

Electrical Sequence of Events

June 24, 2004

07:40:55.747      Fault #1 inception  
Fault #1 type = C-N  
Fault #1 cause/location = Phase down (broken bells)  
reported near 115th Ave. & Union Hills (WW-LBX Line)

At Westwing, the Liberty line relays operated properly and issued a trip signal. Incorporated in this scheme is a Westinghouse high-speed "AR" auxiliary tripping relay that is used to "multiply" that trip signal toward both trip coils of two breakers (WW1022 & WW1126). The "AR" relay failed (partially) and issued the trip signal to breaker WW1126 only. Since the trip signal was never successfully issued to WW1022, breaker failure for WW1022 was also never initiated (this would have cleared the Westwing 230kV West bus and isolated the fault). Therefore, the "remote" ends of all lines feeding into the 525kV and 230kV yards were required to trip to isolate the fault.

07:40:55.814      4.0 cycles after fault #1 inception  
WW1126 opened (LBX / PPX 230kV crossover breaker)

07:40:55.822      4.5 cycles after fault #1 inception  
LBX1282 opened (Westwing 230kV Line)

07:40:56.115      22.1 cycles after fault #1 inception  
AFX732 & AFX735 opened (Westwing 230kV Line)

07:40:56.122      22.5 cycles after fault #1 inception  
YP452 & YP852 opened (Westwing 525kV Line)

07:40:56.136      23.3 cycles after fault #1 inception  
WW1426 & WW1522 opened (Agua Fria 230kV Line)

07:40:56.142      23.7 cycles after fault #1 inception  
WW856 & WW952 opened (Yavapai 525kV Line)

07:40:56.165      25.1 cycles after fault #1 inception  
DV322 & DV722 & DV962 opened (Westwing 230kV Line)

07:40:56.172      25.5 cycles after fault #1 inception  
WW1726 & WW1822 opened (Deer Valley 230kV Line)

07:40:56.196      26.9 cycles after fault #1 inception  
RWYX482 & RWYX582 & RWYX782 opened  
(Westwing 230kV Line)  
(Waddell 230kV Line)  
(230/69kV Transformer #8)

07:40:56.515      46.1 cycles after fault #1 inception  
WW1222 opened (Pinnacle Peak 230kV Line)

Bb7

t = unknown      Surprise Lockout "L" operated (230/69kV Transformer #4 Differential & B/U Over-Current)

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June 24, 2004

07:40:56.548	48.1 cycles after fault #1 inception SC622 & SC922 & SC262 opened (Surprise 230/69kV Transformer #4)
07:40:57.549	108.1 cycles after fault #1 inception SC1322 opened (Westwing 230kV Line)
07:40:57.800	123.2 cycles after fault #1 inception RWP-CT2A opened (Redhawk Combustion Turbine 2A)
07:40:57.807	123.6 cycles after fault #1 inception RWP-ST1 opened (Redhawk Steam Turbine 1)
07:40:57.814	124.0 cycles after fault #1 inception RWP-CT1A opened (Redhawk Combustion Turbine 1A)
07:40:58.339	155.5 cycles after fault #1 inception RIV762 opened (Westwing 69kV Line)
07:40:58.372	157.5 cycles after fault #1 inception HH762 opened (Westwing 69kV Line)
t = unknown	Westwing Lockout "AK" operated (230/69kV Transformer #11 Differential & B/U Over-Current)
07:40:59 (EMS)	WW2026 & WW2122 opened (Westwing 230/69kV Transformer #11 - High Side)
07:40:59.272	211.5 cycles after fault #1 inception WK362 opened (Westwing 69kV Line)
07:40:59.489	224.5 cycles after fault #1 inception HAAX935 & HAAX938 opened (Hassayampa - Arlington 525kV Line) (Time stamp provided by SRP)
07:41:00 (EMS)	WW862 & WW962 & WW1362 opened (Westwing 230/69kV Transformer #11 - Low Side)
07:41:00.392	278.7 cycles after fault #1 inception WW752 opened (South 345kV Line)
07:41:01.982	Fault #1 type changed = B-C-N
07:41:02.144	383.8 cycles after fault #1 inception PSX832 closed auto (Perkins Cap-Bank Bypass) (Time stamp provided by SRP)
07:41:02.154	Fault #1 type changed = C-N
07:41:02.799	Fault #1 type changed = B-C-N

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June 24, 2004

07:41:03.966	493.1 cycles after fault #1 inception SC562 opened (McMicken 69kV Line)
07:41:05.373	577.6 cycles after fault #1 inception MQ562 opened (McMicken 69kV Line)
07:41:07.849	12.102 seconds after fault #1 inception HAAX922 & HAAX925 opened (Palo Verde 525kV Line #2) (Time stamp provided by SRP)
07:41:07.851	12.104 seconds after fault #1 inception PLX972 & PLX975 opened (Hassayampa 525kV Line #2) (Time stamp provided by SRP)
07:41:07.859	12.112 seconds after fault #1 inception HAAX932 opened (Palo Verde 525kV Line #1) (Time stamp provided by SRP)
07:41:07.875	12.128 seconds after fault #1 inception PLX982 & PLX985 opened (Hassayampa 525kV Line #3) (Time stamp provided by SRP)
07:41:07.878	12.131 seconds after fault #1 inception HAAX912 & HAAX915 opened (Palo Verde 525kV Line #3) (Time stamp provided by SRP)
07:41:07.880	12.133 seconds after fault #1 inception PLX942 & PLX945 opened (Hassayampa 525kV Line #1) (Time stamp provided by SRP)
07:41:08.104	Fault #1 type changed = A-B-C-N
07:41:10.445	14.698 seconds after fault #1 inception NV1052 & NV1156 opened (Westwing 525kV Line)
07:41:10.456	14.709 seconds after fault #1 inception WW556 & WW652 opened (Navajo 525kV Line)
07:41:12 (EMS)	WW424J opened (Westwing 230kV West Bus Reactor)
07:41:20.005	24.258 seconds after fault #1 inception PLX992 opened (Devers 525kV Line) (PLX995 out-of-service at this time) (Time stamp provided by SRP)
07:41:20.113	24.366 seconds after fault #1 inception  PLX932 & PLX935 opened (Rudd 525kV Line) (Time stamp provided by SRP)

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June 24, 2004

- 07:41:20.145      24.398 seconds after fault #1 inception  
RUX912 & RUX915 opened (Palo Verde 525kV Line)  
(Time stamp provided by SRP)
  
- 07:41:20.864      25.117 seconds after fault #1 inception  
PLX912 & PLX915 opened (Westwing 525kV Line #1)  
(Time stamp provided by SRP)
  
- 07:41:20.873      25.126 seconds after fault #1 inception  
WW1456 & WW1552 opened (Palo Verde 525kV Line #2)
  
- 07:41:20.874      25.127 seconds after fault #1 inception  
WW1156 & WW1252 opened (Palo Verde 525kV Line #1)
  
- 07:41:20.895      25.148 seconds after fault #1 inception  
PLX922 & PLX925 opened (Westwing 525kV Line #2)  
(Time stamp provided by SRP)

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- 07:41:23.848      28.101 seconds after fault #1 inception  
PLX988 opened (Palo Verde Unit-3)  
(Time stamp provided by SRP)
  
- 07:41:24.280      System Frequency = 59.514 Hz  
(Measured at APS Reach Substation)
  
- 07:41:24.641      28.894 seconds after fault #1 inception  
PLX918 opened (Palo Verde Unit-1)  
(Time stamp provided by SRP)
  
- 07:41:24.652      28.905 seconds after fault #1 inception  
PLX938 opened (Palo Verde Unit-2)  
(Time stamp provided by SRP)
  
- 07:41:25 (DOE)      ED4-122 & ED4-322 opened (DOE ED4 Substation)  
Tripped on under-frequency (Note frequency low at 07:41:24.280)
  
- 07:41:25 (EMS)      ML142, ML542, ML1042 & ML1442 opened (Moon Valley 12kV Feeders)  
Tripped on under-frequency (Note frequency low at 07:41:24.280) --
  
- 07:41:28 (DOE)      MEX794 closed auto (Mead Cap Bank bypass)
  
- 07:41:34.615      38.868 seconds after fault #1 inception  
MEX1092 & MEX1692 opened (Perkins - Westwing 525kV Line)  
Fault #1 cleared
  
- 07:42:22.773      System Frequency = 59.770 Hz  
(Measured at APS Reach Substation)

*Palo Isolated  
from  
Fault*

*} Fault  
cleared  
@  
38.863  
seconds*

MEX1092 & MEX1692 opened (Perkins - Westwing 525kV Line)  
Fault #1 cleared

