Proposed SCE Submittals into the 2023-2024 Transmission Planning Process

2023-2024 CAISO TPP
September 27, 2023

Summary of Proposed Projects

SCE conducts its Annual Transmission Reliability Assessment (ATRA) in coordination with the California ISO (CAISO). Based on the results, SCE is submitting the following reliability projects into the annual California ISO Transmission Planning Process (TPP) window:

#	Project	Driver	Estimated Cost	Proposed In-Service Date
1	Eldorado 500 kV Bus Short Circuit Duty (SCD) Mitigation	SCD	$20M	12/31/2028
2	Mira Loma 500 kV Bus SCD Mitigation	SCD	$5M	6/30/2027
3	Etiwanda 230 kV Bus SCD Mitigation	SCD	$40M	12/31/2027
4	Inyo 230 kV Shunt Reactor	Voltage	$20M	12/31/2027

All costs are in 2023 dollars and estimated according to the SCE 2023 Draft Per Unit Cost Guide: https://www.caiso.com/InitiativeDocuments/SCE2023DraftPerUnitCostGuide.xlsx

Proposed Reliability Projects

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Eldorado 500 kV Bus Short Circuit Duty (SCD) Mitigation

Area Challenges

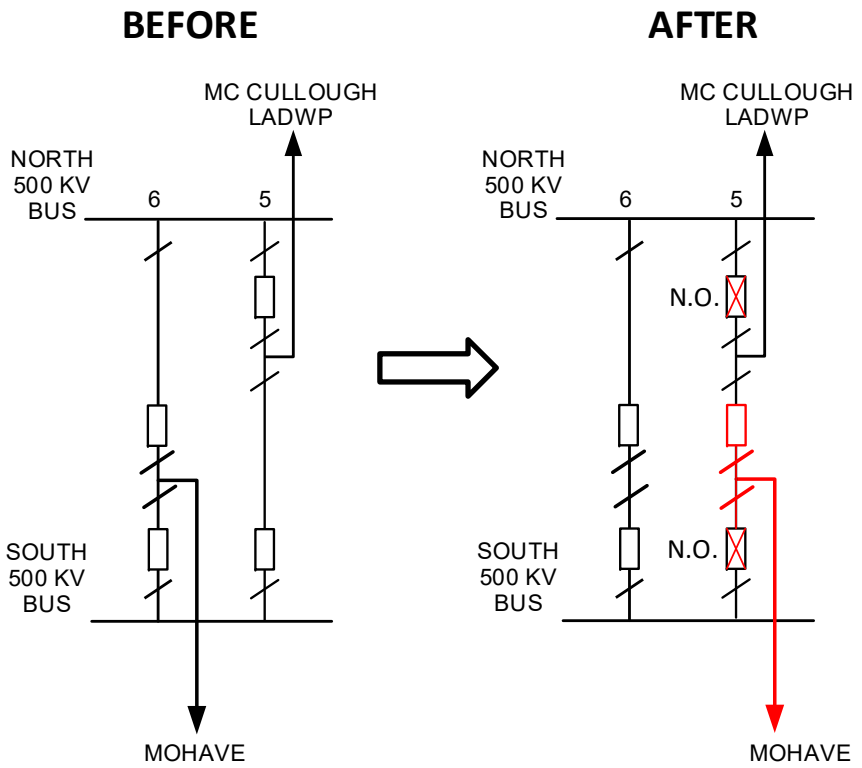
- The short-circuit duty at the Eldorado joint owned 500 kV bus has been calculated to be 72.5 kA for end of Queue Cluster 14

Proposed Scope

- Relocate the Mohave 500 kV line from Position 6S to Position 5S
- Add a middle circuit breaker to Position 5
- Open North and South circuit breakers on Position 5
- Update the Lugo-Victorville CRAS
- Add functionality to provide grid operators real-time short circuit duty levels in and around the area

Impact of Proposed Project

- The de-loop option is relatively inexpensive and allows significant generation and other planned TPP projects to reliably connect in the area



Main System	Estimated Cost ($M)	Proposed In-Service Date
Eldorado 500 kV bus SCD Mitigation	20	12/31/2028

Eldorado 500 kV Bus Short Circuit Duty (SCD) Mitigation

SCD Calculation Results

Scenario	Pre Eldorado 500 kV SCD		Post Eldorado 500 kV SCD	
	Eff 3PH SCD	% Loaded	Eff 3PH SCD	% Loaded
End of Queue Cluster 14 (June 2022)*	72.5 kA	**115%**	40.2 kA	64%

*The CAISO queued local generation (total resources) modeled in this area is approximately 13,000 MW and the CPUC 2023-2024 TPP portfolio is 8,535 MW, which shows directionally the same resource assumptions in the area.

Alternatives and Risks

Alternatives (Non-exhaustive list)	Risks
Eldorado-Victorville De-loop Option	This alternative reduces SCD similarly and shows preliminary benefits, but implementation is outside of the CAISO controlled grid (the scope of work is at McCullough substation)
Build a new substation and move some lines to that substation	High cost, licensing issues, and long lead time to build, this alternative was dismissed
Upgrade substation to 80 kA capability	High cost, long lead time to construct, loss of bay positions due to size of circuit breakers and need to rebuild the entire bus rack for all associated equipment
Split the north and south buses and add 17 Ω reactors	This option was dismissed because the size of reactors prevents the installation of required protection and isolation equipment within the existing switch rack
Change the bypass mechanism on series capacitors to bypass at an earlier fault level to decrease the short circuit fault duty at Eldorado and McCullough	Due to lack of industry experience and potential system instability with this alternative, this option was dismissed

Mira Loma 500 kV Bus SCD Mitigation

Area Challenges

- In the 2022-2023 TPP, the CAISO approved the Mira Loma 500 kV Circuit Breaker Upgrade Project to address the short circuit duty concerns on 500 kV circuit breakers at Mira Loma 500/230 kV substation that are loaded to greater than 95% and 100% of the rated short circuit duty capability in the near-term and the longer-term planning horizons
- The scope of the approved project consists of replacing four 500 kV circuit breakers at Mira Loma with new higher rated circuit breakers
- After field verification, 500 kV circuit breakers were identified as potentially being loaded to greater than 100% of the rated short circuit duty capability in the near-term and the longer-term planning horizons

Proposed Scope

- Replace two (2) 500 kV circuit breakers at Mira Loma with new higher rated circuit breakers (two in addition to the four already approved in the 2022-2023 TPP)

Impact of Proposed Project

- Increases SCD margin at Mira Loma 500 kV
- Enables renewable generation and transmission interconnection in the area

Main System	Estimated Cost ($M)	Proposed In-Service Date
Mira Loma 500 kV Bus SCD Mitigation	5	6/30/2027

Mira Loma 500 kV Bus SCD Mitigation

SCD Calculation Results

Scenario	Pre Mira Loma 500 kV Bus SCD Mitigation		Post Mira Loma 500 kV Bus SCD Mitigation	
	Eff 3PH SCD	% Loaded	Eff 3PH SCD	% Loaded
2025	47.5 kA	**118.7%**	47.5 kA	75.4%
2035	54.9 kA	**137.2%**	54.9 kA	87.1%

Alternatives and Risks

Alternatives	Risks
Develop operating procedure to open 500 kV transmission lines in real time	Opening 500 kV transmission lines during peak times would be burdensome to Grid Operators, may not be possible due to other real time system issues, and could result in significant curtailment of renewable resources

Etiwanda 230 kV Bus SCD Mitigation

Area Challenges

- Twelve (12) 230 kV circuit breakers at Etiwanda Substation are expected to be loaded to greater than 95% of their rated three-phase SCD capability in the near term (2025) and to 100% in the long term (2035)
- Anticipated SCD exceeds 100% of the 63 kA capability in current generation queue cluster studies (QC14)
- SCD could exceed 100% before the currently identified triggering cluster due to system changes and short circuit equivalent updates
- Supply chain challenges have increased the lead time for 230 kV circuit breakers, which limits SCE ability to quickly complete the required mitigation and the associated delay could become a barrier to new generation

Proposed Scope

- Replace twelve (12) 230 kV circuit breakers at Etiwanda currently rated 63 kA tested at X/R ratio of 17 with new 63 kA rated circuit breakers tested at X/R ratio of 35

Impact of Proposed Project

- Increases SCD margin at Etiwanda 230 kV
- Enables renewable generation and transmission interconnections in the area

Eastern	Estimated Cost ($M)	Proposed In-Service Date
Etiwanda 230 kV Bus SCD Mitigation	40	12/31/2027

Etiwanda 230 kV Bus SCD Mitigation

SCD Calculation Results

Scenario	Pre Etiwanda 230 kV Bus SCD Mitigation		Post Etiwanda 230 kV Bus SCD Mitigation	
	Eff 3PH SCD	% Loaded	Eff 3PH SCD	% Loaded
2025	60.6 kA	96.2%	56.6 kA	89.8%
2035	63.0 kA	100.0%	58.0 kA	92.1%

Alternatives and Risks

Alternatives	Risks
Develop operating procedure to open 230 kV transmission lines in real time	Opening 230 kV transmission lines during peak times would be burdensome to Grid Operators, may not be possible due to other real time system issues, and could result in significant curtailment of renewable resources

Inyo 230 kV Shunt Reactor

Area Challenges

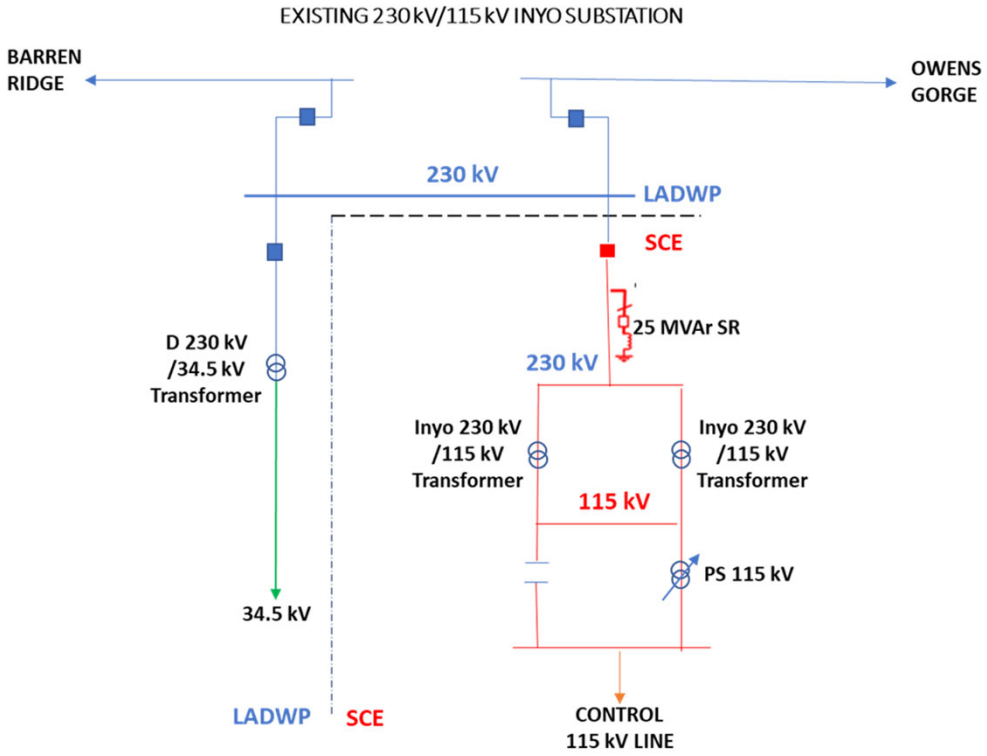
- In the 2022-2023 TPP, the CAISO approved the Control 115 kV Shunt Reactor Project to mitigate high voltage issues following P6 contingencies at Inyo 230 kV bus. Based on the historical Inyo 230 kV bus voltage data, the Inyo area has been experiencing high voltage issues in real time operation
- The scope of the TPP approved project consist of installing a 45 MVAr 115 kV shunt reactor at Control Substation
- Upon further evaluation, installing a shunt reactor on the SCE side of the Inyo 230 kV Substation instead of at the Control 115 kV Substation was found to be more effective in addressing the high voltage issues and a more viable location for construction

Proposed Scope

- Replace the 45 MVAR shunt reactor at Control 115 kV with a 25 MVAR shunt reactor at Inyo 230 kV Substation

Impact of Proposed Project

- Mitigates high voltages in the Inyo area
- Alleviates need to coordinate with CAISO on reducing area generation to mitigate high voltage issues



North of Lugo Area	Estimated Cost ($M)	Proposed In-Service Date
Inyo 230 kV Shunt Reactor	20	12/31/2027

Inyo 230 kV Shunt Reactor

Voltage Results

Substation	SCE 25 MVAR shunt reactor at Inyo 230 kV	
	OFF	ON
Inyo 230 kV	**242.6**	231.3
W&E LTC Tap Position	7	7
Kramer 230 kV	230.4	230.0
Barren Ridge 230 kV	245.4	244.1
Inyo 115 kV	122.2	117.7
Control 115 kV	122.0	117.6

Alternatives and Risks

Alternatives	Risks
Continue to utilize the existing system operating bulletins (SOB 80 and SOB 17)	• Coordinate with CAISO on reducing area generation to maintain voltage • SCE system operators can't manage the voltage issue without accepting about 10 MVARs from LADWP's system, although the Inyo intertie contracted capacity is 0 MW when the phase shifter is in-service
Install a 45 MVAr shunt reactor at SCE Control 115 kV Substation.	• There is no physical space at Control Substation; expansion outside the existing fence line is required. • Project would be significantly delayed past 2027 due to existing planned work at Control Substation.
LADWP recently confirmed plans to install a +/- 200 MVAr STATCOM by the end of 2023 at their Barren Ridge substation. This STATCOM was considered in the Inyo 230 kV high voltage mitigation assessment	• The voltage setpoint and droop characteristic for the LADWP's STATCOM have yet to be defined. Moreover, this STATCOM is unlikely to resolve the high voltage issue at Inyo because it will be located ~150 miles from the Inyo 230 kV station