



APS Emergency Restoration

Prepared for:

U.S.-Jordan Electric Transmission
Partnership Executive Exchange
Visit – April 2010

Advanced Planning & Preparation

- (Desert) Southwest Sub-Region Restoration (controlled by Regional Reliability Org)
 - Palo Verde Backup Power Restoration
 - Arizona Triangle Restoration
 - PSNM Restoration
 - EPE Restoration
 - Yuma Restoration
 - IID Restoration
 - TEP Restoration
 - Total System Restoration

Advanced Planning & Preparation

- (APS) Black Start System Restoration Guideline

- Revised annually
- Trained annually
- Drilled annually

Advanced Planning & Preparation

- (APS) Black-Start System Restoration Procedures and Powerflow Simulations
 - Palo Verde and Redhawk
 - Metro 230
 - Northern AZ 345 and 230
 - Southern AZ 230
 - Metro Central/East/West 69
 - NW/NE/SE/SW 69
 - EHV
 - Powerflow Simulations
 - Contracts

System Assessment

- Identifying Causes of Critical Disturbances
 - EMS / SCADA
 - Regional Reliability Organization
 - WECCNet
 - Reliability Coordinator(s)
- Assessing the State of the Entire System
 - EMS / SCADA
 - Regional Reliability Organization
 - Reliability Coordinator(s)

Voltage/Balance

- Voltage Control
 - Inherent challenges; Seasonal
 - VAR production
 - VAR consumption
 - Static and Dynamic Reactive Resources
 - AGC Generator Excitation Control
- Maintaining Load/Generation Balance
 - Governors
 - Area Frequency Response Criteria
 - AGC

Frequency/Synchronizing

- Frequency Control (Under Islanded Condition)
 - Isochronous with WALC; governor only
 - Transition to AGC - Flat Frequency
 - Transition to AGC – Tie Line Bias
- Synchronization Considerations
 - Reliability Coordinator approvals
 - Voltage/Frequency/Power Angle
 - Sync scopes/Sync check relays
 - Locations

System Protection Considerations

- Insufficient fault current
- UFLS
- UVLS
- Generator protection
 - Underspeed
 - Overspeed
 - Reverse power
- Impedance relay challenges

Black-Start Generation

- Startup (Automatic, Manual)
 - Contract with WALC for Glen Canyon/Hoover (Blackstart)
 - Safe shutdown power to PVNGS (26 MW)
 - Fairview CT (Blackstart)
 - Auto-start/sync
 - Douglas island only (16 MW)
 - Yucca CT (Blackstart)
 - Manual start/sync
 - Yuma island only (36 MW)
 - Ocotillo CTs (Quickstart)
 - 2 x 55 MW
 - West Phoenix (Quickstart)
 - 2 x 55 MW
 - Saguaro (Quickstart)
 - 3 x 55 MW

Location Considerations

- Black-Start Generation
 - Colorado River via USBR
 - RRO maintains regional Blackstart Capability Plan
- Transmission (Paths Between Black-Start Units, Long Distances)
 - VAR production/Line charging
 - Reactors/generators/load