

# TEP Compliance Study

Gary Trent

Presentation to SATS

September 25, 2008

# Disclaimer

This presentation contains critical transmission information. The presentation to be provided with the meeting notes and posted on the West Connect website will have confidential information removed.

# Overview

- Years/Conditions
  - 2010 Heavy Summer
  - 2013 Heavy Summer
  - 2018 Heavy Summer
- Studies
  - Powerflow
  - Transient Stability

# Assumptions

- Sundt Steam Units 1, 2, 3, 4 on-line
- TEP Local CTs dispatched as needed
- Tortolita Phase Shifting Transformer Out of Service
- TEP Load Margin of 5%

# Assumptions (con't)

- Powerflow – ALIS and IOS
  - Category B
    - All Applicable TEP EHV
  - Category C
    - All Applicable TEP EHV
  - Category D
    - All remaining pairs of Category B contingencies above
    - All other multi-circuit EHV tower lines or multi-circuit corridors
  - All Tie Lines and Tie Transformers to TEP's EHV System are Included Regardless of Ownership

# Assumptions (con't)

- Transient Stability
  - No-disturbance flat line
  - Three-phase faults at selected TEP EHV buses with normal clearing (Category B)
  - Three-phase faults at selected TEP EHV buses with delayed clearing (Category D)
    - If problems identified, SLG fault is simulated (Category C)
  - Loss of both lines in a common corridor without a fault (Category C)
  - Loss of unrelated components (Category D)

# 2010 Heavy Summer

- WECC 10hs2sa case
- All Lines In Service (ALIS)
- 14 EHV Initially Out of Service (IOS) Cases
- Power Flow Contingencies

Category	ALIS	IOS
A	1	1
B	34	0
C	29	33
D	528	0

# 2010 Heavy Summer

- Transient Stability Disturbances

Category	ALIS	IOS
A	1	1
B	30	0
C	23	30
D	3	0

# 2010 Transient Stability Results

- Category A (ALIS and IOS)
  - One (1) generator (not owned by TEP) did not flat line
    - Owner to be notified separately
- Category B, C, D
  - Same generator was not damped for any disturbance
- Category C
  - Delayed clearing for 3-phase fault at *Generator X* showed loss of synchronization of *Generator X* units
  - Equivalent SLG met performance measures

# 2010 ALIS Power Flow Results

- Category A Violations
  - None
- Category B Violations
  - One element is overloaded for 2 separate contingencies

# 2010 ALIS Power Flow Results (con't)

Category	Outage	Violation	Result
A	N/A	NONE	N/A
B	GL-CV 345 kV line	GL-SW 345/230 transformer overload	>125% emergency
B	GL-WN 345 kV line	GL-SW 345/230 transformer overload	<105% emergency

Category B Violations should be addressed in SATS

# 2010 ALIS Power Flow Results (con't)

- Category C
  - No Regional Transmission Lines Overloaded
    - TEP Controlled Load Shed
    - Allow tripping of the Bicknell 345/230 kV transformer
      - SP-VL and WN-VL 345 kV lines
  - TEP 138 kV Overloads

# 2010 ALIS Power Flow Results (con't)

Category	Outage	Violation	Result
C	SA-TO 1 & 2	IRV-SCZ 138 overload	<101% emergency
C	NL Long Bus	RV – NJA 138 overload	>125% emergency
C	NL Long Bus	TO – NJA 138 overload	>125% emergency
C	NL Long Bus	RV – LC 138 overload	<105% emergency
C	IRV Bus	LR-VL 138 overload	<101% emergency
C	IRV Bus	PAN – LR 138 overload	>115% emergency
C	IRV Bus	ELP – PAN 138 overload	>115% emergency

TEP Will Address these issues through Operating Procedures and 138 kV projects

# 2010 ALIS Power Flow Results (con't)

- Category D
  - TEP 138 and SWTC Overloads

Worst Outage	Overload	% Loading	Frequency
SP-VL & VL T1	DXL – MVL 138	<101% emergency	2
SP-VL & VL T1	IRV – SO 138	>125% emergency	2
SP-VL & VL T1	SO – MVL 138	>125% emergency	2
WN-VL & VL T2	Bicknell 345/230	>150% emergency	2
WN-VL & VL T2	Apache – Butterfield 230	<115% emergency	1
SO T2 and T3	IRV – VL 138	>115% emergency	1
SO T2 and T3	RBW – VL 138	>115% emergency	1

# 2010 HS IOS Results

- Category A
  - Power Flow – Three issues
- Category C
  - Controlled TEP load shed
  - Allow tripping of the Bicknell 345/230 kV transformer.
    - WN-VL 345 with PW-SO 345 IOS
    - WN-VL 345 with SP-VL IOS

# 2010 IOS Power Flow Results (con't)

- Category C (con't)
  - TEP 138, SWTC, and MW&E issues
  - TEP will address TEP 138 kV issues with operating procedures and planned projects
  - SATS should address SWTC and MW&E issues
    - Copper Verde 345/230 kV transformer is overloaded for all IOS cases
    - GL-SW 345/230 kV transformer overloads for 5 IOS cases

# 2010 IOS Power Flow Results

Category	IOS Element	Overload	% Loading
A	TO T1	TO T2	<110% continuous
A	GL – WN 345	CV 345/230	<110% continuous
A	GL – WN 345	GL-SW 345/230	>110% continuous

- TEP to address TO issue with operating procedures until T3 is installed
- SATS should address the CV and GL-SW transformer issues

# 2010 IOS Category C (TEP 138)

Overload	Worst IOS Condition	Worst Outage	% Overload (emergency)	Frequency
IRV – SO 138	VL T1	SP – VL	>125%	2 IOS cases 3/1 outages
SO – MVL 138	VL T1	SP – VL	>125%	2 IOS cases 3/1 outages
IRV – VL 138	SO T2	SO T3	>105%	1 IOS case 1 outage
NL – WI 138	WN – VL	SP – VL	<105%	1 IOS case 2 outages
NE – RIL 138	WN – VL	SP – VL	>105%	1 IOS case 2 outages
RBW – VL 138	SO T2	SO T3	>105%	3 IOS case 1/1/1 outages
TOR – NJA 138	WN – VL	SP – VL	>105%	1 IOS case 2 outage

# 2010 IOS Category C (SWTC)

<b>IOS</b>	<b>Worst Outage</b>	<b>GL-SW Overload (emergency)</b>	<b>Frequency</b>
PW – SO	GL – WN	>125%	1
SJ – MK	GL – CV	>125%	2
SP – VL	GL – WN	>150%	2
GL – WN	VL T2	>150%	29
MK – SP	GL – CV	>125%	2



# 2013 Heavy Summer

- West Connect 2013 Heavy Summer Case
- All Lines In Service (ALIS)
- 17 EHV Initially Out of Service (IOS) Cases
- Power Flow Contingencies

Category	ALIS	IOS
A	1	1
B	46	0
C	48	34
D	985	0

# 2013 ALIS Power Flow Results

- Category A Violations
  - None
- Category B Violations
  - Copper Verde 345/230 kV transformer overloads (128.2% of emergency) for loss of the Greenlee – Greenlee-SW 345 kV line
  - SATS should address this issue

# 2013 ALIS Power Flow Results (con't)

- Category C
  - Copper Verde transformer overloads for loss of SP-VL and WN-WL
    - SATS should address this issue
  - TEP 138 kV Overloads
    - Five (5) 138 kV lines overload for various outages
    - TEP will address with operating procedures and planned projects

# 2013 ALIS Power Flow Results (con't)

<b>Category</b>	<b>Outage</b>	<b>Violation</b>	<b>Result</b>
C	IRV Bus	ELP – PAN 138	<i>&gt;150%</i>
C	IRV Bus	PAN – LR 138	<i>&lt;125%</i>
C	PW-SO & VL-SO	TEC – VL 138	<i>&lt;125%</i>
C	PW-SO & VL-SO	IRV – TEC 138	<i>&gt;115%</i>
C	IRV Bus	LR – VL138	<i>&lt;110%</i>

# 2013 ALIS Power Flow Results (con't)

- Category D – TEP 138 Overloads

Worst Outage	Overload	% Loading (emergency)	Frequency
SO T2 SO T3	TEC – VL 138	>125%	28
SO T2 & SO T3	IRV – TEC 138	<125%	5
SO T2 & SO T3	RBW – VL 138	<105%	1
VL T1 & VL T2	22 <sup>nd</sup> – ELP 138	<105%	3
PC-TO & CH-SA	ELP – PAN 138	<105%	3

# 2013 ALIS Power Flow Results (con't)

- Category D – SWTC Overloads

Worst Outage	Overload	% Loading (emergency)	Frequency
GL-WL & WN-VL	APA-BUT 230	>125%	40
GL-WL & WN-VL	BK 345/230	>125%	38
GL-WL & WN-VL	WN 345/230	>115%	2
GL-WL & WN-VL	PAN-New TUC 230	<115%	2
GL-WL & WN-VL	BUT-SLN 230	<115%	1
GL-WL & WN-VL	SLN-PAN 230	<115%	1
GL-WL & WN-VL	New TUC-SAH 230	<115%	2
GL-WL & WN-VL	APA_WN 230	<105%	1
GL-WL & WN-VL	SAH-BK 230	<105%	1

# 2013 HS IOS Results

- Category A
  - Power Flow – Three issues
- Category C
  - Controlled TEP load shed
  - Allow tripping of the Bicknell 345/230 kV transformer.
    - WN-VL 345 with PW-SO 345 IOS
  - Overloads on TEP 138, SWTC, and MW&E systems
    - TEP to address 138 issues with operating procedures and planned facilities
    - SATS should address SWTC and MW&E issue
      - Contingencies involve more than 1 entity
      - CV 345/230 overloads under all IOS conditions

# 2013 IOS Power Flow Results

Category	IOS Element	Overload	% Loading
A	WL – WN 345	CV 3445/230	<101% continuous
A	WN – VL 345	BK 345/230	<115% continuous
A	WN – VL 345	APA – BUT 345/230	<105% continuous

- SATS should address the CV issues
- SWTC overloads can be relieved through operating procedures, i.e., reduced output of the Bowie Power Station

# 2013 IOS Category C (TEP 138)

Overload	Worst IOS Condition	Worst Outage	% Overload (emergency)	Frequency
IRV – TEC 138	SO T2	SO T3	<115%	3 IOS cases 1/1/2 outages
TEC – VL 138	SO T2	SO T3	>125%	3 IOS cases 1/1/3 outages
22 <sup>nd</sup> – ELP 138	VL T?	VL T1	<105%	1 IOS case 2 outages
DMP – NL 138	PW – SO	WN – VL	<105%	1 IOS case 1 outage
NL – RIL 138	PW – SO	WN – VL	<101%	1 IOS case 1 outage

# 2013 IOS Category C (SWTC)

IOS	Worst Outage	Overloaded Element	GL-SW Overload (emergency)	Frequency
WN – VL	HI – GL	BK 345/230	>105%	1
WN – VL	GL – CV	APA – BUT 230	<105%	2

SATS should address these issues and the Copper Verde 345/230 transformer issue



# 2018 Heavy Summer

- WECC 2018 HS1A Case
- All Lines In Service (ALIS)
- 18 EHV Initially Out of Service (IOS) Cases
- Power Flow Contingencies

Category	ALIS	IOS
A	1	1
B	56	0
C	60	55
D	0	0

# 2018 Heavy Summer

- Transient Stability Disturbances

Category	ALIS	IOS
A	1	1
B	27	0
C	18	27
D	0	0

# 2018 Transient Stability Results

- Category A (ALIS and IOS)
  - One (1) generator (not owned by TEP) did not flat line
    - Owner to be notified separately
- Category B, C, D
  - Same generator was not damped for any disturbance
- Category C
  - Delayed clearing for 3-phase fault at *Generator X* showed loss of synchronization of *Generator X* units
  - Equivalent SLG met performance measures

# 2018 ALIS Power Flow Results

- Category A Overloads
  - Two (2) lines/transformers external to TEP
- Category B Overloads
  - Four (4) lines/transformers external to TEP
- Category C Overloads
  - Four TEP 138 kV lines
  - Four (4) lines/transformers external to TEP

# 2018 ALIS Power Flow Results (con't)

Category	Worst Outage	Violation	Worst Overload	Frequency
A	N/A	GL-SW 345/230	<101% of continuous	1
A	N/A	Saguaro East – Oracle 115	<101% of continuous	1
B	GL – CV	GL-SW 345/230	>150% of emergency	6
B	GL – GL-SW	CV 345/230	>125% of emergency	7
B	PW – CS1	Saguaro East – Oracle 115	>105% of emergency	54
B	PW – CS1	Saguaro East – Marana 115	<125% of emergency	56

SATS should address these issues

# 2018 ALIS Power Flow Results (con't)

Category	Worst Outage	Violation	Worst Overload	Frequency
C	IRV Bus	PAN – LR 138	<125% of emergency	1
C	IRV Bus	ELP – PAN 138	>105% of emergency	1
C	IRV Bus	LR – VL 138	>105% of emergency	1
C	SP-VL & WN-WL	NE – RIL 138	<105% of emergency	1

TEP will address these issues through operating procedures and planned improvements

# 2018 ALIS Power Flow Results (con't)

Category	Worst Outage	Violation	Worst Overload	Frequency
C	WN-VL & WN-WL	GL-SW 345/230	>150% of emergency	13
C	SP-VL & WN-WL	CV 345/230	>150% of emergency	13
C	SP-VL & WN-WL	Sag.E – Marana 115	>125% of emergency	60
C	SA-TO 1 & 2	Sag.E – Oracle 115	>125% of emergency	58

SATS should address these issues

# 2018 HS IOS Results

- Category A Overloads
  - Four (4) lines/transformers external to TEP
- Category C Overloads
  - Two TEP 138 kV lines
  - Four (4) lines/transformers external to TEP

# 2018 IOS Power Flow Results

Category	Worst IOS Case	Violation	Worst Overload	Frequency
A		GL-SW 345/230	<115% of continuous	~75% of IOS Cases
A	WL – WN	CV 345/230	>125% of continuous	5 IOS cases
A		Saguaro East – Oracle 115	>115% of continuous	All IOS Cases
A	PW – CS1	Saguaro East – Marana 115	>115% of continuous	4 IOS cases

SATS should address these issues

# 2018 IOS Power Flow Results

Category	Worst IOS / Outage	Violation	Worst Overload	Frequency
C	WN – WL SP-VL	TOR-NLP 138	<101% of emergency	1 IOS case 2 outages
C	WN – WL SP-VL	NE – RIL 138	<115% of emergency	3 IOS cases 2/2/2 outages
C	??? GL – GL-SW	CV 345/230	>200% of continuous	All IOS Cases 1 outage
C	??? WN-WL	GL-SW 345/230	>200% of emergency	67% of IOS cases multiple outages
C	SP-VL PW-CS1	Saguaro East – Oracle 115	<125% of emergency	5 IOS cases Up to 55 outages
C	WN-WL PW – CS1	Saguaro East – Marana 115	>125% of emergency	7 IOS cases Up to 55 outages

- SATS should address the CV issues
- TEP will address 138 kV issues through Operating procedures and planned facilities

# Questions