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**LESSONS LEARNED FROM THE 1977 BLACKOUT**

**CASE STUDY 1**

**SEQUENCE OF EVENTS**

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## 1977 BLACKOUT SEQUENCE OF EVENTS

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### Prior to 20:37

System Load 5868MW, imports 2860MW, operating reserve 1998MW, synchronized reserve 1208MW.

20:37

Lightning strike causes W97 and W98 to flash over B phase to ground. Circuit breaker configuration causes Indian Point 3 to trip. Feeder Y88 opens automatically at Ladentown S/S. W97 reclosed successfully at Millwood.

Feeders W8 1 and A2253 flows greater than normal, less than LTE.

### LESSONS LEARNED

- \* Verify and correct tower grounding
- \* Test to extent possible complete relay system
- \* Lockout Relay philosophy

20:45

Fast load pickup alarm is initiated to the generating stations. Astoria GT site is ordered via telephone to but jet engine units in service.

### LESSONS LEARNED

- \* Prepare procedures for operator response to overloads and drill
- \* Gas turbines should always be available or available via remote start control
- \* Install alarms at all GT sites
- \* Periodically test generating units' emergency response

20:55

Lighting strike causes feeders W93 and W99 to flash over C phase to ground. W99 successfully reclosed. W93 reclosed at Sprain Brook only. Angle too great at Buchanan. W81 trips due to faulty relay. Feeder 80 > LTE, A2253 > normal. East River No. 5 generation being reduced and forced out of service.

### LESSONS LEARNED

- \* Every Megawatt counts
- \* Syncheck relays vs. blackout potential
- \* Prepare and drill on procedures for major emergencies
- \* Prepare and continuously drill on procedures for rapid restoration
- \* Provide information to operators in clear, concise manner
- \* Prepare procedures for NYPP/member company interface
- \* Prepare procedures for proper relay handling
- \* Have an organization properly staffed to handle all emergencies

**21:14**

System wide 5% voltage reduction initiated.

**LESSONS LEARNED**

- \* Master push buttons for quick response

**21:18**

System wide 8% voltage reduction initiated.

**LESSONS LEARNED**

- \* Procedure to initiate 8% first

**21:19**

Feeder 92 (feeder SO) faults opening the last 345kV tie to the north. S1 transformer trips on overload.

**LESSONS LEARNED**

- \* Review tree trimming schedules

**21:22**

LILCO tie feeder 901 is opened by LILCO because it exceeded its emergency rating. Feeder A2253 above its STE rating by 150%.

**21:24**

4kV manual load shedding initiated.

**LESSONS LEARNED**

- \* Operating procedures needed for all equipment
- \* Master pushbuttons required for fast response
- \* Expand procedures to give operators authority to shed load prior to last element failure

**21:29:41**

A2253 opens automatically due to failure of the phase angle regulator. Two 138kV feeders 11 and 16 open due to power surge. System islands.

**21:29:47**

Ravenswood No. 3 trips.

**LESSONS LEARNED**

- \* Review system voltage response
- \* Prepare Islanded System Criteria

**21:36**

System shutdown due to mismatch between generation and load.

**LESSONS LEARNED**

- \* Avoid islanding

**22:26**

Attempt rapid reenergization without sectionalizing the system.

**LESSONS LEARNED**

- \* Prepare procedures for the rapid restoration of the system
- \* Keep the system restoration plan up to date

**22:45**

Six part restoration plan implemented. Problems encountered that hindered the process of restoration included: high system voltage, loss of oil pressure on the pipetype cables, equipment damage during the shutdown and restoration and the unavailability of certain generation.

**LESSONS LEARNED**

- \* Add or modify system voltage control facilities
- \* Install diesel-generators in substations for L&P
- \* Modify GT's for black start operation to supply their own auxiliary load
- \* Modify GT's voltage controls to supply cable charging
- \* Investigate isolation of generation to own auxiliaries prior to shutdown
- \* Provide backup supply for communications equipment

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Additional problems were encountered and significant delays resulted due to the amount of communications required to energize each network.

**LESSONS LEARNED**

- \* Provide controls to permit restoration of networks remotely from the ECC
- \* Prepare restoration plan so that load can be energized as the transmission feeders are energized