PJM System Restoration Strategy Task Force Meeting

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Overview of System Restoration Strategy

- System Restoration strategy in a zone is straightforward if
  - Equipment not damaged during the blackout and ready to be re-energized
  - Ample distributed critical and Tier 2 Blackstart generation to
    - Re-energize the system
    - Provide cranking power to non-blackstart units and station power to Nuclear units
    - Restore Critical Load and customers
  - Adequate generation to supply all loads to meet the targeted ERT (expected restoration time)
Keys and Impediments to Successful Restoration

- Equipment Availability (available by assumption)
- Blackstart generation (how much MW, where and preferred MW redundancy)
- Critical Load (what, where and when)
- Cranking Power to restart non-Blackstart units (how much MW, where and by when)
- Station Power to Nuclear (how much MW and when)
- MW availability from non-Blackstart and Nuclear units (how much and when)
- Targeted ERT or full system restoration (Overall Goal)
- Target not met, consider outside help from tie lines or top down restoration (how much MW and when)
Blackstart Generator Characteristics

• Critical Blackstart Generators
  – MW available when called
  – Maximum MW output maintained through restoration period

• Tier 2 Blackstart Generators
  – No outside cranking power needed to restart
  – MW available after startup and ramp up
  – Maximum output maintained
Non-Blackstart Generator Characteristics

• “Latest Time” Generators
  – Cranking power needed **no later** than some specific time for hot restart
  – MW output available at a certain time after cranking power is provided
  – Unit not available if the specific time is missed
  – Maximum MW after ramping up

![Characteristics of Latest Time Generators](image-url)
Non-Blackstart and Nuclear Generator Characteristics

- **“Earliest Time” Generators**
  - Cannot hot restart
  - Cranking power needed **no sooner** than certain time before the unit can be restarted
  - MW available at a certain time after cranking power is provided
  - Maximum MW after ramping up

- **Nuclear Generators**
  - Station Power needed **at a specific time** for safe shutdown
  - MW not available until after a certain time
  - Maximum MW after ramping up
Major Independent Zonal SRS Components

• Targeted ERT (expected restoration time)
  – Final time to restore all loads
  – Is the interim restoration progress important?
• Definition of Critical Loads (cranking power, station power to Nuclear, power to critical infrastructure, etc.) at a pre-determined time
• Available MW from critical Blackstart units and number of critical units needed
• Available MW from Tier 2 Blackstart and non-Blackstart units during the restoration period
• Can a zone meet the Targeted ERT without outside help? If not, consider jointed SRS between multiple zones or a top down restoration strategy
Some Observations

- **Specific time when a specified MW amount is needed at a specific location is paramount to the success of a SRS**
- If enough MW is available to serve all loads at targeted ERT, a corresponding minimum Blackstart MW amount can be determined given the characteristics of all generators and critical loads in the zone
- If available Blackstart generation is less than this minimum amount, incentives (i.e. raising the price for providing BS service) or a tie line/ top down / multiple zonal restoration strategy need to be considered
- The number of critical Blackstart units can be determined from and preferred MW redundancy needs to be defined by this minimum Blackstart MW
- The redundant Blackstart MW can be used to pick up load during restoration
- If the targeted ERT can be met with minimum Blackstart generation, MW available above the minimum Blackstart MW is not for restarting the system but for restoring load (here, the load restoration progress objective plays an important role.)
- Tier 2 Blackstart units are for restoring load if their MW are not available until after non-Blackstart units have been re-started
Questions

Questions after playing with the restoration example