WIRAB Webinar:
Introduction to Remedial Action Schemes (RAS) in the West

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Presenters

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Outline

1. What are RAS and why do we use them in the Western Interconnection?
2. Western vs Eastern Interconnections
3. RAS Results, Actions, and Triggers
4. RAS classifications: LAPS, WAPS, SN
5. The WECC Remedial Action Scheme Reliability Subcommittee (RASRS)
6. RAS Modeling and EMS
7. Simple RAS Example
8. Explanation of WECC-1
9. Event #1: April 14, 2017 WECC-1 event
10. Event #2: January 20, 2017 PAC Bonanza Generation Tripping
11. Conclusion
12. Questions?
1. What are Remedial Action Schemes (RAS)?

NERC Glossary Definition
A scheme designed to detect predetermined System conditions and automatically take corrective actions that may include, but are not limited to, adjusting or tripping generation (MW and Mvar), tripping load, or reconfiguring a System(s). RAS accomplish objectives such as:
• Meet requirements identified in the NERC Reliability Standards;
• Maintain Bulk Electric System (BES) stability;
• Maintain acceptable BES voltages;
• Maintain acceptable BES power flows;
• Limit the impact of Cascading or extreme events.
1. Why do we use RAS in the WI?

Often used to comply with NERC reliability requirements without building new transmission lines or other large electrical equipment. RAS are often installed to:

- Increase system transfer capacity
- Meet project schedules

RAS are generally designed to mitigate three types of power system problems and time scales:

- Thermal (minutes)
- Voltage Stability (seconds to minutes)
- Transient Stability (cycles to seconds)
2. Western vs Eastern Interconnection

- Higher load (160GW vs 550GW)
- Geography and population
- History
2. Western vs Eastern Interconnection
3. RAS Results

RAS actions are **intended to bring the system back into balance** and may include:

- Changes in demand
- Changes in generation
- Changes to system configuration to maintain system stability, acceptable voltage, and/or power flows
# 3. RAS Triggers and Actions

**RAS Triggers**
- Line or Transformer Loss – 148
- Protection Trip – 29
- Overcurrent / MW / MVA – 89
- Thermal – 28
- Directional – 1
- Under Frequency – 3
- Acceleration – 1
- Under / Over Voltage – 31
- Out of Step - 2

**RAS Actions**
- Trip Generation – 134
- Island the System – 8
- Brake Insertion – 3
- Multiple Actions – 77
- Series Capacitor or Reactor Switching – 8
- Shunt Capacitor or Reactor Switching – 23
- Configuration Changes – 95
- Load Shed or Rejection – 59
- HVDC Ramp – 8
- Excitation Forcing - 1
4. RAS Classifications: LAPS, WAPS, and SN

- **LAPS** – Local Area Protection Scheme (185)
- **WAPS** – Wide Area Protection Scheme (75)
- **SN** – Safety Net (19)

- Approximately **279** RAS in the Western Interconnection
4. LAPS, WAPS, and SN Flow Chart

Start

Safety Net? (Used for TPL)
- NO
  - RAS Failure could lead to load loss >= 300MW?
    - NO
    - RAS Failure could lead to generation loss >= 1,000MW?
      - NO
        - Violate WECC TPL Criteria?
          - NO
            - LAPS
          - YES
            - Safety Net
        - YES
          - YES
            - Safety Net

- YES
  - WAPS
5. WECC RASRS RAS Review

WECC’s Remedial Action Scheme Reliability Subcommittee (RASRS):

• Reviews and approves all RAS in WECC, including their classifications

• Provides outside feedback and comment on entity schemes

• Develops of WECC RAS Criteria (PRC-(012-014)-WECC-CRT)

• Maintains the RAS Database
6. RAS Modeling in EMS

- Energy Management System (EMS)
  - Need to model RAS in EMS to study the impact in Real-Time Contingency Analysis

- EMS Network Applications (NetApps) Group at PEAK Reliability is responsible for all RAS model build and maintenance

- NetApps group is also responsible for RAS model update in other real-time applications-V&R Peak-ROSE Voltage Stability Analysis (VSA) and PowerTech Transient Stability Analysis Tool (TSAT)
7. Simple Illustration of RAS

- **RAS**
  - Loss of Line2, may overload Line1
  - Need to trip G1 to protect line1 under loss of line2
  - This scheme (referred to RAS scheme) is wired in the field to protect the line1

![Diagram of power grid with G1, G2, G3, Line1, Line2, Line3, Load: 1000 MW, Max Capacity 700 MW, Limit 500 MW]
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8. Explanation of WECC-1

WECC-1
(the big one!)
8. Why WECC – 1

THE DOUGHNUT
Major load center in California, especially around the LA basin

Major generation in the Pacific Northwest and coal generation in Montana, Wyoming and Utah. Nuclear in Arizona and empty space in Nevada, Western Utah, and the area surrounding where Transmission lines swing through
8. WECC-1 Names

WECC – 1 is also known as:
• COI RAS (in the WECC database, California Oregon Intertie)
• PACI RAS (primarily PG&E, Pacific AC Intertie)
• AC RAS (primarily BPA)
• Four Corners Scheme
• NE / SE Separation scheme
• Pacific Intertie Transfer Trip Scheme (PITT)

The scheme primarily watches loading and line conditions on COI
8. WECC-1 Parameters
WECC-1 has the potential to split the interconnection in half

If the system was split, the scheme would then trip load in California and generation around the northwest to try and balance the two systems.

The complete remedial action scheme for loss of the California-Oregon AC Intertie encompasses detection schemes, control logic, communication paths, and tripping schemes involving utilities in almost all states and provinces in the Western Interconnection.
9. Event #1

April 14, 2017 WECC-1 Event
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System conditions at the time of the event
Two 500kV lines in COI out of service for scheduled work
• 500kV Malin – Round Mountain #2 and
• 500kV Round Mountain – Table Mountain #2

The Event
09:34 PPT: Round Mountain-Table Mountain #1 500kV line relayed. No estimated time of return.
• North to South: 600 MW
• South to North: 2450 MW
With Path 66 (COI) now severely restricted, this immediately caused path 49 to run up to its System Operating Limit (SOL)
9. April 14, 2017 WECC-1 Event

To alleviate the flows on path 49 and 66 (and likely other areas as well) the WECC-1 controller chose to trip generation in the Pacific Northwest. The WECC-1 operating procedure for tripping generation in the Pacific Northwest includes generation plants at:

- Carty
- Chief Joseph
- GM Shrum (BCHA)
- Grand Coulee
- John Day
- McNary
- Mica (BCHA)
- Peace Canyon (BCHA)
- Revelstoke (BCHA)
- Various Wind Plants (a dozen plus)
- Wells (DCPUD)

The controller immediately tripped 1,300 MW somewhere in the Pacific Northwest.
At 09:34 PPT, system frequency in the Western Interconnection dropped to 59.830 Hz due to the loss of generation the Pacific Northwest Frequency.

Frequency returned to normal in 10 minutes.
10. Event #2

January 20, 2017
PAC Bonanza Generation trip
10. PAC Bonanza Gen shed
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Path 30 (AKA TOT 1A) rated at 650 MW East to West

Path 33 (AKA Bonanza West) rated at 785 MW East to West

Coal generation at Bonanza ~ 500 MW
10. PAC Bonanza Gen shed

At about 5AM the Bonanza - Mona 345kV line trips

This creates a potential line and equipment overload situation for the Flaming Gorge 115/230kV XFMRS and the Upalco to Carbon 115kV line

RAS immediately trips generation at Bonanza to reduce flows on the Upalco – Carbon line and Flaming Gorge XFMR
When the Bonanza plant tripped off this tripped the frequency down to about 59.935 but recovered quickly. Because of the RAS action there were no stability issues and the system returned to normal in minutes (namely ACE and Frequency)
11. Conclusion

- RAS are used in the west because they are much cheaper than building long, high voltage transmission lines and they help increase the transfer capabilities of lines.

- They act as a smart controller, watching system conditions and taking calculated actions in order to prevent a credible threat to the grid.

- About 280 RAS in the Western Interconnection of differing sizes and complexities.
Questions?