TRANSCO.ENERGY

Gates Dynamic Reactive Power Support Project

Project Coordination Study
Final Study Report

Prepared for
PROJECT COORDINATION REVIEW GROUP

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EXECUTIVE SUMMARY

In early 2020, LS Power Grid California, LLC (LSPGC or Project Sponsor) was selected by the CAISO to procure, install, and operate two (2) +/-424 MVar Static Synchronous Compensator (STATCOM) blocks at the CAISO approved Orchard 500 kV Substation adjacent to Gates 500 kV Substation. The new 500 kV STATCOM (Project or Gates DRS) is proposed to resolve high voltages identified at Diablo, Gates and Midway 500 kV buses, following the planned retirement of the Diablo Canyon Nuclear Power Plant (DCPP) in 2025.

In January 2021, the Project Sponsor informed the Western Electricity Coordination Council's (WECC) Reliability Assessment Committee (RAC) and Studies Subcommittee (StS) of the Project and requested a waiver of the Project Coordination Process under Section 4 (Waiver of "Significant Impact" Status) of the WECC Project Coordination, Path Rating and Progress Report Processes.. The WECC RAC and StS received letters in opposition to the Waiver of "Significant Impact" Status for the Project from Modesto Irrigation District (MID), Turlock Irrigation District (TID), Western Area Power Administration-Sierra Nevada Region (WASN), and Transmission Agency for Northern California (TANC). As a result of this opposition, the Project Sponsor initiated a WECC Project Coordination Process for the Project.

On July 19, 2021, WECC announced that the Project will be entering into the Project Coordination Process. As part of the notice, an open invitation was provided for interested parties to join the WECC Project Coordination Review Group (PCRG). A Study Plan that outlines the objectives, scope, and methodology for the Project Coordination Study (PCS) for the Project was approved by the PCRG on November 16, 2021.

The PCS is performed using the CAISO Transmission Planning Process (TPP) base case (PG&E Bulk 2026 Spring Off-peak power flow model) as the starting base case. The Gates DRS was modeled to maintain a 1.06 per unit voltage at the Orchard 500 kV bus during the Spring off-peak operating condition. Power flow, transient stability and post-transient voltage stability analyses were conducted to determine any adverse impacts caused by the Project to the regional transmission system. In all, five (5) different operating scenarios involving WECC Path 15, WECC Path 26 and Helms pump scheme status were evaluated.

This study was performed in coordination with the PCRG to assess the potential impacts of the Gates DRS project on the affected systems. Provided below are the findings of the PCS:

- In the 2026 Spring off peak operating conditions with high Path 15 south-north flow and either Helms offline or 2 units in pumping mode, the addition of Gates DRS resulted in thermal overloads (up to 100.3%) on two 230 kV transmission lines (Warnerville – Wilson 230 kV line and Moss Landing - Las Aguilas 230 kV line) following NERC Standard TPL-001-4 Planning Event P1. These post-contingency thermal overloads were mitigated by setting the pre-contingency Orchard 500 kV bus voltage at 1.07 per unit using the Gates DRS.
- Based on the study results, the Gates DRS project is not expected to affect the RAS arming thresholds for selected NERC TPL-001-4 Standard P6 events significantly. Future operational studies will monitor and update the arming threshold in the Operating Horizon, if required.

- No voltage violation was identified in any of the operating conditions studied that could be attributable to the Project.
- The Project did not cause any transient stability performance criteria violation. All simulated fault events resulted in stable system performance with positive damping
- The Project did not impact the post-transient voltage stability limits of the interconnected transmission system. Positive reactive margin was observed for all simulated fault events.

Based on the above findings, it is concluded that interconnecting the Gates DRS project to PG&E's 500kV Gates substation would not cause Adverse Impacts to MID, TID, WASN, and TANC's Systems as well as to the other interconnected Systems.

INTRODUCTION

The California ISO's 2018-2019 Transmission Planning Process (TPP) identified a need for +/-800 MVar Dynamic Reactive power Support (DRS) at PG&E's Gates 500 kV Substation for reliability purposes. The CAISO governing board approved the DRS project in March 2019.

In early 2020, LS Power Grid California, LLC (LSPGC or Project Sponsor) was selected by the CAISO through a competitive bidding process to procure, install and operate two (2) +/-424 MVar Static Synchronous Compensator (STATCOM) blocks at the CAISO approved Orchard 500 kV Substation adjacent to the Gates 500 kV Substation.

The new 500 kV STATCOM (Project or Gates DRS) is proposed to resolve high voltages identified at Diablo, Gates and Midway 500 kV buses, following the planned retirement of Diablo Canyon Nuclear Power Plant (DCPP) in 2025.

Project Background

In early 2020, the Project Sponsor was selected by the CAISO to procure, install, maintain, and operate the Gates DRS Project.

In January 2021, the Project Sponsor informed the Western Electricity Coordination Council's (WECC) Reliability Assessment Committee (RAC) and Studies Subcommittee (StS) of the Project. The Project Sponsor requested a waiver of the Project Coordination Process under Section 4 (Waiver of "Significant Impact" Status) of the WECC Project Coordination, Path Rating and Progress Report Processes.

The WECC RAC and StS received letters in opposition to the Waiver of "Significant Impact" Status for the Project from Modesto Irrigation District (MID), Turlock Irrigation District (TID), Western Area Power Administration-Sierra Nevada Region (WASN), and Transmission Agency for Northern California (TANC). Subsequently, the Project was denied the waiver in April 2021. based on the grounds that the CAISO TPP did not fully evaluate the impacts of the Project on Affected Systems. Consequently, the Project Sponsor initiated the WECC Project Coordination Process for the Project. On July 19, 2021, WECC announced that the Project will be entering into the Project Coordination Process. As part of the notice, an open invitation was provided for interested parties to join the WECC Project Coordination Review Group (PCRG). Appendix A includes the list of PCRG members who participated in this study. The first PCRG meeting to kick off this study was held on July 22, 2021, via a web-conference.

The PCRG, Project Sponsor and with technical support from TransCo.Energy, LLC (TRANSCO), developed a Study Plan providing guidance for the PCRG study objectives, scope and methodology for the required study that needs to be completed for the Project. After several iterations of reviews, comments, and discussions in web-conferences, the PCRG approved the Study Plan on November 16, 2021.

Study Objective and Scope

The main objective of this Project Coordination study is to evaluate the impact of the Gates DRS Project on Affected Systems. This Study is performed in accordance with the guidelines specified in the WECC Project Coordination Process.

The scope of this work is to identify any adverse impacts caused by the Gates DRS Project to the regional transmission system. This study is performed in coordination with the WECC PCRG members. The technical analysis is performed in accordance with the North American Electric Reliability Corporation (NERC) reliability standards and WECC System Performance criteria.

Project Description and Plan of Service

The Project will be comprised of two +/- 424 MVar STATCOM blocks and a new 500 kV Orchard switchyard adjacent to the existing Gates 500 kV substation. The Project will be connected directly to Gates 500 kV bus.

The Project's plan of service is detailed below:

- Construct new 500 kV Orchard switchyard
- Install two +/-424 STATCOM Blocks
- Install two 424 MVA, 500/97.5 kV transformers at Orchard

A conceptual one-line diagram for the Project is depicted in Figure 1.

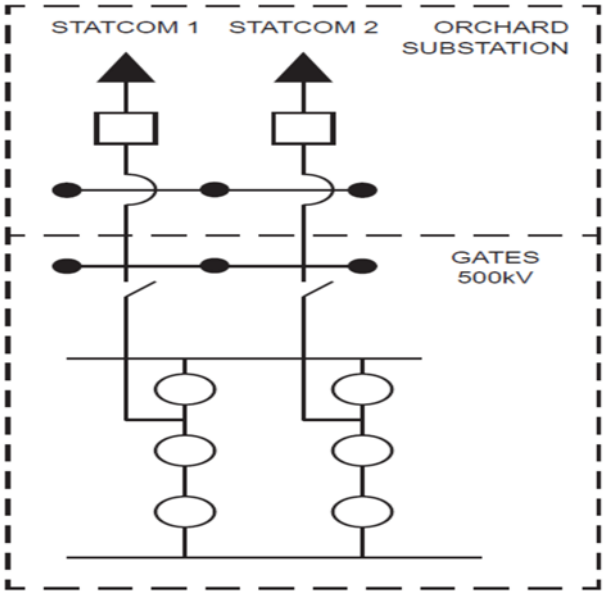

Figure 1: Simplified Representation of Gates DRS Project

STUDY DESCRIPTION AND METHODOLOGY

The analysis is conducted using the CAISO TPP base case (PG&E Bulk 2026 Spring Off-peak power flow model) as the starting base case for the study. According to the CAISO 2021-2022 TPP Study Plan, the 2026 Spring off-peak case is developed for a weekend day in April for HE13. The case had high solar output and relatively low load (net load) in PG&E (Area 30) service territory. The Diablo Canyon Nuclear Power Plant (DCPP) is modeled off-line while the Helms Pump Storage is modeled in pumping mode. The starting base case also had the 800 MVar DRS and 500 MVar DRS modeled at Gates and Round Mountain – Table Mountain 500 kV lines respectively.

In developing the benchmark or pre-Project base cases, the 800 MVar Gates DRS was initially removed from service. Five (5) pre-Project base cases were developed for the study based on the status of the Helms Units, WECC Path 15 flow, and path stressing guideline recommended by the PCRG and summarized in Table 1.

TABLE 1: PRE-PROJECT STUDY BASE CASES

CASE #	HELMS STATUS	PATH 15 FLOW*	PATH STRESSING GUIDELINE
1	Helms offline	Path 15 S-N stressed (flow <=5400 MW)	Stress based on N-0 or N-1 limit, (whichever occurs first)
2	Helms online (Two pumps at 300 MW each)	Path 15 S-N stressed (flow<=5400 MW)	Stress based on N-0 or N-1 limit, (whichever occurs first)
3	Helms online (Two pumps at 300 MW each)	Path 15 N-S stressed (flow>= 2000 MW and Path 26 N-S flow<=4000 MW)	Stress based on N-0 or N-1 limit, (whichever occurs first)
4	Helms offline	Path 15 S-N stressed (flow <=5400 MW)	Stress based on N-2 limit
5	Helms online (Two pumps at 300 MW each)	Path 15 S-N stressed (flow<=5400 MW)	Stress based on N-2 limit

* RAS were not triggered in setting up flows in the pre-Project cases.

Post-project study base cases were developed from the pre-project base cases in Table 1 by modeling the Gates DRS Project in accordance with its current plan of service. The voltage at Orchard 500 kV was set at 1.06 per unit.

In all, a total of ten (10) bases cases were used for evaluating the impact of the Project on the interconnected transmission system. Table 2 provides a summary of the study cases.

TABLE 2: STUDY BASE CASES

CASE #	CASE NAME	CASE DESCRIPTION
1	Pre-26SOP_Helms_off_GA_P15-SN_N-1	Pre-project base case developed from the 2026 Spring off peak case. Helms modeled offline and Path 15 S-N flow (<=5400 MW) is determined to be 4,060 MW based on N-1 limit.
2	Pre-26SOP_Helms_on_GA_P15-SN_N-1	Pre-project base case developed from the 2026 Spring off peak case. Two Helms pumps (300 MW each) modeled online. Path 15 S-N flow (<=5400 MW) is determined to be 4,150 MW based on N-1 limit
3	Pre-26SOP_Helms_on_GA_P15-NS	Pre-project base case developed from 2026 Spring off peak case. Two Helms pumps (300 MW each modeled

TABLE 2: STUDY BASE CASES

		online. Path 15 N-S flow (>=2000 MW) is determined to be 3,040 MW and Path 26 N-S (<=4000 MW) modeled as 4,000 MW based on N-1 limit
4	Pre-26SOP_Helms_off_GA_P15-SN_N-2	Pre-project base case developed from the 2026 Spring off peak case. Helms modeled offline and Path 15 S-N flow (<=5400 MW) is determined to be 3,050 MW based on N-2 limit.
5	Pre-26SOP_Helms_on_GA_P15-SN_N-2	Pre-project base case developed from the 2026 Spring off peak case. Two Helms pumps (300 MW each) modeled online. Path 15 S-N flow (<=5400 MW) is determined to be 3,165 MW based on N-2 limit
1a	Pst-26SOP_Helms_off_GA_P15-SN_N-1	Post-project base case developed from Case #1 and models Gates DRS. Orchard 500 kV bus voltage set at 1.06 per unit.
2a	Pst-26SOP_Helms_on_GA_P15-SN_N-1	Post-project base case developed from Case #2 and models Gates DRS. Orchard 500 kV bus voltage set at 1.06 per unit.
3a	Pst-26SOP_Helms_on_GA_P15-NS	Post-project base case developed from Case #3 and models Gates DRS. Orchard 500 kV bus voltage set at 1.06 per unit.
4a	Pst-26SOP_Helms_off_GA_P15-SN_N-2	Post-project base case developed from Case #4 and models Gates DRS. Orchard 500 kV bus voltage set at 1.06 per unit.
5a	Pst-26SOP_Helms_on_GA_P15-SN_N-2	Post-project base case developed from Case #5 and models Gates DRS. Orchard 500 kV bus voltage set at 1.06 per unit.

Apart from the stated modeling assumptions, the transmission and load assumptions in the starting base cases were not altered in developing the post- Project base cases. Power flow, post-transient and transient stability analyses were performed to ensure that the system performance criteria prescribed in the NERC reliability standards and WECC System Performance Criteria are met. Specific studies conducted, and their evaluation criteria are outlined below:

Power Flow Analysis

Power flow analysis was performed on the pre- and post-Project base cases summarized in Table 2. The Study evaluated the impact of the Gates DRS Project on the existing transmission system for NERC TPL-001-4 normal operating conditions (Category P0), single event (Category P1) as well as multiple (Category P6-P7) events. The outages simulated using pre- and post-Project cases (Cases 1/1a, 2/2a and 3/3a) include:

- P1: Los Banos - Gates #1 500 kV line
- P1: Los Banos - Gates #3 500 kV line
- P1: Diablo - Gates 500 kV Line
- P1: Diablo – Midway #2 500 kV line
- P1: Diablo – Midway #3 500 kV line
- P1: Tesla – Los Banos 500 kV line
- P1: Moss Landing – Los Banos 500 kV line

- P1: Gates – Midway 500 kV line
- P1: Midway – Los Banos 500 kV line
- P1: Metcalf – Tesla 500 kV line
- P1: Metcalf – Moss Landing 500 kV line
- P1: Tracy – Tesla 500 kV line
- P1: Tracy – Los Banos 500 kV line
- P1: Palo Verde G-1
- P1: Diablo G-1
- P6: Tesla – Tracy & Tracy- Los Banos 500 kV lines
- P6: Tesla - Los Banos 500 kV & Tracy – Los Banos 500 kV
- P6: Los Banos – Midway #2 500 kV & Los Banos – Gates #1 500 kV
- P6: Los Banos – Midway #2 500 kV & Gates - Midway #1 500 kV
- P6: Diablo – Midway #2 and #3 500 kV
- P6: Midway - Vincent #1 and #2 500 kV
- P7: Tesla – Los Banos & Tesla -Tracy 500 kV lines
- P7: PDCI Bi-pole outage
- P7: Palo Verde G-2

The purpose of Cases 4/4a and 5/5a was to capture any impacts caused by the Project to the existing RAS arming threshold. Therefore Cases 4/4a and 5/5a were studied for the following three (3) contingencies only:

- P6: Tesla - Los Banos 500 kV & Tracy – Los Banos 500 kV
- P6: Los Banos – Midway #2 500 kV & Los Banos – Gates #1 500 kV
- P6: Los Banos – Midway #2 500 kV & Gates - Midway #1 500 kV

The NERC reliability standards and the WECC System Performance Criteria were used to evaluate the study results. The following criteria were adhered to in evaluating the power flow results:

- Pre-contingency bus voltage must be between 0.95 per unit and 1.05 per unit unless specific minimum and maximum operating voltage requirements exists. For the post-Project case, the Orchard 500 kV bus voltage shall be between 1.05 -1.06 per unit.
- Pre-disturbance loading to remain within continuous ratings of all equipment and line conductors.
- Post-disturbance loading to remain within emergency ratings of all equipment and line conductors.
- Post-disturbance bus voltages to remain within applicable criteria:
    - Between 0.9 per unit and 1.10 per unit for Category P1-P7 events unless lower standards have previously been adopted.
- Post-disturbance bus voltage deviation to remain within applicable criteria:
    - Within 8% for Category P1 events, unless lower standards have previously been adopted

- Existing Remedial Action Schemes (RAS) were deployed as part of contingency definition as applicable.

Transient Stability Analysis

Transient stability analysis was conducted on the post-Project study Cases 1a, 2a and 3a summarized in Table 2. The dynamic data file developed for use with the pre-Project base cases was updated to include the Gates DRS dynamic model.

Transient stability runs were simulated for 30 seconds excluding a 1 second pre-outage run to ensure the system is stable and positively damped. Three-phase faults with 4 cycle clearing time were simulated for all the selected planning events.

The following selected critical disturbances were considered as part of the transient stability analysis. For each of the outages below, the fault was applied at the first bus for P1 events, and at the common bus for P6 events.

- P1: Los Banos - Gates #1 500 kV line
- P1: Los Banos - Gates #3 500 kV line
- P1: Diablo - Gates 500 kV Line
- P1: Diablo – Midway #2 500 kV line
- P1: Diablo – Midway #3 500 kV line
- P1: Tesla – Los Banos 500 kV line
- P1: Moss Landing – Los Banos 500 kV line
- P1: Gates – Midway 500 kV line
- P1: Midway – Los Banos 500 kV line
- P1: Metcalf – Tesla 500 kV line
- P1: Metcalf – Moss Landing 500 kV line
- P1: Tracy – Tesla 500 kV line
- P1: Tracy – Los Banos 500 kV line
- P1: Palo Verde G-1
- P6: Tesla – Tracy & Tracy- Los Banos 500 kV lines
- P6: Tesla - Los Banos 500 kV & Tracy – Los Banos 500 kV
- P6: Los Banos – Midway #2 500 kV & Los Banos – Gates #1 500 kV
- P6: Los Banos – Midway #2 500 kV & Gates - Midway #1 500 kV
- P6: Diablo – Midway #2 and #3 500 kV
- P6: Midway - Vincent #1 and #2 500 kV
- P7: Tesla – Los Banos & Tesla -Tracy 500 kV lines
- P7: PDCI Bi-pole outage
- P7: Palo Verde G-2

The following transient stability evaluation criteria were used to evaluate the impact of the Project on the stability limits of the existing transmission system:

- All machines in the interconnected system shall remain in synchronism as demonstrated by their relative rotor angles.
- System stability was evaluated based on the damping of the relative rotor angles and the damping of the voltage magnitude swings.
- System damping was assessed visually with the aid of stability plots. All oscillations that do not show positive damping within 30-seconds after the start of the studied event was deemed unstable.
- Transient voltage deviation was assessed using the TPL-0100-WECC-CRT-3 transient voltage dip criteria:
    - Following fault clearing, the voltage shall recover to 80% of the pre-contingency voltage within 20 seconds of the initiating event for all P1 through P7 events, for each applicable BES bus serving load.
    - Following fault clearing and voltage recovery above 80%, voltage at each applicable BES bus serving load shall neither dip below 70% of pre-contingency voltage for more than 30 cycles nor remain below 80% of pre-contingency voltage for more than two seconds, for all P1 through P7 events.

Post-Transient Voltage Stability Analysis

Post-transient voltage stability analysis was performed following the addition of Gates DRS. Post-transient analysis were performed on post-Project Cases 1a, 2a and 3a. For each post-Project case, the flow on Path 15 was modeled at 5% higher than the flow in each case for P1 planning events and 2.5% higher for P6 and P7 planning events. Positive reactive power margins must be recorded for each outage.

The outage list for the post-transient stability analysis is as follows:

- P1: Los Banos - Gates #1 500 kV line
- P1: Los Banos - Gates #3 500 kV line
- P1: Diablo - Gates 500 kV Line
- P1: Diablo – Midway #2 500 kV line
- P1: Diablo – Midway #3 500 kV line
- P1: Tesla – Los Banos 500 kV line
- P1: Moss Landing – Los Banos 500 kV line
- P1: Gates – Midway 500 kV line
- P1: Midway – Los Banos 500 kV line
- P1: Metcalf – Tesla 500 kV line
- P1: Metcalf – Moss Landing 500 kV line
- P1: Tracy – Tesla 500 kV line
- P1: Tracy – Los Banos 500 kV line
- P1: Palo Verde G-1
- P1: Diablo G-1
- P6: Tesla – Tracy & Tracy- Los Banos 500 kV lines

- P6: Tesla - Los Banos 500 kV & Tracy – Los Banos 500 kV
- P6: Los Banos – Midway #2 500 kV & Los Banos – Gates #1 500 kV
- P6: Los Banos – Midway #2 500 kV & Gates - Midway #1 500 kV
- P6: Diablo – Midway #2 and #3 500 kV
- P6: Midway - Vincent #1 and #2 500 kV
- P7: Tesla – Los Banos & Tesla -Tracy 500 kV lines
- P7: PDCI Bi-pole outage
- P7: Palo Verde G-2

To achieve post-transient voltage stability, positive reactive power margins must be recorded for each outage.

STUDY RESULTS

This section details the key findings of the power flow, post-transient voltage stability and transient stability analyses. NERC reliability standards and WECC System Performance Criteria were used to assess the adequacy of the system performance based on the study results.

Base Case Summary

A summary of selected base case transmission line / path flows and the statuses of Helms and Gates DRS for both pre- and post-Project study base cases with all transmission lines in service is provided in Table 3. Selected 500 kV bus voltages in the pre- and post-Project base cases with all transmission lines in service are provided in Table 4.

TABLE 3: SUMMARY OF BASE CASE TRANSMISSION LINE / PATH FLOWS

BASE CASE	GA DRS STATUS	HELMS UNITS	TRANSMISSION LINE / PATH FLOWS (MW)			
			COI	PATH 15	PATH 26	PDCI
Pre-26SOP_Helms_off_GA_P15-SN_N-1 (Case 1)	Off	3 Units off	(2,605)	4,060	55	(1,400)
Pst-26SOP_Helms_off_GA_P15-SN_N-1 (Case 1a)	On	3 Units off	(2,601)	4,060	55	(1,400)
Pre-26SOP_Helms_on_GA_P15-SN_N-1 (Case 2)	Off	2 Units on	(2,592)	4,150	(36)	(1,400)
Pst-26SOP_Helms_on_GA_P15-SN_N-1 (Case 2a)	On	2 Units on	(2,590)	4,146	(33)	(1,400)
Pre-26SOP_Helms_on_GA_P15-NS (Case 3)	Off	2 Units on	(906)	(3,039)	4,000	500
Pst-26SOP_Helms_on_GA_P15-NS (Case 3a)	On	2 Units on	(907)	(3,040)	4,000	500
Pre-26SOP_Helms_off_GA_P15-SN_N-2 (Case 4)	Off	3 Units off	(2,696)	3,050	50	(1,400)
Pst-26SOP_Helms_off_GA_P15-SN_N-2 (Case 4a)	On	3 Units off	(2,692)	3,050	49	(1,400)
Pre-26SOP_Helms_on_GA_P15-SN_N-2 (Case 5)	Off	2 Units on	(2,673)	3,165	(255)	(1,400)
Pst-26SOP_Helms_on_GA_P15-SN_N-2 (Case 5a)	On	2 Units on	(2,669)	3,165	(255)	(1,400)

TABLE 4: 500 KV BUS VOLTAGES

BASE CASE	GA DRS STATUS	BUS VOLTAGES (PU)				
		ORCHARD	GATES	MIDWAY	DIABLO	LOS BANOS
Pre-26SOP_Helms_off_GA_P15-SN_N-1 (Case 1)	Off	N/A	1.073	1.070	1.087	1.064
Pst-26SOP_Helms_off_GA_P15-SN_N-1 (Case 1a)	On	1.060	1.061	1.064	1.079	1.058
Pre-26SOP_Helms_on_GA_P15-SN_N-1 (Case 2)	Off	N/A	1.072	1.070	1.086	1.063
Pst-26SOP_Helms_on_GA_P15-SN_N-1 (Case 2a)	On	1.060	1.061	1.064	1.078	1.057
Pre-26SOP_Helms_on_GA_P15-NS (Case 3)	Off	N/A	1.073	1.060	1.079	1.074
Pst-26SOP_Helms_on_GA_P15-NS (Case 3a)	On	1.060	1.061	1.056	1,.072	1.069
Pre-26SOP_Helms_off_GA_P15-SN_N-2 (Case 4)	Off	N/A	1.081	1.075	1.093	1.072
Pst-26SOP_Helms_off_GA_P15-SN_N-2 (Case 4a)	On	1.060	1.061	1.066	1.080	1.062
Pre-26SOP_Helms_on_GA_P15-SN_N-2 (Case 5)	Off	N/A	1.080	1.075	1.093	1.072
Pst-26SOP_Helms_on_GA_P15-SN_N-2 (Case 5a)	On	1.060	1.061	1.066	1.080	1.063

Power Flow Analysis Findings

Case 1/1a: 2026 SOP-Helms Units Off & High Path 15 S-N

Case 1 and Case 1a were used to evaluate the impact of the Project on Path 15 south-north flow with Helms offline. For a no single element outage (P1 planning event) thermal overload, Path 15 flow was determined to be 4060 MW in the pre-Project case (Case 1). The limiting element and associated contingency were found to be Warnerville – Wilson 230 kV line (99.6%) and Los Banos – Tesla 500 kV line respectively. Post-Project base case (Case 1a) was developed from Case 1 by adding the Gates DRS while maintaining the Path 15 flow at pre-Project level. The Gates DRS was modeled to control the Orchard 500 kV bus at 1.06 per unit.

Power flow solutions were obtained for all the P1 and P7 outage events simulated. Summary of the power flow results can be found in Appendix B, Table B-1.

Provided below are key findings from the power flow analysis using Case 1 and Case 1a:

- **Two (2) New Transmission facility overloads Identified**

The post-Project case shows two (2) transmission facility overloads following P1 outage event with Path 15 south-north flow of 4,060 MW and Helms offline. The Warnerville – Wilson 230 kV line overloaded up to 100.3% of the line's emergency rating following the outage of the Los Banos – Tesla 500 kV line. The pre-Project loading on the Warnerville – Wilson 230 kV line following the outage of the Los Banos – Tesla 500 kV Line is 99.8%. Also, the Moss Landing - Las Aguilas #2 230 kV line loading increased to 100.1% of the

line's emergency rating from 99.6% following the outage of the Los Banos – Moss Landing 500 kV line.

The recommended mitigation is to set the pre-contingency Orchard 500 kV bus voltage at 1.07 per unit using the Gates DRS. Table 5 summarizes the results of the power flow analysis with and without the proposed mitigation.

TABLE 5: POWER FLOW RESULTS -- CASE 1/1A

Outage Element (s)	Overloaded Facility	Applicable Rating	Loading (%)			Comments
			Case 1	Case 1A	Case 1A w/ Mitigation	
Category P1 Contingencies						
Los Banos– Tesla 500 kV line	Warnerville – Wilson 230 kV line	786 A	99.6	100.3	99.8	Set the Orchard 500 kV bus voltage at 1.07 per unit to mitigate the overloads
Los Banos – Moss Landing 500 kV line	Moss Landing SW – Las Aguilas #2 230 kV line	1,005 A	99.5	100.1	99.6	

•Existing P6/P7 Transmission facility overload Exacerbated with the Project

Existing P6/P7 outage event thermal overloads without RAS exacerbated marginally following the addition of the Gates DRS. System adjustments including redispatching generation and switching actions are expected to mitigate these pre-Project overloads. Appendix B, Table B-1 summarizes the pre- and post-Project power flow results.

•No voltage criteria violation identified

No voltage criteria violation identified for the planning outages simulated.

Case 2/2a: 2026 SOP-Helms Units On & High Path 15 S-N

Case 2 and Case 2a were used to evaluate the impact of the Project during high Path 15 south-north flow with two Helms pumps in operation. For a no single element outage (P1 planning event) thermal overload, Path 15 flow was determined to be 4,150 MW in the pre-Project case (Case 2). The limiting element and associated contingency were found to be Moss Landing – Las Aguilas #2 230 kV line (99.5%) and Los Banos – Moss Landing 500 kV line respectively. Summary of the power flow results can be found in Appendix B, Table B-2.

Provided below are key findings from the power flow analysis using Cases 2 & Case 2a:

•One (1) New Transmission facility overload identified

The post-Project case (Case 2a) shows one (1) transmission facility overload. The Moss Landing – Las Aguilas #2 230 kV line loaded up to 100.1% of the line's emergency rating

following the outage of the Los Banos – Moss Landing 500 kV line. The pre-Project loading on the line following the same outage is 99.5%.

The recommended mitigation is to set the pre-contingency Orchard 500 kV bus voltage at 1.07 per unit using the Gates DRS. Table 6 summarizes the results of the power flow analysis with and without the proposed mitigation.

TABLE 5: POWER FLOW RESULTS -- CASE 2/2A

Outage Element (s)	Overloaded Facility	Applicable Rating	Loading (%)			Comments
			Case 2	Case 2A	Case 2A w/ Mitigation	
Category P1 Contingencies						
Los Banos – Moss Landing 500 kV line	Moss Landing SW – Las Aguilas #2 230 kV line	1,005 A	99.5	100.1	99.6	Set the voltage at Orchard 500 kV bus to 1.07 per unit to mitigate the overload

•Existing P6/P7 Transmission facility overload exacerbated with the Project

Existing P6/P7 outage event thermal overloads without RAS exacerbated marginally following the addition of the Gates DRS. System adjustments including redispatching generation and switching actions are expected to mitigate these pre-Project overloads. Appendix B, Table B-2 summarizes the pre- and post-Project power flow results.

•No voltage criteria violation identified

No voltage criteria violation identified for the planning outages simulated.

Case 3/3a: 2026 SOP-Helms Units On & High Path 26 N-S

Case 3 and Case 3a were used to evaluate the impact of the Project on Path 26 with two Helms pumping units in operation. For a no single element outage (P1 planning event) thermal overload, the maximum achievable Path 26 north -south flow of 4,000 MW was modeled in the pre-Project case (Case 3). Power flow solutions were obtained for all P1/P7 outages simulated. Summary of the power flow results can be found in Appendix B, Table B-3.

Provided below are key findings from the power flow analysis using Case 3 and Case 3a:

•No P1 Event Transmission facility overload Identified

The post-Project case (Case 3a) did not show any transmission facility overload following the P1 planning outages simulated.

•Existing P6/P7 Transmission facility overload Exacerbated with the Project

Existing P6/P7 outage event thermal overloads without RAS increased marginally following the addition of the Gates DRS. System adjustments including redispatching generation and switching actions are expected to mitigate these pre-Project overloads. Appendix B, Table B-3 summarizes the pre- and post-Project power flow results.

•No voltage criteria violation identified

No voltage criteria violation identified for the planning outages simulated.

Case 4/4a: 2026 SOP-Helms Units Off & Path 15 S-N limit Based on P6 Event

Case 4 and Case 4a were used to evaluate the impact of the Gates DRS to the existing RAS arming threshold of the following critical P6 events:

- P6: Tesla - Los Banos 500 kV & Tracy – Los Banos 500 kV
- P6: Los Banos – Midway #2 500 kV & Los Banos – Gates #1 500 kV
- P6: Los Banos – Midway #2 500 kV & Gates - Midway #1 500 kV

Case 4 had Helms units modeled offline. Path 15 flow in the south-north direction was determined to be 3,050 MW based on a no thermal overload under the selected P6 events above. Post-Project case (Case 4a) was developed from Case 4 by modeling the Gates DRS to control the Orchard 500 kV bus at 1.06 per unit. Path 15 flow was not varied from the pre-Project level in the post-Project case.

Power flow solutions were obtained for all three P6 outages simulated. Summary of the power flow results can be found in Appendix B, Table B-4.

Provided below are key findings from the power flow analysis using Case 4 and Case 4a:

•One (1) New Transmission facility overload Identified

The addition of the Gates DRS resulted in one new transmission facility overload following the three (3) P6 planning events simulated. In particular, the Warnerville – Wilson 230 kV line is marginally loaded to 101% of the line's emergency rating following the P6 planning event of Los Banos – Tracy and Los Banos – Tesla 500 kV outage (without RAS). The pre-Project loading following the same P6 planning event is 99.8%. The P6 planning events were simulated without any system adjustments in between the two outages. Based on these results, the Gates DRS project is not expected to affect the RAS arming thresholds significantly. Future operational studies will monitor and update the arming threshold in Operating Horizon, if required.

•No voltage criteria violation identified

No voltage criteria violation identified.

Case 5/5a: 2026 SOP-Helms Units On & Path 15 S-N limit Based on P6 Event

Case 5 and Case 5a were used to evaluate the impact of the Gates DRS to the existing RAS arming threshold of the following critical P6 events:

- P6: Tesla - Los Banos 500 kV & Tracy – Los Banos 500 kV
- P6: Los Banos – Midway #2 500 kV & Los Banos – Gates #1 500 kV
- P6: Los Banos – Midway #2 500 kV & Gates - Midway #1 500 kV

Case 5 modeled two Helms pumping units online. Path 15 flow in the south-north direction was determined to be 3,165 MW based on a no thermal overload under the selected P6 events above. Case 5a was developed from Case 5 by modeling the Gates DRS to control the Orchard 500 kV bus at 1.06 per unit. Path 15 flow in the post-Project case was not varied from the pre-Project level.

Power flow solutions were obtained for all three P6 outages simulated. Summary of the power flow results can be found in Appendix B, Table B-5.

Provided below are key findings from the power flow analysis using Case 5 & Case 5a:

•Two (2) New Transmission facility overloads Identified

The addition of the Gates DRS caused two new transmission facility overloads following the P6 planning events simulated. The P6 planning events were simulated without any system adjustments in between the two outages. Table 6 provides a summary of the overloaded facilities. Based on these results, the Gates DRS project is not expected to affect the RAS arming thresholds significantly. Future operational studies will monitor and update the arming threshold in Operating Horizon, if required.

TABLE 6: POWER FLOW RESULTS -- CASE 5/5A

Outage Element (s)	Overloaded Facility	Applicable Rating	Loading (%)	
			Case 5	Case 5A
Category P6 Contingencies				
Los Banos – Tracy & Los Banos – Tesla 500 kV lines/ (no RAS)	Warnerville – Wilson 230 kV line	786 A	99.5	100.5
Midway – Los Banos & Midway - Gates 500 kV lines/ (no RAS)	Gates F – Midway F 230 kV line	850 A	99.8	100.1

•No voltage criteria violation identified

No voltage criteria violation identified.

Transient Stability Analysis Findings

Transient stability analysis was performed on post-Project base cases Case 1a, Case 2a and Case 3a.

Key findings from the stability analysis include:

- All outages simulated including P6/P7 Planning Events resulted in stable system performance with positive damping. Stability plots for the 2026 spring off-peak post-Project base cases studied can be found in Attachment A.
- TPL-001-WECC-CRT-3 transient voltage dip criteria were met for all outages simulated

Post Transient Voltage Stability Analysis Findings

Post-transient voltage stability analysis was performed on the post-Project base cases 1a, 2a and 3a. For each post-Project case, the flow on Path 15 was modeled at 5% higher than the flow in each case for P1 planning events and 2.5% higher for P6-P7 planning events.

As summarized in Table 7, power flow solutions were achieved for all outages simulated. Therefore, positive reactive margins were obtained for all outages simulated. Thus, the addition of Gates DRS did not impact the post-transient voltage stability limits of the interconnected transmission system.

TABLE 7: SUMMARY OF POST-TRANSIENT VOLTAGE STABILITY ANALYSIS

OUTAGE SIMULATED	POST-TRANSIENT VOLTAGE STABILITY CRITERIA MET?		
	CASE 1A	CASE 2A	CASE 3A
Gates – Los Banos #1 500 kV line	Yes	Yes	Yes
Gates – Los Banos #3 500 kV line	Yes	Yes	Yes
Tesla – Los Banos 500 kV line	Yes	Yes	Yes
Diablo – Gates 500 kV line	Yes	Yes	Yes
Diablo – Midway #2 500 kV line	Yes	Yes	Yes
Diablo – Midway #3 500 kV line	Yes	Yes	Yes
Moss Landing – Los Banos 500 kV line	Yes	Yes	Yes
Gates – Midway 500 kV line	Yes	Yes	Yes
Midway – Los Banos 500 kV line	Yes	Yes	Yes
Metcalf – Tesla 500 kV line	Yes	Yes	Yes
Metcalf – Moss Landing 500 kV line	Yes	Yes	Yes
Olinda – Tracy 500 kV line	Yes	Yes	Yes
Tracy – Tesla 500 kV line	Yes	Yes	Yes
Tracy – Los Banos 500 kV line	Yes	Yes	Yes
Palo Verde G-1	Yes	Yes	Yes
Diablo g-1	Yes	Yes	Yes
Tesla – Tracy & Tracy – Los Banos 500 kV lines	Yes	Yes	Yes
Tesla – Los Banos & Tesla – Tracy 500 kV lines	Yes	Yes	Yes
Tesla – Los Banos & Tracy – Los Banos 500 kV lines	Yes	Yes	Yes
Los Banos – Midway #2 & Los Banos – Gates #1 500 kV lines	Yes	Yes	Yes
Los Banos – Midway #2 & Gates – Midway #1 500 kV lines	Yes	Yes	Yes
Diablo – Midway #2 & 3 500 kV lines	Yes	Yes	Yes
Midway – Vincent #1 & 2 500 kV lines	Yes	Yes	Yes
PDCI Bi-pole	Yes	Yes	Yes
Palo Verde G-2	Yes	Yes	Yes

CONCLUSIONS

This Project Coordination study was conducted using the CAISO TPP base case (PG&E Bulk 2026 Spring Off-peak power flow model) as the starting power flow cases. A total of 10 pre- and post-Project cases were developed per the PCRG recommendation to represent "corner points" under a variety of system operating conditions. The study included evaluation of steady state, transient and post-transient stability performances for the simulated operating conditions. Key findings of the study are summarized below:

- For the 2026 Spring off peak operating conditions with high Path 15 south-north flow and either Helms offline or 2 units in pumping mode (Case 1a and Case 2a), the addition of Gates DRS resulted in thermal overloads (100.3%) on two 230 kV transmission lines (Warnerville – Wilson 230 kV line and Moss Landing - Las Aguilas 230 kV line), following Planning Event P1. These contingency thermal overloads were mitigated by setting the pre-contingency Orchard 500 kV bus voltage at 1.07 per unit using the Gates DRS.
- Given the minimal loading changes between pre- and post-Project conditions for Case 4 and 5, the Gates DRS project is not expected to affect the RAS arming thresholds for selected P6 events. Future operational studies will monitor and update the arming threshold in Operating Horizon, if required.
- No voltage violation was identified in any of the operating conditions studied that could be attributable to the Project.
- The Project did not cause any transient stability performance criteria violation. All simulated fault events resulted in stable system performance with positive damping
- The Project did not impact the post-transient voltage stability limits of the interconnected transmission system. Positive reactive margin was observed for all simulated fault events.

Based on the above findings, it is concluded that interconnecting the Gates DRS project to PG&E's 500kV Gates substation would not cause Adverse Impacts to MID, TID, WASN, and TANC's Systems as well as to the other interconnected Systems.

APPENDIX A: PCRG MEMBERS

Table A-1: Study Participants (PCRG Representatives)

Company	Representatives	
	First Name	Last Name
California ISO	Ebrahim	Rahimi
	Binaya	Shrestha
DesertLink LLC	Tim	Cook
	Ramya	Nagrajan
Long Road Energy	Radha	Soorya
Modesto Irrigation District	Martin	Caballero
NV Energy	Jeff	Watkins
Pacific Gas & Electric	Sophie	Xu
	Marco	Rios
	Bill	Wang
	Simrit	Basrai
	Ron	Markham
Pacificorp	Jamie	Austin
Sacramento Municipal Utility District	Patrick	Truong
Transmission Agency of Northern California	Dave	Larsen
	Ellie	Foruzan
	Tim	Schiermeyer
	Amy	Cuellar
Turlock Irrigation District	Brett M.	Bodine
	Danna M.	Anguiano
	Kody J.	Heppner
WAPA - Sierra Nevada Region	Patrick	Montplaisir
	Bryan	Griess
	Page	Andrews
	Chris	Mensah-Bonsu
	Gary	Farmer
	Chris	Effiong
WECC Staff	Doug	Tucker
LS Power Grid California (Project Sponsor)	Sandeep	Arora
	Mark	Milburn
	Diwakar	Tewari
Transco Energy (Consultant for Project Sponsor)	John	Kyei

APPENDIX B: SUMMARY OF POWER FLOW RESULTS

Table B-1: Summary of Power Flow Results—Cases 1/1A

Outage Element (s)	Overloaded Facility	Applicable Rating	Loading (%)	
			Case 1	Case 1A
Category P0—Normal Overloads				
None/(P0)	N/A	N/A	N/A	N/A
Category P1 Contingencies				
Los Banos– Tesla 500 kV line	Warnerville – Wilson 230 kV line	786 A	99.6	100.3
Los Banos – Moss Landing 500 kV line	Moss Landing SW – Las Aguilas #2 230 kV line	1,005 A	99.5	100.1
Category P6-P7 Contingencies				
Los Banos – Tracy & Los Banos – Tesla 500 kV lines/ (no RAS)	Warnerville – Wilson 230 kV line	786 A	137.5	138.4
	Westley – Quinto 230 kV line	3,000 A	106.1	106.4
	Quinto – Los Banos 230 kV line	3,000 A	100.2	100.7
Los Banos – Gates & Los Banos – Midway 500 kV lines/ (no RAS)	Warnerville – Wilson 230 kV line	786 A	124.0	125.0
	Panoche – Gates E #1 230 kV line	850 A	110.3	111.8
	Panoche – Gates E #2 230 kV line	850 A	110.3	111.8
Midway – Los Banos & Midway - Gates 500 kV lines/ (no RAS)	Cal Flats – Gates D 230 kV line	975 A	115.7	116.5
	Gates F – Arco 230 kV line	850 A	141.0	141.8
	Gates F – Midway F 230 kV line	850 A	144.4	144.9
Tesla – Tracy & Tesla – Los Banos 500 kV lines / (no RAS)	Warnerville – Wilson 230 kV line	786 A	102.6	103.3

Table B-2: Summary of Power Flow Results—Cases 2/2A

Outage Element (s)	Overloaded Facility	Applicable Rating	Loading (%)	
			Case 2	Case 2A
Category P0—Normal Overloads				
None/(P0)	N/A	N/A	N/A	N/A
Category P1 Contingencies				
Los Banos – Moss Landing 500 kV line	Moss Landing SW – Las Aguilas #2 230 kV line	1,005 A	99.5	100.1
Category P6-P7 Contingencies				
Los Banos – Tracy & Los Banos – Tesla 500 kV lines/ (no RAS)	Warnerville – Wilson 230 kV line	786 A	134.2	134.9
	Westley – Quinto 230 kV line	3,000 A	106.9	107.1
	Quinto – Los Banos 230 kV line	3,000 A	101.1	101.5
Los Banos – Gates & Los Banos – Midway 500 kV lines/ (no RAS)	Warnerville – Wilson 230 kV line	786 A	120.6	121.3
	Panoche – Gates E #1 230 kV line	850 A	112.5	113.7
	Panoche – Gates E #2 230 kV line	850 A	112.5	113.7
Midway – Los Banos & Midway - Gates 500 kV lines/ (no RAS)	Cal Flats – Gates D 230 kV line	975 A	117.3	118.0
	Gates F – Arco 230 kV line	850 A	144.1	144.8
	Gates F – Midway F 230 kV line	850 A	148.1	148.5
	Arco – Midway E 230 kV line	850 A	102.1	102.2

Table B-3: Summary of Power Flow Results—Cases 3/3A

Outage Element (s)	Overloaded Facility	Applicable Rating	Loading (%)	
			Case 3	Case 3A
Category P0—Normal Overloads				
None/(P0)	N/A	N/A	N/A	N/A
Category P1 Contingencies				
None	N/A	N/A	N/A	N/A
Category P6-P7 Contingencies				
Los Banos – Tracy & Los Banos – Tesla 500 kV lines/ (no RAS)	Mendota – Panoche 115 kV line	1,126 A	100.1	100
Midway – Los Banos & Midway - Gates 500 kV lines/ (no RAS)	Gates F – Midway F 230 kV line	850 A	123.8	125.5
	Arco – Midway E 230 kV line	850 A	111.0	112.2
	Midway – BELRDG J 115 kV line	463 A	109.1	109.4
Midway – Vincent #1 & 2500 kV lines / (no RAS)	Midway– Whirlwind #3 500 kV line	2,400 A	175.1	176.1

Table B-4: Summary of Power Flow Results—Cases 4/4A

Outage Element (s)	Overloaded Facility	Applicable Rating	Loading (%)	
			Case 4	Case 4A
Category P6 Contingencies				
Los Banos – Tracy & Los Banos – Tesla 500 kV lines/ (no RAS)	Warnerville – Wilson 230 kV line	786 A	99.8	101.0
Midway – Los Banos & Midway - Gates 500 kV lines/ (no RAS)	Gates F – Midway F 230 kV line	850 A	99.2	99.4

Table B-5: Summary of Power Flow Results—Cases 5/5A

Outage Element (s)	Overloaded Facility	Applicable Rating	Loading (%)	
			Case 5	Case 5A
Category P6 Contingencies				
Los Banos – Tracy & Los Banos – Tesla 500 kV lines/ (no RAS)	Warnerville – Wilson 230 kV line	786 A	99.5	100.5
Midway – Los Banos & Midway - Gates 500 kV lines/ (no RAS)	Gates F – Midway F 230 kV line	850 A	99.8	100.1