JUNE 14, 2004 230KV FAULT EVENT AND RESTORATION

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EXECUTIVE SUMMARY

On June 14, 2004, at approximately 7:41 a.m. MST, a ground-fault occurred on Phase "C" of a 230 kV transmission line between the "Westwing" and "Liberty" substations. A failure in protective relaying associated with Westwing breaker WW1022 resulted in the ground-fault not isolating from the local grid for approximately 38 seconds. This uninterrupted fault cascaded into the protective tripping of 230 kV and 525 kV transmission lines, and the loss of a number of power generating units, most notable of these were the three Palo Verde Nuclear Generating Stations.

At the time of the event, the Energy Control Center (ECC) was staffed with an Operating Crew consisting of two fully qualified "ECC Supervisors" and one "ECC Supervisor" trainee. The trainee was NERC certified with prior transmission control experience at another utility. He was in the early part of the APS training and qualification program and was not qualified to perform unsupervised operations at the 230KV or EHV voltage classifications.

The Westwing-Liberty line fault initiated an event of a size and scope not previously experienced by the on-shift Operators. During interviews, the Operating crew stated that they had never experienced or simulated an emergency event that had such a significant impact to the electrical system. They continued that during the event the Operations Center was inundated with data and communication inputs. These inputs came in the form of system alarms, phone/radio traffic, and equipment status indications on the EMS system. Within the first two minutes of the event alone there were over 17 pages of alarms to review as well as a steady stream of phone and radio calls. After reviewing industry reports of other major grid events and interviewing additional senior ECC Operators it appears reasonable to classify this as a "once in a career" event.

As the effects of the fault event stabilized the Operating crew began system assessment and restoration planning. The crew conducted a tailboard and determined that the most effective method for coordinating restoration efforts would be to assign each Operator specific tasks and responsibilities. These assignments were based on system restoration plan priorities (in line with NERC's "Electrical System Restoration Reference Document") and on the qualifications and experience of the Operators. One Operator took responsibility for off-site power restoration to Palo Verde (highest priority) while the Lead Operator took responsibility for the restoration of the Westwing 525kV and 230kV substations. Because of the extraordinary amount of phone and radio traffic coming into the Operating Center, and the Operator trainees limited qualifications, he took responsibility for answering, screening, and directing incoming communications.

At the time restoration activities were started the Operators were not aware of what had caused the event or why it had propagated. This course of action is typical when responding to grid emergencies as the size and remote nature of the grid makes it nearly impossible for the Operators to verify where or why a line or piece of equipment has failed.

Because of these conditions, the Operators utilized the NERC recommended restoration strategies, outlined in NERC's "Electrical System Restoration Reference Document". These recommended strategies rely heavily upon the existence and performance of the electrical protection system to prevent undesirable system alignments.

The Lead Operator began restoration to the Westwing Substations using the "controlled operation" strategy. Under this strategy only those breakers necessary to allow system restoration to proceed are opened. As the Operator attempted restoration to the 230kV substation he recognized that this strategy was not being successful and made the decision to go to an "all open" strategy. This "all open" strategy consists of the Operator ensuring that all breakers are opened so that the substation being restored is in a dead and isolated condition.

In ensuring the Westwing 230kV bus was dead and isolated the Lead Operator had to resolve a conflict regarding the position of breaker WW1022 (breaker from the 230kV bus to the Westwing-Liberty line). EMS indication showed the breaker to be in the "closed position" however, communication from a field inspection indicated that the breaker had been damaged. From this communication the Lead Operator determined that the EMS "closed" indication was incorrect and was the result of the damage that had occurred to the breaker. With the conflict of WW1022's position apparently resolved the Operator believed that the Westwing 230kV bus was in a dead and isolated condition.

From this condition the Lead Operator began taking action to align power onto the 230kV bus. During those attempts the Operator closed breakers on three separate occasions that resulted in inadvertent alignment and energization into the Westwing–Liberty line fault through WW1022. On the first two occasions the electrical protection system operated as designed and the breaker the Operator closed immediately tripped open. On the third occasion however, the breaker closure resulted in feeding the fault through the Westwing T-1 transformer until operator action was taken to terminate it. The fault lasted 19.75 seconds.

Findings

This investigation concludes that the response to the June 14th ground-fault event by ECC Operators was prompt, professional and in line with the guidelines identified in NERC's "Electric System Restoration Reference Document". Operators utilized diagnostic techniques and response strategies appropriate and in line with their training and experience. Based on the size and scope of this event the Operator's overall response to the event was exceptional.

1. The 19.75 second duration that occurred during the third inadvertent alignment into the Westwing-Liberty line fault was due to:

   a) Electrical Protection not utilized - Transformer backup protection on the 525kV to lower voltage transformers (such as WW T-1) was not being utilized in the electrical protection scheme. Backup protection was not utilized, reportedly due to past trouble with tripping on inrush current.

      During restoration of the Westwing 230kV bus the Lead ECC Operator closed WW1322. This configuration resulted in energizing into the initial Westwing-Liberty line fault through the Westwing 525/230kV T-1 transformer for 19.75 seconds. Had backup protection been installed on the three 525/230kV transformers, it is anticipated that the effect of closing WW1322 would have resulted in the tripping of transformer T-1 within two seconds, thereby preventing any damage.

      Further, and more significantly, had the backup protection been installed, the initial 38-second fault would have been cleared by backup protection and would have prevented the disturbance from being cleared within the 525kV system.

2. The three inadvertent alignments to the Westwing–Liberty Fault were due to:

   a) Communication Breakdown - A communication breakdown occurred between a field technician and the Lead Operator regarding the position of breaker WW1022 (this breaker provided a path from the Westwing 230kV bus to the Westwing-Liberty line fault). This communication breakdown resulted in the Lead Operator incorrectly determining that WW1022 was in the "open" position, contrary to the "closed" indication on the EMS system. The Lead Operator's determination that WW1022 was "open" resulted in him believing that the Westwing 230kV bus was in a dead and isolated condition. A condition appropriate for the "all open" restoration strategy he was utilizing.

   b) Alarm Misinterpretation – During the first two inadvertent alignments into the "Westwing-Liberty" line fault, when the Operator gave the desired breaker the "breaker closed" command, an EMS message of "breaker Closed-Open" was immediately received. This message provided indication that the breaker the Operator had just closed tripped open. The Lead Operator however believed the EMS messages to be "glitches" in the EMS system and that the breaker had not actually closed. The Operator did not pursue further diagnosis.

   c) Fault Identification – ECC Operators did not know that a fault existed on the Westwing-Liberty line when restoration activities were begun. This course of action is appropriate and is within the guidelines provided by NERC's "Electric System Restoration Reference Document" however, had the fault location been identified and understood by the Operators prior to restoration activities beginning, the miscommunication and incorrect alarm interpretation may have been avoided.

Corrective Action Recommendations:

1.a.1 – Provide backup protection for 525kV to lower voltage transformers

Status: Complete - Reference MAXIMO W220165 (WW T10), W223285 (WW T4), W220367 (Yavapai), and W220372 (North Gila)

2.a.1 – Review the findings of this report with all ECC Operators. Reinforce communication practices and expectations during emergency conditions. Review expectations for three-legged (repeat back) communications.

Status: Complete - Lessons learned regarding this event were discussed at the Team Meeting on 11/3/04.

2.a.2 – Review the findings of this report with all applicable field personnel. Reinforce communication practices and expectations during emergency conditions. Review expectations for three-legged (repeat back) communications when communicating with Operating Centers.

Status: Will be complete by 1/24/2005.

2.b.1 - Conduct meeting with all ECC Operators to review diagnostic practices and expectations.

Status: In Progress - All ECC transmission operators will review and be tested on NERC Policy #5.

2.b.2 – Evaluate adequacy of EMS system

Status: Complete **-**EMS IS staff reviewed operating system logs and performance information and application (SCADA, AGC, etc.) events, alarms and logs to assess overall system performance. It was determined that on 06/14, that there was no degradation in application process execution and that the servers performed at or above expectations

2.c.1 - Conduct meeting with all ECC Operators to review the emergency response guidelines contained in NERC's "Electrical System Restoration Reference Document"

Status: Will complete by 6/1/2005.

INVESTIGATION

Event Timeline

This description relates to the Westwing 525kV and 230 kV systems. The Westwing substation has five incoming 525kV lines. The lines are Yavapai, Navajo, Palo Verde #1, Palo Verde #2 and the SRP Mead-Perkins.

07:40 Initial fault occurs on the 230kV Liberty-Westwing line.

07:40 A protective AR relay associated with Westwing 230kV breaker WW1022 fails. This failure prevents the breaker from opening, isolating the Liberty –Westwing line fault from the Westwing 230kV bus, and results in all five incoming 525kV lines to isolate remotely. The initial fault is not cleared from the system for 38.8 seconds.

At the time the Westwing-Liberty line fault cleared, there was no source to the 525kV Westwing bus. There are three 525/230/34.5 kV transformers that step down voltage to supply the Westwing 230kV bus from the 525 kV buses. They are T1, T4 and T10. The Westwing 230kV bus supplies six 230 kV lines. The lines are Raceway, WAPA Liberty, Surprise, WAPA Pinnacle Peak, Deer Valley and Aqua Fria. These lines can also be used to supply power to the Westwing 230kV bus. All lines de-energized on the initial fault.

The Westwing 230kV bus had no source from the 525kV bus and all lines outgoing/incoming were isolated from the substation such that there was no source to the Westwing 230kV substation after the fault cleared. The Aqua Fria and Deer Valley lines isolated remotely and within the substation. The Raceway, WAPA Liberty and Surprise lines isolated remotely (outside the substation). The WAPA Pinnacle Peak line isolated within the Westwing substation.

Restoration Timeline

07:44 Lead Operator makes two attempts to close breaker WW952 to bring power into the Westwing 525kV bus from the Yavapai 525kV line. On both attempts the breaker close command failed to execute. If closure had been successful, 525kV power would have been aligned to the Liberty-Westwing line fault.

07:54 DOE tests into the 230kV Liberty-Westwing line by closing the breaker at the Liberty substation, the breaker trips opens immediately. DOE does not immediately notify ECC of the testing or its result.

08:00 Lead ECC Operator tags Liberty-Westwing line breakers WW1022 and WW1126 “Do Not Operate”. Breaker WW1126 is tagged while in the open position and WW1022 is tagged while in the closed position. The ECC operator has a closed indication on breaker WW1022 but believes that the indication is incorrect and that the breaker is in the open position. This belief is based on communication he has received from field personnel indicating the breaker to be damaged.

08:03 Lead ECC Operator closes Westwing breaker WW1222 in an attempt to align 230kV power from Pinnacle Peak substation to the 230kV Westwing bus. The breaker immediately trips open due to a direct path to the Liberty-Westwing line fault through WW1022.

08:03-08:10	Lead Operator opens Westwing breakers WW622, WW526, WW1322 and WW256. Opening of these breakers isolates 525kV Westwing T-1 transformer from the 230kV bus and isolates the Surprise 230kV line from the Westwing substation.
08:10	Lead Operator makes two attempts to close Westwing breaker WW1222 to bring power from the Pinnacle Peak substation into the 230kV Westwing bus. On both attempts the breaker close command failed to execute. If closure had been successful, 230kV power from Pinnacle Peak would have been aligned to the Liberty-Westwing line fault through breaker WW1022.
08:15	Lead Operator closes WW1252 to bring in 525kV power into the Westwing substation from Palo Verde (#1) 525kV line. Breakers WW1252 (Westwing end) and PLX912 (Palo Verde end) immediately trip. 525kV power was aligned through Westwing transformer T-4 and T-10 to the Westwing 230kV bus, through WW1022, and into the Liberty-Westwing line fault.
08:15-08:21	Lead Operator opens Westwing 230kV breakers WW1622, WW2422, WW422, WW122 and WW226. The opening of these breakers isolates 500/230kV transformers T4 and T10 and the Raceway line from the 230kV Westwing bus. 230/69kV transformer T-14 is also isolated from the 230kV bus. Breakers WW756 and WW1652 are opened to isolate the SRP Meads-Perkins line from the Westwing 525kV bus.
08:17-08:23	Lead Operator closes breakers WW1252, WW1552, WW952 and WW652, to energize the Westwing 525kV bus from Palo Verde #1, Palo Verde #2, Yavapai and Navajo lines respectively.
08:31	Lead Operator closes WW256 to energize Westwing 500/230kV transformer T-1.
08:32	Lead Operator closes Westwing 230kV breaker WW1322 to energize the 230kV bus from the Westwing 525kV through transformer T-1. This results in alignment through T-1, through WW1022, and into the Liberty-Westwing line fault.
08:32	Lead Operator manually opens breaker WW1322 19.746 seconds after closing it to terminate the fault.
08:42	Field personnel manually open 230kV disconnect switches WW1021 and WW1023 to isolate the Liberty-Westwing line fault from the Westwing substation. The ECC operator tags 230kV disconnect switches WW1021 and WW1023 “Do not Operate” in the open position.

Restoration Consequence

The Lead Operator, not knowing that a fault existed on the Westwing-Liberty line and under the belief that he was attempting to bring power into a dead and isolated Westwing 230kV bus closed WW1322. This action resulted in creating an electrical path from the Westwing 525kV bus, through Westwing transformer T-1, through WW1022 (which the Operator believed to be open) and into the Liberty-Westwing line fault. Because transformer backup protection on the 525kV to lower voltage transformers was not being utilized in the electrical protection scheme, no auto isolation occurred to clear the fault and it continued for 19.746 seconds at which time Operator action was taken to terminate it.

Personnel Interviews

On June 14th the Westwing-Liberty line fault initiated an event of a size and scope that had never been experienced or simulated by the on-shift Operators and can be classified as a "once in a career" event. This conclusion is based on information obtained from interviews conducted with ECC Operators and reviews of industry reports from other major grid events.

Generally, the on-shift Operators stated that the June 14th event was by far the largest and most significant event they had ever experienced or simulated. They stated that because of the large impact to the grid, along with the loss of power generating stations, they had difficulty trying to understand what had initiated the event. They continued that their response was similar to that of less significant events and was based on their training, experience, and NERC/departmental guidelines.

All Operators interviewed stated that restoration practices are heavily reliant on the proper operation of the electrical protection system. Because of the size and remote nature of the grid and the extensive number of possible combinations of failures that can occur during an event it is almost impossible for the Operator to identify and understand the cause of an event in a reasonable amount of time.

Operators stated that restoration strategies are used to deal with events where the initiating condition is not known. These include "line testing", "controlled operation" and "all open" strategies and are determined by the Operator based on his or her evaluation of conditions.

Document Review

The North American Electrical Reliability Council (NERC) provides industry operating standards, policies, and guidelines to System Operators for normal system operation, emergency response, and system restoration. The primary NERC document for addressing major grid events is the "Electrical System Restoration Document" (ESR).

Section 1 - Introduction

NERC recognizes that during a major event that immediate diagnosis of the problem may be difficult and recommends that general guidelines be utilized in dealing with the event. The "Electrical System Restoration Document" states, "It is impossible to predict all the possible combinations of problems which may occur after a major electric system failure. It is therefore, the responsibility of system Operators to restore the electrical system by applying the general guidelines in this document and their respective …system restoration plans."

- ECC Operators were not aware of what had initiated the event (Westwing-Liberty line fault) or why it had propagated (failure of the AR relay on WW1022 resulting in the breaker failing to open to isolate the fault.) Operators initially took appropriate actions to stabilize the grid after the event cascade had ended. During restoration activities Operators assessed known system condition during event diagnosis and utilized appropriate restoration strategies outlined in Section V of the NERC restoration document.

Section III - Determine Blackout Extent and System Status

ERS III.B, *Customer Calls* refers to the dispatch centers being "bombarded with phone calls from employees and customers." It continues that, "…continual calls inquiring into the status of service serves no useful purpose."

- During the event Operators described being inundated with phone and radio traffic, much of which was simply inquiry as to status of the event from non-essential personnel. The Operators stated that these calls were a distraction.

ESR III.H, *Nuclear Plant Status* states that "Off-site power should be restored as soon as possible even though the unit start-up will be delayed." Also, starting units with blackstart capability and providing auxiliary power to units that have just shut down is clearly a very high priority.

- In planning restoration efforts the Operators recognized the priority of restoring off-site power to the Palo Verde Nuclear Generating stations and began coordinating this effort as soon at practicable. The second priority identified was the restoration of power to the Westwing Substations. These priorities appear to be in line with the guidelines outlined in this section.

Section V - Preparation for the Transmission System Restoration

ERS V.A, *Restoration Switching Strategies* states, "…there are two general switching strategies, which may be used to sectionalize the transmission system for restoration. This first is the "all open approach … The second is the controlled operation…"

- During system restoration efforts the Lead Operator stated that he began actions to restore power to the Westwing Substations utilizing the "controlled operation" strategy. However, as his actions progressed the Operator recognized that this strategy was not achieving the desired results and appropriately made the decision to change to an "all open" strategy. This strategy is more conservative as it opens all breakers to and from the bus so that it is dead and isolated.

ERS V.D, *System Assessment* states that, "In preparation for an actual restoration, the efforts to ascertain faulted system equipment will detract from the restoration process. …System Operators should exercise care to avoid closing into a fault when energizing the transmission system."

- Operators were not aware of what caused the event when restoration efforts were begun. Also unknown to the Operators at the time of restoration was that breaker WW1022 had not opened as designed due to an AR relay failure. Early in the restoration to the Westwing 230kV bus the Lead Operator received a call from a Substation Technician at the Sub indicating that breaker WW1022 "was damaged and should not be closed." From this communication the Operator incorrectly determined that WW1022 was in the "open" position and not the "closed" position as indicated on EMS.

  The Operator's subsequent actions to restore power to the Westwing 230kV bus were based on an "all open" strategy, which relied on the bus being dead and isolated. The Operator believed he had taken the appropriate steps to ensure system conditions prior to aligning power onto the Westwing 230kV bus. All subsequent inadvertent alignments to the Westwing-Liberty fault were a result of WW1022 being in the "closed" position. The Lead Operators action to resolve identified conflicts appears to be in line with this recommendation. Unfortunately, mutual understanding between the Substation Technician and the Lead Operator was not achieved regarding the position of WW1022.

Event Findings

1. The 19.75 second fault duration that occurred during the third inadvertent alignment into the Westwing-Liberty line fault was due to:

   a) Electrical Protection not utilized - Transformer backup protection on the 525kV to lower voltage transformers (WW T-1) was not being utilized in the electrical protection scheme. During restoration of the Westwing 230kV bus the Lead ECC Operator closed WW1322. This configuration resulted in energizing into the initial Westwing-Liberty line fault through the Westwing 525/230kV T-1 transformer for 19.75 seconds. Had backup protection been installed on the three 525/230kV transformers, it is anticipated that the effect of closing WW1322 would have resulted in the tripping of transformer T-1 within two seconds, thereby preventing any damage. Further, and more significantly, had the backup protection been installed, the initial 38-second fault would have been cleared by backup protection and would have prevented the disturbance from being cleared within the 525kV system.

   Supporting Facts:

   - In interviews the Operators stated that their normal operating practices are predicated on the belief that engineered electrical protection is available and functioning properly.
   - Backup protection was not utilized on the 525kV to lower voltage transformers, reportedly due to past trouble with tripping on inrush current.
   - In this event the Operators were not aware that backup electrical protection for 525/230kV transformers was not being utilized.

   Corrective Action Recommendations:

   1.a. - Provide backup protection for 525kV to lower voltage transformers

   Status: Complete - Reference MAXIMO W220165 (WW T10), W223285 (WW T4), W220367 (Yavapai), and W220372 (North Gila)

2. The three inadvertent alignments to the Westwing–Liberty Fault were due to:

   a) Communication Breakdown - A communication breakdown occurred between a field technician and the Lead Operator regarding the position of breaker WW1022 (this breaker provided a path from the Westwing 230kV bus to the Westwing-Liberty line fault). This communication breakdown resulted in the Lead Operator incorrectly determining that WW1022 was in the "open" position, contrary to the "closed" indication on the EMS system. The Lead Operator's determination that WW1022 was "open" resulted in him believing that the Westwing 230kV bus was in a dead and isolated condition; a condition appropriate for the "all open" restoration strategy he was using.

   Supporting Facts:

   - In an interview, the Lead Operator stated that he was involved in a phone conversation with another ECC Operator and a Substation Technician at the Westwing Substation. During that conversation the Lead Operator heard the Technician state that WW1022 was damaged and that it should not be closed. Based on this information the Lead Operator determined WW1022 to be in the "open" position and damaged. He stated he placed a "Do Not Operate" tag on WW1022 so that it would not be operated during restoration.

- A review of ECC phone transcripts taken on June 14th found a conversation between two ECC Operators and a Substation Technician discussing the condition of the Westwing 230kV yard and breaker WW1022. Communication between the parties was somewhat confusing and contradictory. It appears that during the communication information was not mutually understood between parties.
  Excerpts from transcript: (field personnel was not identified in transcript)

  Field: "Hey we just took a visual of the 230"

  Lead Operator: Uh huh

  Field: and uh, breaker 1022 had a flashover on the center phase."

  Lead Operator: "1022?"

  Field: 1022, "WW1022, so we don't want to close this one, looks like it melted the top of the lead off on top the bushing

  ECC Operator 2: "Actually it's open…I mean it's closed."

  Lead Operator: Yeah it never…

  Field: Are you saying it's closed?"

  Lead Operator: "Yeah"

  Field: "We don't have any, we don't have any power to it do we?"

  ECC Operator 2: "Well it just failed to trip and that's maybe what caused everything else so..."

  Field: "Yeah, yeah she's pretty hot, I wouldn't close this one back in."

  (few lines later)

  Lead Operator: "Yeah we're not gonna, I put "Do Not Operate" tags on both of those breakers so we won't energize 1022.
- At 0800, the EMS alarm typer shows breaker WW1022 and WW1126 being tagged "Do Not Operate". Breaker WW0122 was tagged while indicating "closed" and WW1126 was tagged while indicating "open

Corrective Action Recommendations:

2.a.1 - Review the findings of this report with all ECC Operators. Reinforce communication practices and expectations during emergency conditions. Review expectations for three-legged (repeat back) communications.

Status: Complete - Lessons learned regarding this event were discussed at the Team Meeting on 11/3/04.

2.a.2 - Review the findings of this report with all applicable field personnel. Reinforce communication practices and expectations during emergency conditions. Review expectations for three-legged (repeat back) communications when communicating with Operating Centers.

Status: Will complete by 1/24/2005.

b) Alarm Misinterpretation – During system restoration activities the Lead Operator closed breakers WW1222 and WW1252. On both of these occasions the Operator action resulted in energizing into the Westwing – Liberty fault however, because of the proper operation of electrical protection for breakers WW1222 and WW1252 the breakers immediately opened preventing damage. On both occasions the Operator received "EMS" messages of breaker "Closed – Open" which should have provided the Operator indication of a problem and prompted further investigation and diagnosis.

The Operator disregarded the alarm messages because he assumed the messages to be "glitches" in the "EMS" system and because he was under the belief that he was aligning into a stripped and isolated 230kV bus.

Supporting Facts:

- At 8:04 the Operator closed WW1222, the breaker closed and immediately opened. At 8:15 the Operator closed WW1252. Breaker WW1252 closed and immediately opened, as did the breaker at the other end of the line – PLX912. In both cases the Operator did not attempt to determine why the breakers had tripped and stated that be believed the alarms to be "glitches" in the EMS system.
- Investigation found that "EMS" alarms can be due to commands not being received by the breaker control circuits and have occurred in the past.

Corrective Action Recommendations:

2.b.1 - Conduct meeting with all ECC Operators to review diagnostic practices and expectations.

Status: In Progress - All ECC transmission operators will review and be tested on NERC Policy #5.

2.b.2 – Evaluate adequacy of EMS system

Status: Complete **-**EMS IS staff reviewed operating system logs and performance information and application (SCADA, AGC, etc.) events, alarms and logs to assess overall system performance. It was determined that on 06/14, that there was no degradation in application process execution and that the servers performed at or above expectations

c) Fault Identification – ECC Operators did not know that a fault existed on the Westwing-Liberty line when restoration activities were begun. This course of action is appropriate and is within the guidelines provided by NERC's "Electric System Restoration Reference Document" however, had the fault location been identified and understood by the Operators prior to restoration activities beginning, the miscommunication and incorrect alarm interpretation may have been avoided.

Supporting Facts:

- The NERC "Electrical System Restoration Document" states, "It is impossible to predict all the possible combinations of problems which may occur after a major electric system failure. It is therefore, the responsibility of system Operators to restore the electrical system by applying the general guidelines … The Operators did apply appropriate general restoration guidelines in responding to this event.
- Operators stated during interviews that had they known about the fault on the Westwing-Liberty line prior to beginning restoration, it would have influenced their restoration actions.

Corrective Action Recommendations:

2.c.1 - Conduct meeting with all ECC Operators to review the emergency response guidelines contained in NERC's "Electrical System Restoration Reference Document"

Status: Will complete by 6/1/2005.

Appendix A – Documents Reviewed/References

- Drawing G-32900 (sheets 1&2), Westwing 500kV Switchyard Bays 1-9 one line Diagram.
- Drawing G-32901 (sheets 1&2), Westwing 500kV Switchyard Transformer Bays 1& 4 one line Diagram.
- Drawing G-33300 (sheets 1&2), Westwing 230kV Switchyard Bays 1-9 one line Diagram.
- Drawing G-33301 (sheets 1&2), Westwing 230kV Switchyard Bays 10-18 one line Diagram.
- Drawing G-33334, Westwing 69kV Substation one line Diagram.
- Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations (April 2004)
- The August 14, 2003 Blackout One Year Later: Actions Taken in the Unites States and Canada to Reduce Blackout Risk (August 13,2004)
- Status report on NERC Implementation of August 14, 2003, Blackout Recommendations (August 11, 2004).
- August 14, 2003 Blackout; NERC Actions to Prevent and Mitigate the Impacts of Future Cascading Blackouts (February 10, 2004)
- Letter sent to CEO's of all NERC control area and reliability coordinators: Near-Term Actions to Assure Reliable Operations (October 15, 2003)
- ECC communication transcripts for 6/14/04 event.
- ECC alarm typer for 6/14/04 event.
- ECC alarm typer for 7/4/04 event.
- January 9, 2003 ECC file letter 13.4.1, Tom Glock to ECC Supervisors: Responsibilities and Authorities
- APS Black-Start System Restoration Guideline (April 2003)
- ECC logs for 6/14/04
- ECC logs for 7/4/04
- ECC logs back to December 2003 (review)
- ECC alarm report on breaker WW0122 manipulations back to May 2002
- Transmission Operations Work Request (040773)-Repair conductor on WAPA's Liberty-Westwing 230kV Line (5/14/04)
- WECC MORC Section 8.C-Training (Approved 4/23/04)
- NERC Policies (1-8)
- NERC compliance template for policy 8 (Operating Personnel and Training) and Policy 6 (Operations Planning)
- NERC Compliance Template Task Force (CTTF) Implementation Plan for the Compliance Templates
- NERC Continuing Education Program Criteria for Approving and Granting NERC Recognition to Qualified CE Program Providers and Learning Activities (April 14, 2004).
- Sample NERC Certification Test Questions
- NERC Transmission Operator Certification Examination Content Outline
- Draft: Root Cause of Failure Report for the June 14, 2004 Grid Disturbance
- The Western States Power Crisis: Imperatives and Opportunities – An EPRI White Paper (June 25th, 2001)
- NERC "Electrical System Restoration Reference Document" July 16-17, 2003