



Federal Energy Regulatory Commission



FACT SHEET

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Sequence of Events: Southwest Power Outage, September 8, 2011

Phase 1: Before the outage

Timing: Before Hassayampa-North Gila transmission line (H-NG) trips at 15:27:39

- A hot, shoulder season day with some generation and transmission maintenance outages
- Relatively high loading on some key facilities: H-NG at 78% of its normal rating, Coachella Valley (CV) transformers at 83%
- 44 minutes before loss of H-NG, Imperial Irrigation District (IID)'s real time contingency analysis (RTCA) results show that the N-1 contingency loss of one Coachella Valley (CV) transformer would result in the overload of the second CV transformer beyond its trip point. IID did not act on this RTCA result.
- Arizona Public Service (APS) technician skipped a critical step in isolating the capacitor bank, causing H-NG to trip

Phase 2

Timing: 15:27:39 to 15:28:16, just before CV transformer No. 2 trips

- H-NG trips due to fault; APS operators believe they will restore it quickly and notify Western Electricity Coordinating Council (WECC) Reliability Coordinator (RC)
- H-NG flow redistributed to Path 44 transmission line (84% increase in flow), IID (12% of all H-NG flow goes to IID's 92 kV system), and Western Area Power Authority-Lower Colorado (WALC) systems
- Both CV transformers immediately overloaded above their relay setting
- At end of Phase 2, loading on Path 44 at 5,900 out of 8,000 amps needed to initiate San Onofre Nuclear Generating Station (SONGS) separation scheme

Phase 3

Timing: 15:28:16, when CV transformer bank No. 2 tripped, to just before 15:32:10, when Ramon transformer tripped

- Both CV transformers tripped within 40 seconds of H-NG tripping
- IID knew losing both CV transformers would overload Ramon transformer and S Line connecting it with San Diego Gas & Electric (SDG&E)
- Severe low voltage in WALC's 161 kV system
- At end of Phase 3, loading on Path 44 at 6,700 amps out of 8,000 needed to initiate SONGS separation scheme

Phase 4

Timing: 15:32:10 to just before 15:35:40

- IID's Ramon 230/92 transformer tripped at 15:32:10, was set for 207% of its normal rating instead of 120% as IID had intended, which allowed it to last approximately four minutes longer than CV transformers
- IID experienced undervoltage load shedding, generation and transmission line loss in its 92 kV system

- Path 44 loading increased from approximately 6,700 amps, to as high as 7,800 amps, and ended at around 7,200 amps (out of 8,000 needed to initiate the SONGS separation scheme)

Phase 5

Timing: 15:35:40 to just before 15:37:55

- The Gila and Yucca transformers tripped, isolating the Yucca load pocket to a single tie with SDG&E
- Path 44 loading increased from 7,200 to 7,400 amps after Gila transformer tripped, and ended at 7,800 amps after loss of the Yucca transformers and Yuma Cogeneration Associates generator (very close to the 8,000 amps needed to initiate the SONGS separation scheme)

Phase 6

Timing: 15:37:55 to 15:38:21.2

- IID's El Centro-Pilot Knob line tripped, forcing all of IID's southern 92 kV system to draw from SDG&E via the S Line
- S Line Remedial Action Scheme (RAS), a type of protection system, operates, tripping generation at Imperial Valley and worsening the loading on Path 44
- S Line RAS trips S Line, isolating IID from SDG&E
- Path 44 exceeds trip point of 8,000 amps, to as high as 9,500 amps
- SONGS separation scheme operates, creates an island composed of SDG&E, Comisión Federal de Electricidad (Baja California, Mexico) (CFE), and APS's Yuma load pocket

Phase 7

Timing: Just after 15:38:21.2 to 15:38:38

- Underfrequency Load Shedding (UFLS) could not prevent the SDG&E/CFE/Yuma island from collapsing due to generators tripping during load shedding and frequency decline below generator underfrequency protection settings
- SONGS nuclear units shut down even though they had been isolated to the SCE side of the SONGS separation scheme

Effects

- SDG&E lost 4,293 Megawatts (MW) of firm load, affecting approximately 1.4 million customers
- CFE lost 2,205 MW of firm load, affecting approximately 1.1 million customers
- IID lost 929 MW of firm load, affecting approximately 146,000 customers
- APS lost 389 MW of firm load, affecting approximately 70,000 customers
- WALC lost 74 MW of firm load, the majority of which affected APS's customers

Restoration

- None of the affected entities were required to use "black start" plans (which work to energize systems using internal generation to get from shutdown to operating condition without assistance from the BES) because they all were able to access sources of power from their own or a neighbor's system that was still energized.
- The restoration process generally proceeded as expected, and some entities restored load more quickly than they had expected.