SynchroGrid

Achieving Simplicity in System Protection

Selecting, Implementing and Overcoming Challenges when Selecting Coordination Criteria for **Wide Area Applications**

Naveen Ganta, MSEE
Relay Setting Engineer

Lalit Ghatpande, P.E.
Senior Protection Engineer

Joe Perez, P.E.
Founder, Protection Engineer

Presentation Outline

- Introduction to NERC PRC-027-1
- Wide Area Coordination Workflow
- Planning
- Data Collection and Model Validation
- Coordination Criteria Selection
- Coordination Study Implementation and Documentation
- Challenges and Mitigative Measures

Introduction to PRC-027-1

Purpose

"To maintain the coordination of protection systems installed to detect and isolate faults on BES elements, such that those protective systems operate in the intended sequence during faults."

- **R1:** Establish a process for developing new and revised settings. Process shall include:

  R1.1 Review of short circuit model before settings are developed

  R1.2 Review of protection settings

  R1.3 Communication with interconnecting utilities prior to setting implementation

- **R2:** Perform a protection system coordination study:

  Option 1 Wide Area Coordination Study every six years

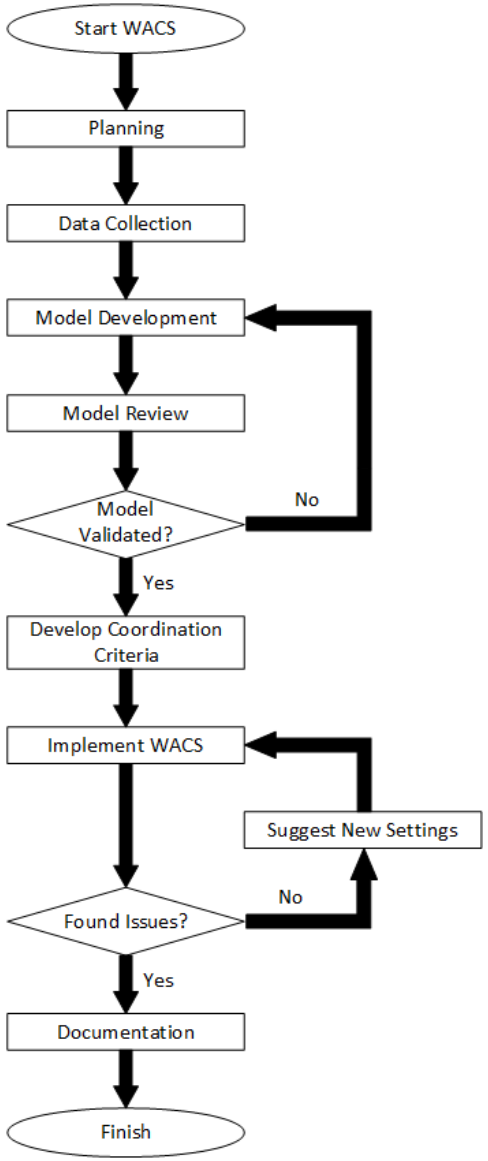
  Option 2 Establish a fault base comparison baseline and perform a study every time the current exceeds 15%

  Option 3 Use a combination of above

- **R3:** Apply R1

Wide Area Coordination Study

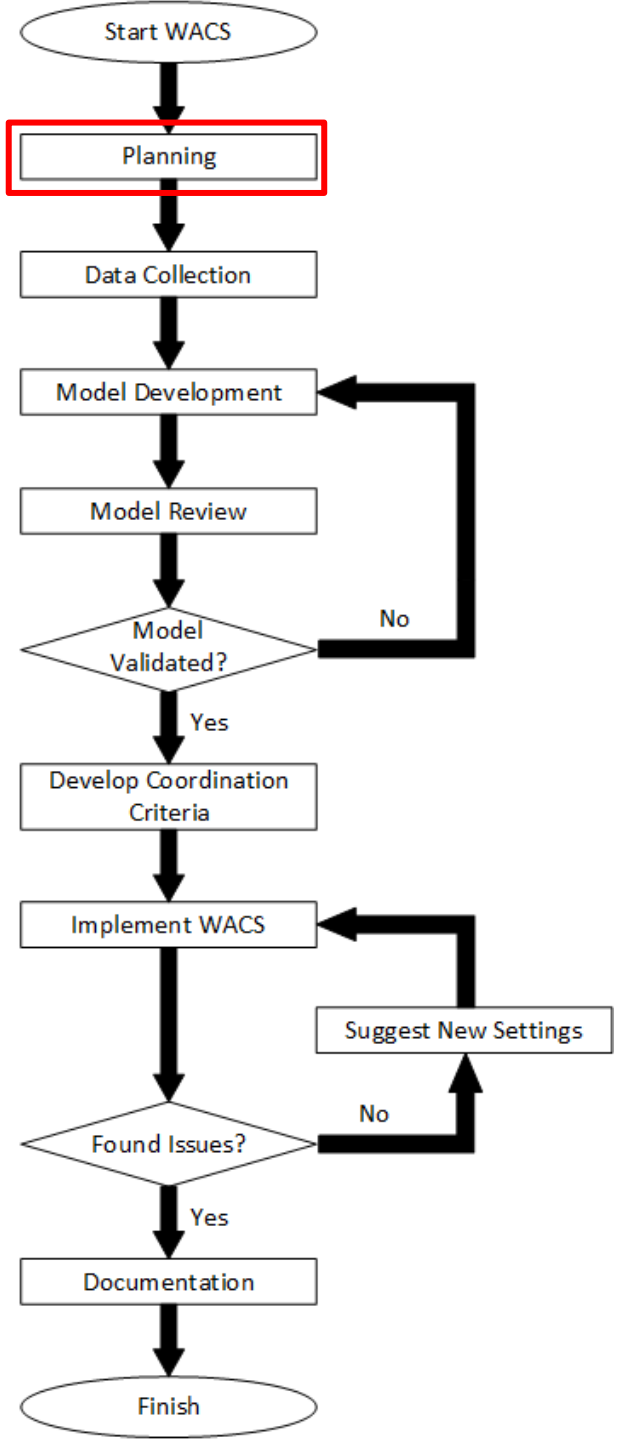
Workflow



Wide Area Coordination Study

Planning

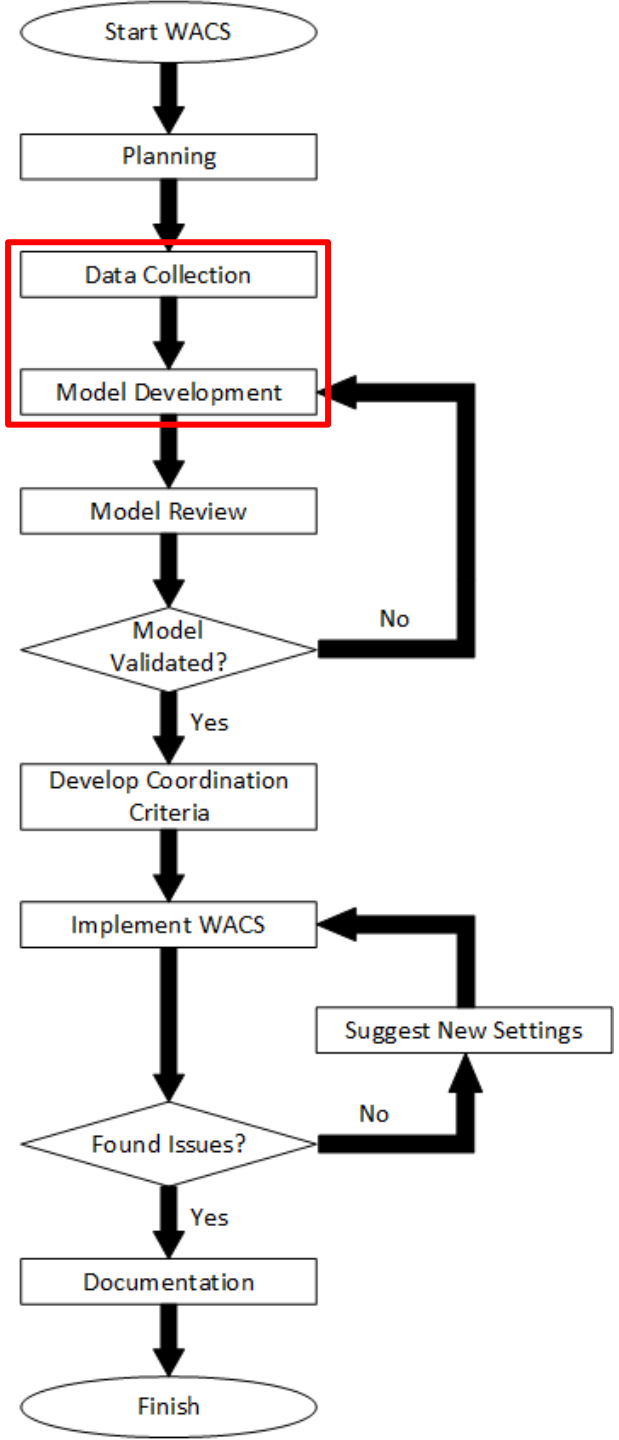
- Evaluation of suitable option from Requirement R2
- Fault deviation criterion
- System under consideration
  - Area
  - Load Capacity
  - Voltage Level
- Project management



Wide Area Coordination Study

Data Collection for Short Circuit Modeling

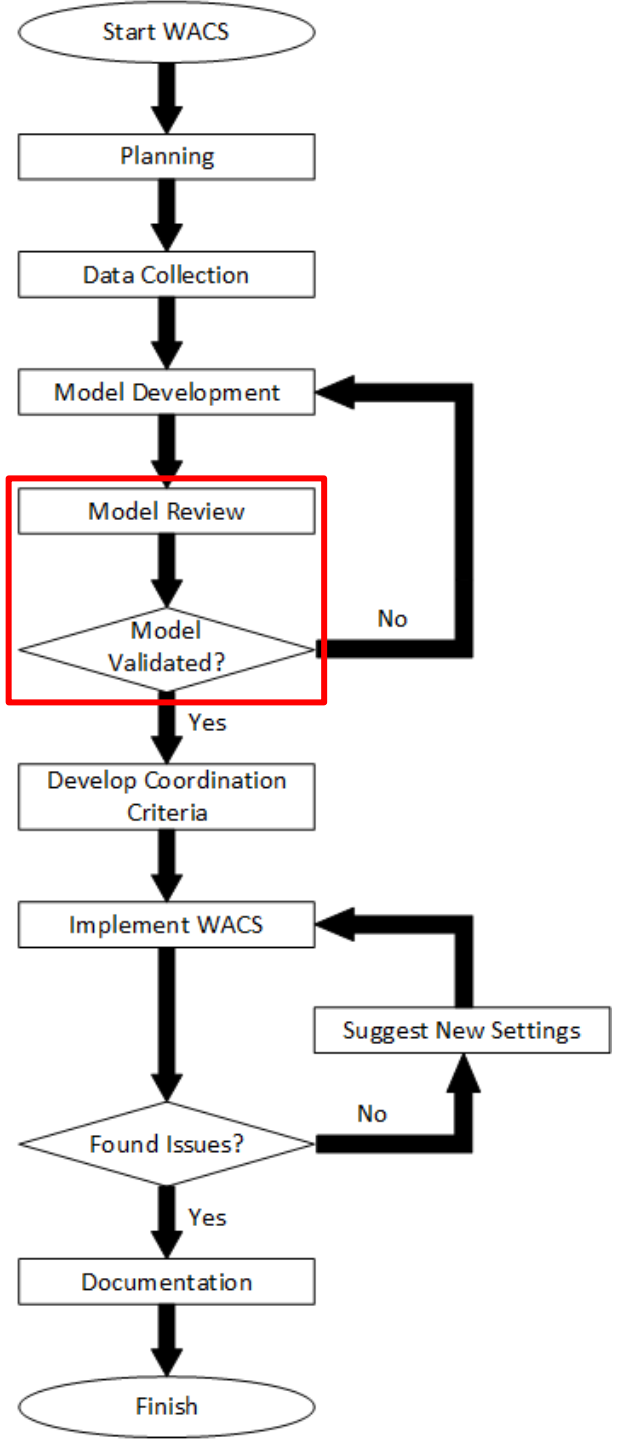
- Latest protective relay settings from field
- Nameplates
- Test reports
- Transmission line facility ratings
- System one-line drawings
- Information from Interconnection utilities
  - Inverter Based Resources (IBR) information



Wide Area Coordination Study

Short Circuit Validation

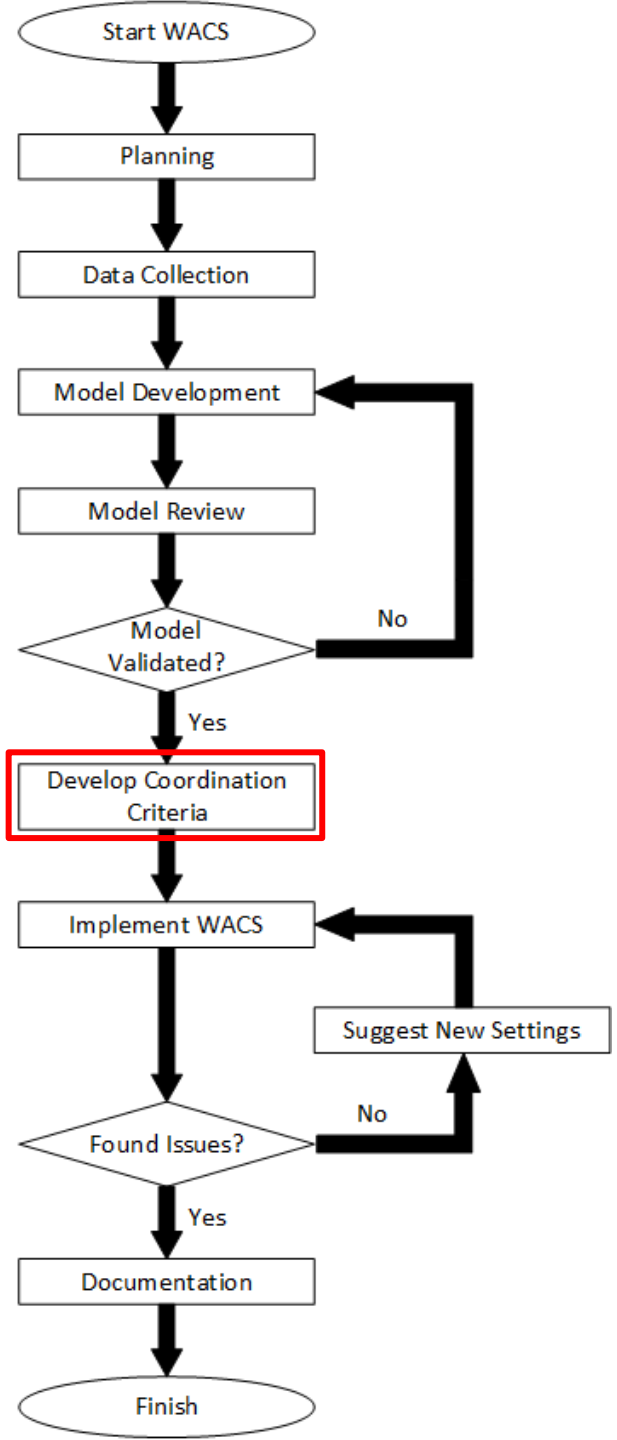
- Peer Review
  - Topology and system parameters
  - Use of automation tools
- Fault current comparison with field records
  - Matching system conditions
  - Criteria to validate (< 5%)
- Short circuit contribution from interconnecting utilities



Wide Area Coordination Study

Coordination Criteria

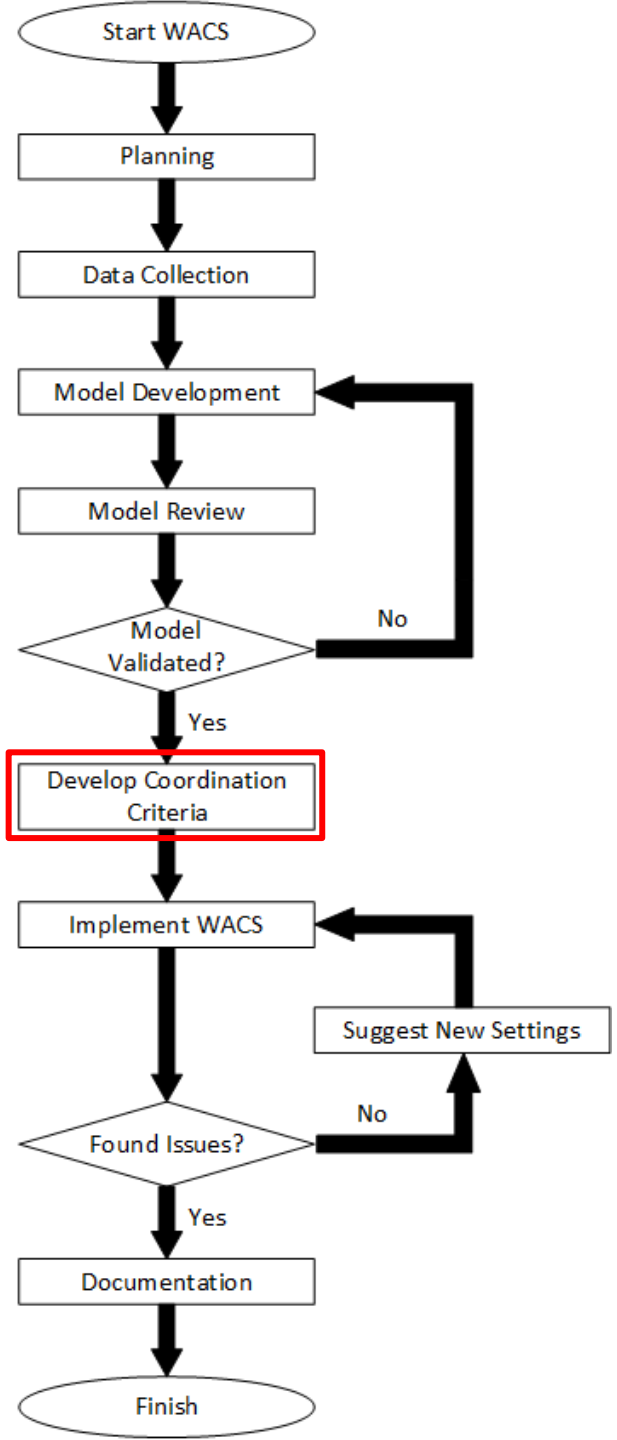
- Protective elements and their priority
  - Distance elements (21)
  - Time overcurrent elements (51)
- Acceptable ranges
  - Distance (Zone 1, Zone 2)
  - CTI
- Type of faults and fault location
  - SLG, LL, LLG, 3LG (Bolted and Impedance)
  - Primary, source and remote lines
  - Tap lines, low side of auto and distribution transformers



Wide Area Coordination Study

Coordination Criteria

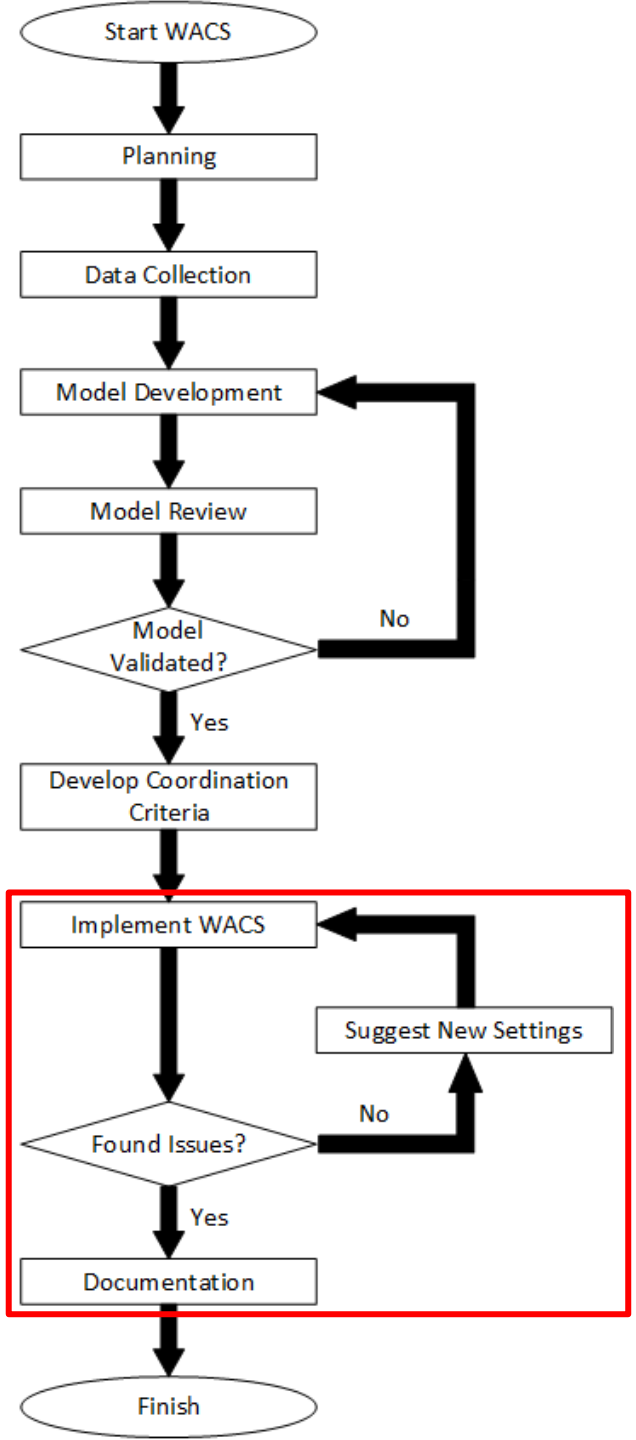
- System scenarios
  - N-1, N-2 contingencies
  - Level of generation
- System configurations that affect flow of current
  - Tie-breaker conditions
  - Series compensation devices
- Categorization of violations
  - High/Medium/Low risk violations



Wide Area Coordination Study

Coordination Study Implementation and Documentation

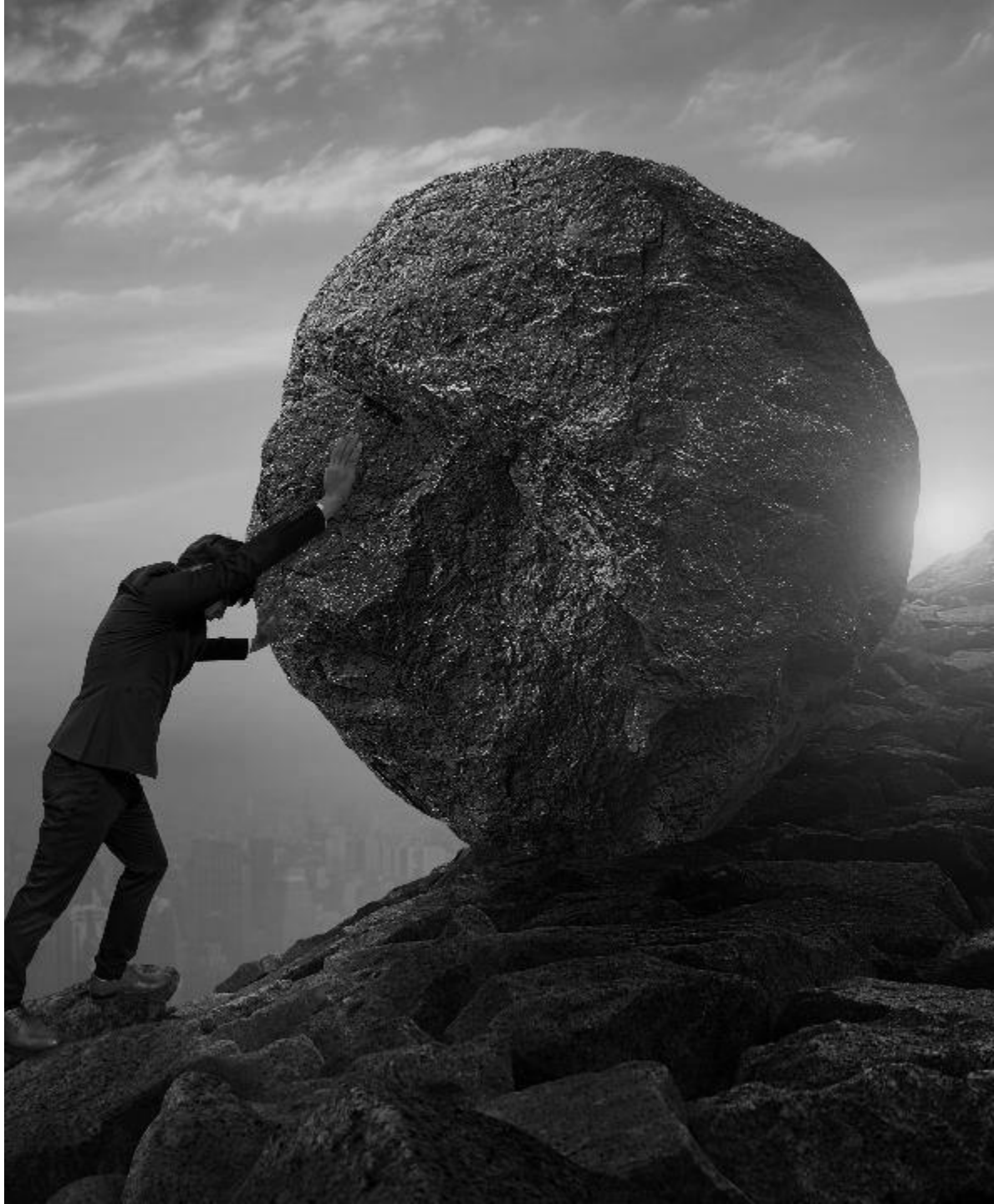
- Coordination study process
  - Distance reaches
  - Distance CTI
  - Time overcurrent CTI
- Prioritize
  - High, Medium and Low risk violations
- Documentation
  - Coordination criteria, Assumptions, Study results
  - Separate reports for Interconnecting utilities



Wide Area Coordination Study

Challenges and Mitigative Measures

- Model Validation
  - Updating SC model periodically
  - Maintaining database
- Miscoordination of Zone 2 elements
  - Standardized protection philosophy
  - Settings Templates



Wide Area Coordination Study

Challenges and Mitigative Measures

- Miscoordination of Time overcurrent elements
  - Closed loops
    - Use of automation tools
  - Radial lines
    - Security over speed
    - Prioritized coordination

Wide Area Coordination Study

Additional Takeaways

- Automation tools
  - Model validation
  - Reach verification
  - CTI evaluation
- Customized coordination criteria
- Overcurrent elements to consider by GO
  - Negative sequence (46)
  - Stator ground fault (64G)
  - Unbalance (60)

Questions?

Naveen Ganta, MSEE
Relay Setting Engineer

Lalit Ghatpande, P.E.
Senior Protection Engineer

Joe Perez, P.E.
Founder - Protection Engineer

Presented at the 74th Annual Texas A&M Relay Conference