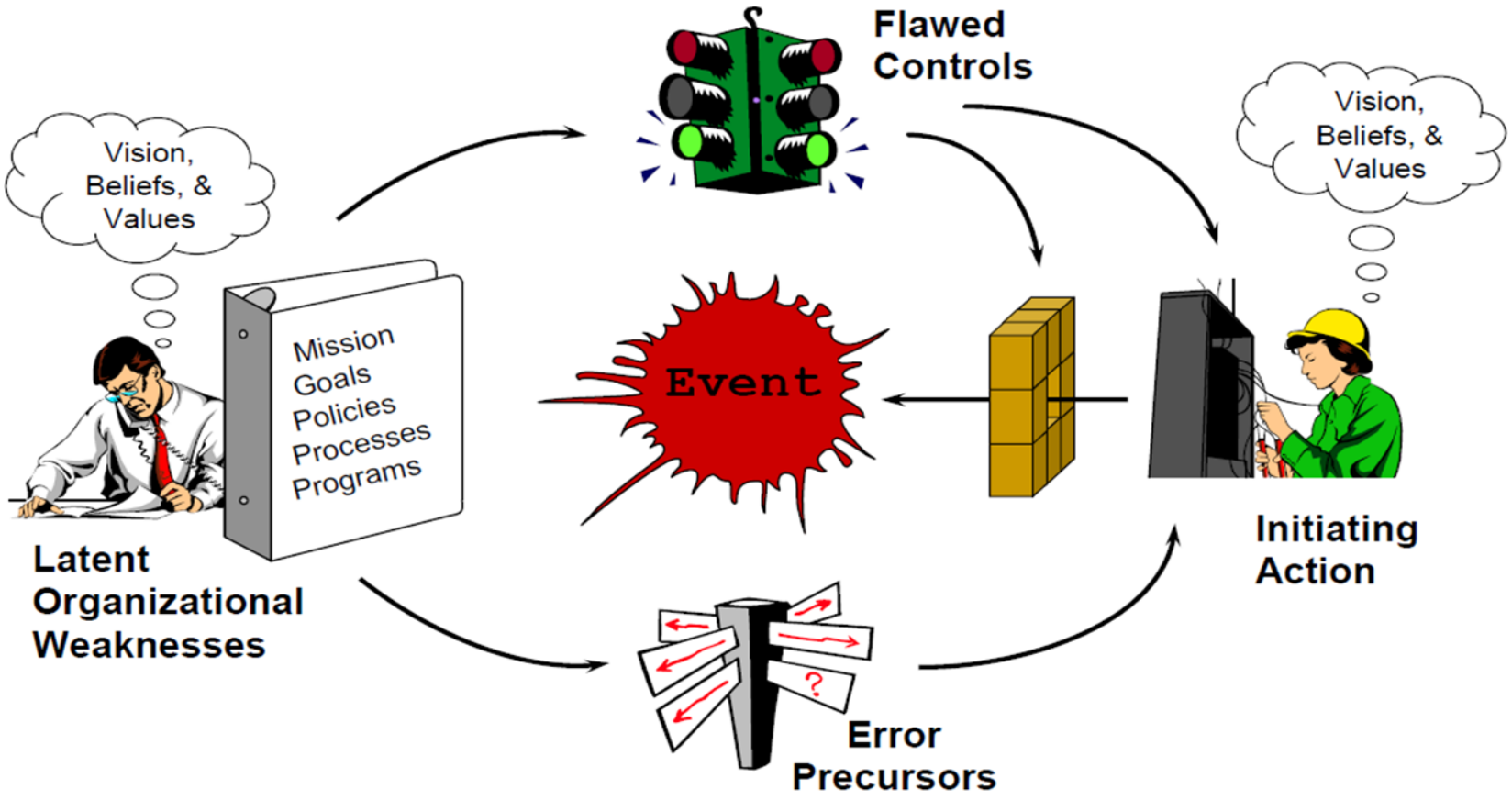
Apparent Cause Analysis

Apparent Cause Analysis (ACA)

- Seeks to determine why a problem happened based on reasonable effort and the investigator's judgment and experience
- The emphasis is mainly to correct a particular event or problem without an effort to identify the underlying contributors to the problem

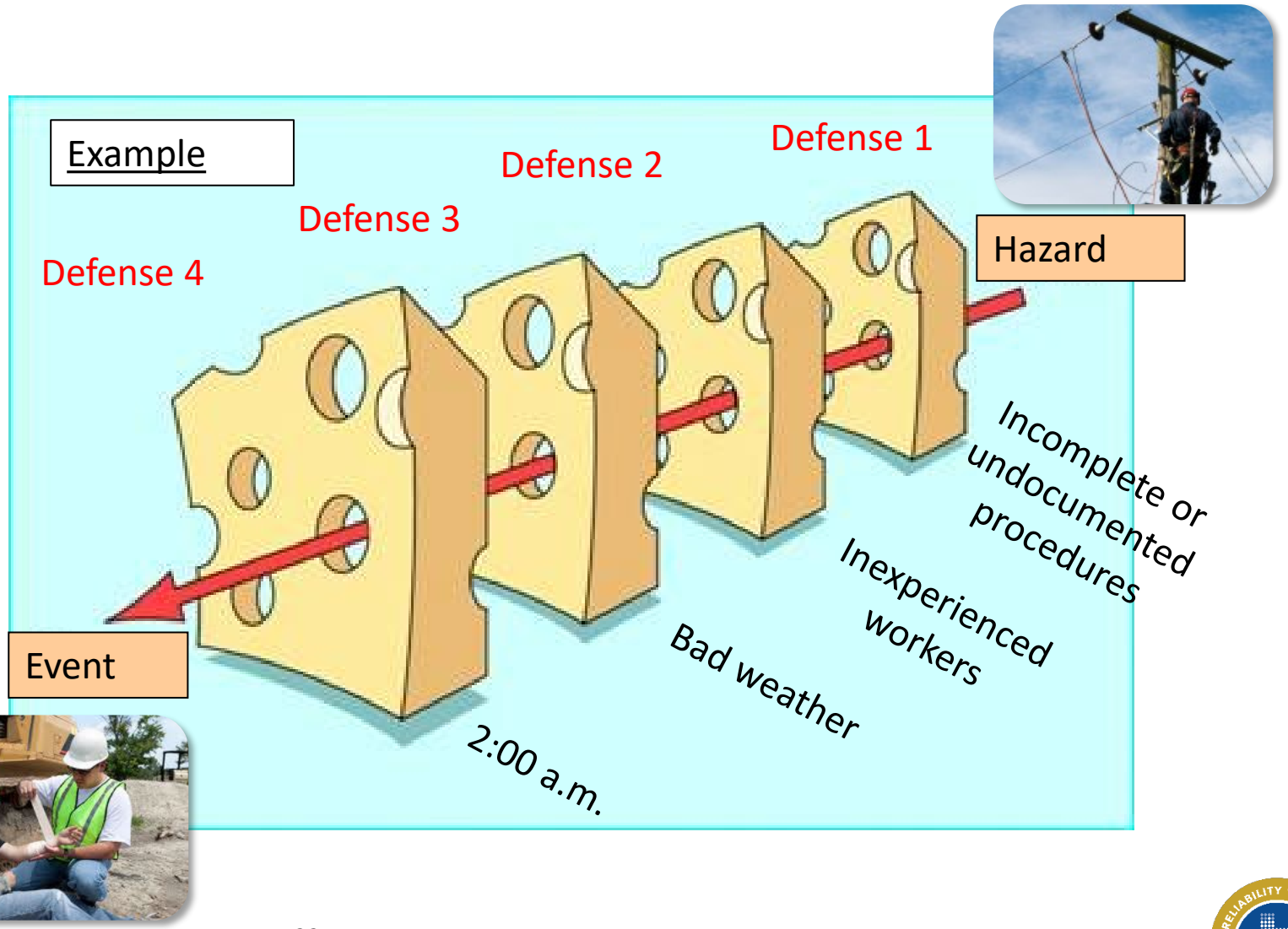
NOTE: ACA is not industry standard for system disturbances or major events and is not referenced in the DOE Guidelines for Root Cause Analysis

Anatomy of an Event

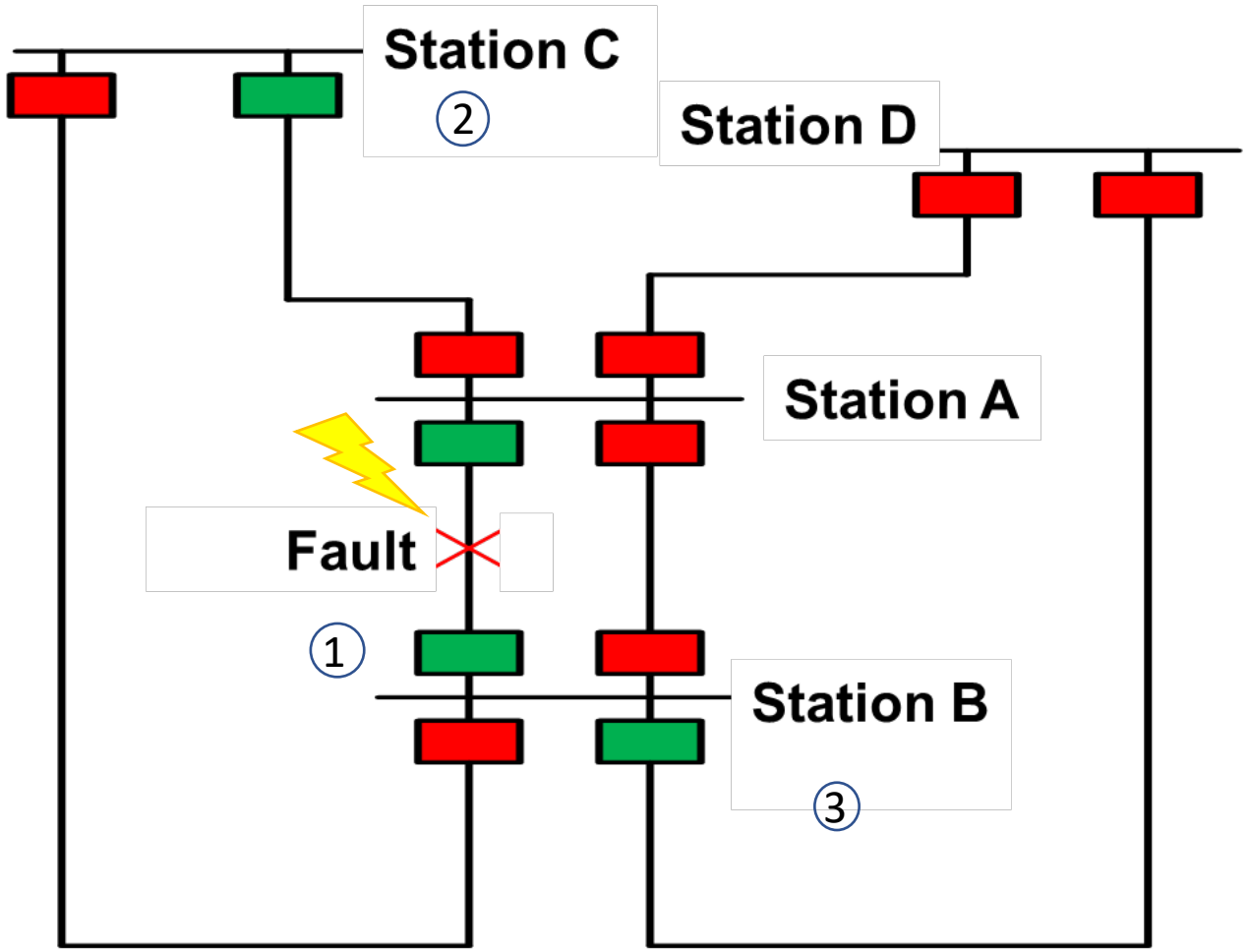


Root Cause Analysis

- Even the best defenses are fallible and can have holes
- Multiple defenses decrease likelihood of an event
- But it is possible that under the wrong set of circumstances, an event could occur



Cause Code Example Event



Event Details

1. Lightning strike on line A-B #1 resulted in a single line to ground fault (SLG), cleared correctly by line A-B #1 protective relays
2. Station C terminal on line A-C primary and backup protective relays also tripped. Instantaneous ground overcurrent elements set too sensitively and picked up for out-of-zone fault
3. Station B terminal on line B-D backup relay also tripped. Investigation found backup relay with incorrect wiring for polarizing current input. Inspection of prints showed incorrect wiring in the design

Cause Code Example Event

Primary Effect #1

- SLG fault on Line A-B #1
- Root Cause
  - Weather or ambient conditions LTA (A7B1C01)
    - A lightning strike on line A-B #1 resultant fault cleared correctly by line A-B #1 protective relays

Primary Effect #2

- Station C Line A-C terminal Misoperation – settings too sensitive
- Root Cause
  - Information to determine cause LTA (AZB1C02)
    - Relay settings developed in 2002 by now-retired engineer, leaving no way to determine the error in the engineer's approach
- Contributing Causes
  - Design output scope not correct (A1B2C01)
    - Setting for instantaneous ground overcurrent elements were too sensitive and picked up for out-of-zone fault

Primary Effect #3

- Station B Line B-D terminal Misoperation
  - Station B terminal on line B-D backup relay also tripped for this fault
- Root Cause
  - Design output not correct (A1B2C03)
    - Backup relay had incorrect wiring to its polarizing current input, resulting in the relay interpreting a reverse fault as forward. The incorrect wiring was due to the incorrect circuit design, not installation
- Contributing Causes:
  - Independent review of design LTA (A1B4C01)
    - The design was reviewed, but the reviewer did not catch the mistake
  - Start-up testing LTA (A2B3C01)
    - Commission testing did not catch the reverse polarity on the polarizing circuit

Failure Mode and Mechanism

Failure Mode*

- The manner whereby the failure is observed

Failure Mechanism

- Physical, chemical, or other processes that led to the failure

Example

Component	Failure Mode	Failure Mechanism
Relay	Contacts fail closed	Electrical short
Relay	Contacts fail open	Contacts dirty
Transformer	Coil shorts	Insulation breakdown
Power Supply	Loss of output	Diode failure

*** 60% stopped at failure mode during cause analysis**

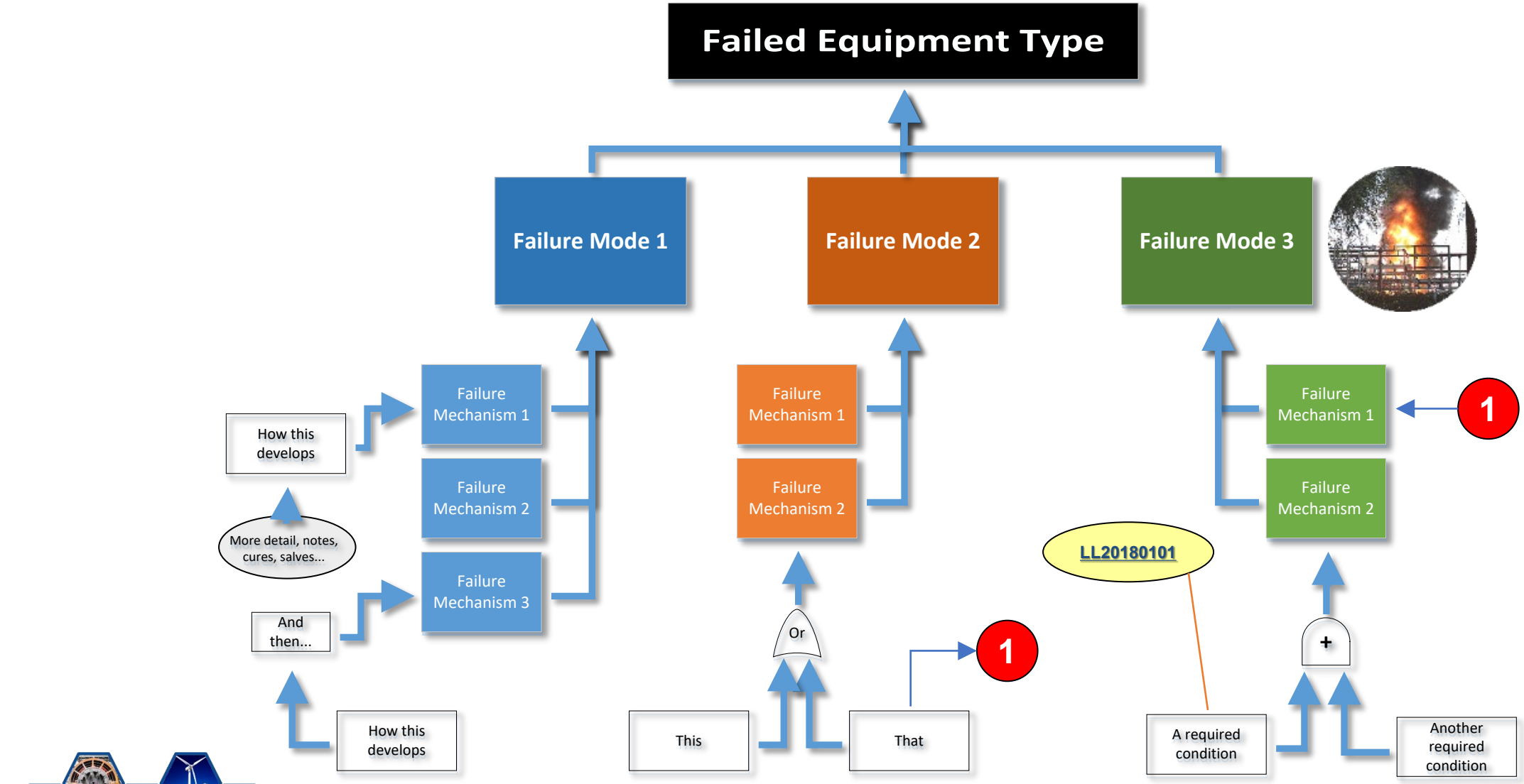
Failure Modes and Mechanisms

Failure Modes are what gets your attention

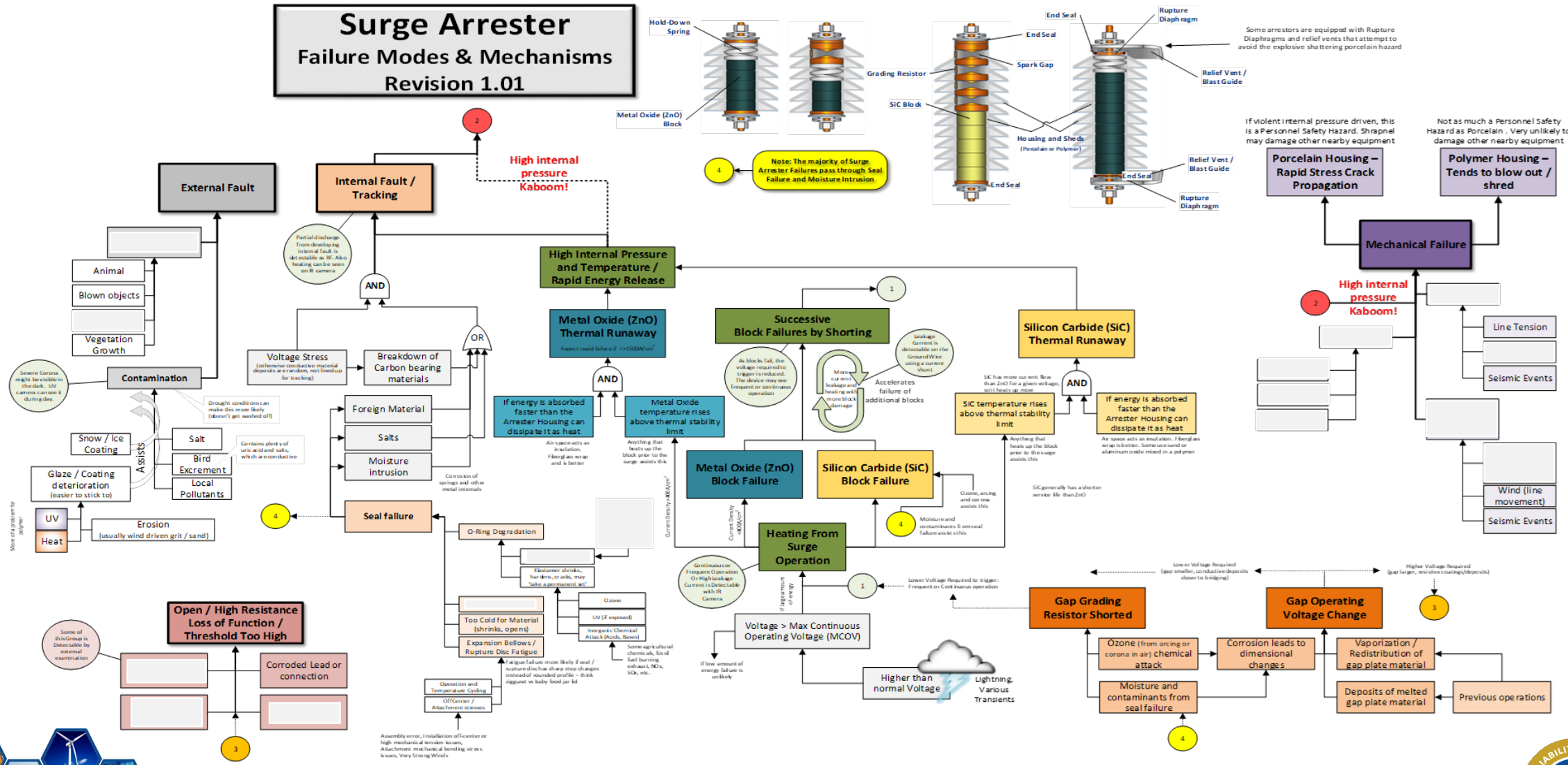
Failure Mechanisms are how the equipment gets going on the path to a failure

- Equipment Failures have logical cause-and-effect relationships behind them
- Physical Evidence Examination and Root Cause Analysis can reveal what Failure Mechanisms were involved
- Aging is not a "cause." It is just a catch-all term for slow moving Failure Mechanisms
- Failure Mechanisms are detectable. Many can be stopped, or at least slowed down so they can be corrected before causing a failure

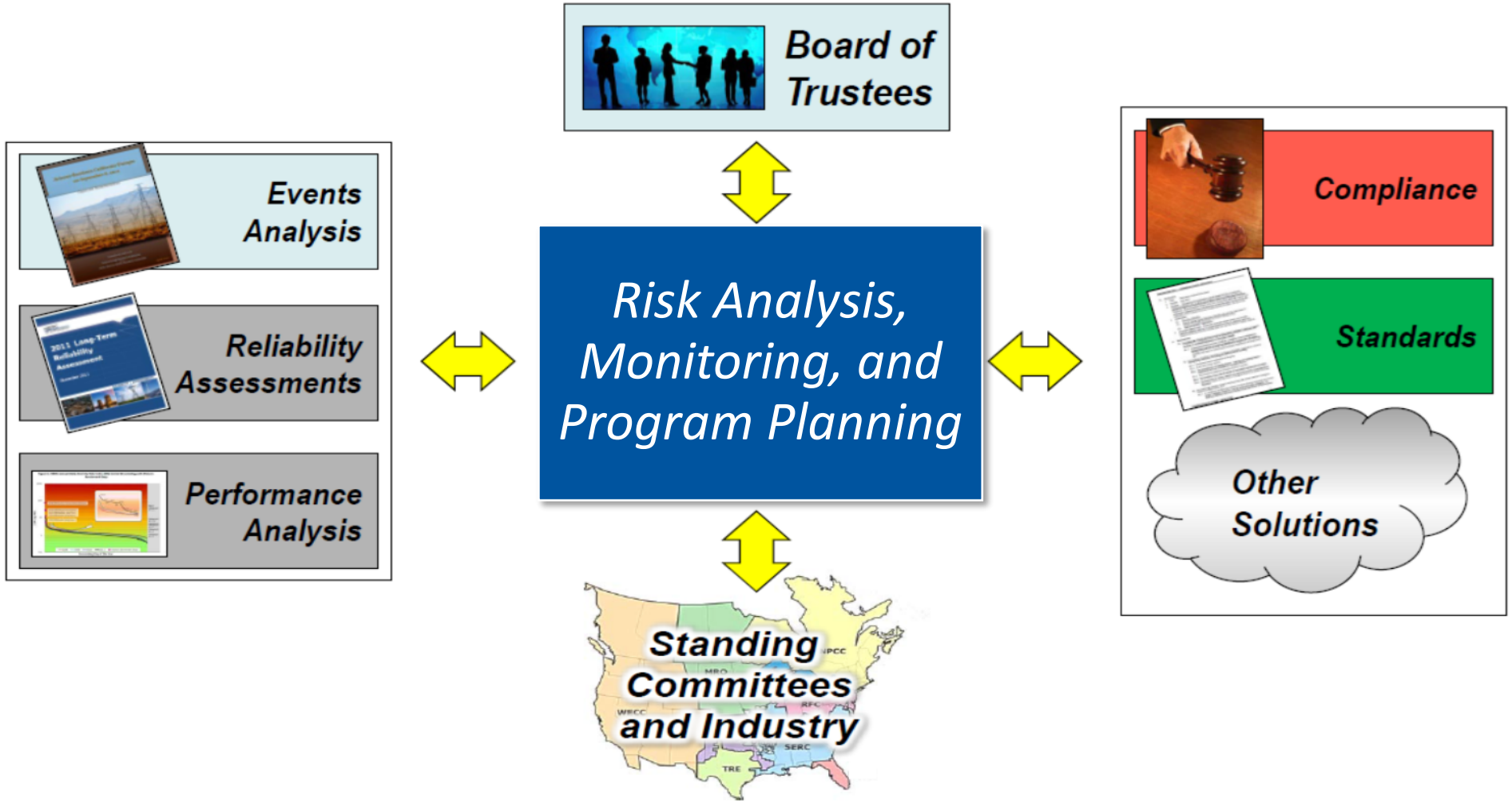
Generic Failure Modes and Mechanisms Layout



Sample Failure Modes and Mechanisms Diagram [Redacted]



Addressing Risks



Summary

NERC's Event Analysis Program aims to "right size" efforts to evaluate system events

Root Cause Analysis forms the core of NERC's Cause Coding efforts, following completion of event reports

Lessons learned provide anonymous sharing information gleaned from events; failure mode and mechanism analysis is another product

Insights from event analysis feed into NERC's overall program planning

References

- NERC Event Analysis Process – Drafts and Past Versions
- Lessons Learned
- NERC Cause Analysis Methods
- NERC Cause Coding Assignment Process Manual
- DOE Root Cause Analysis Guideline Document

Contacts

Mark Henry

Chief Engineer & Director, Reliability Outreach

Mark.Henry@texasre.org

512-583-4988

Bob Collins

Reliability Engineer, III

Bob.Collins@texasre.org

512-583-4986

David Penney

Director, Reliability Services

David.Penney@texasre.org

512-583-4958

Jagan Mandavilli

Reliability Engineer, Sr.

Jagan.Mandavilli@texasre.org

512-583-4942

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