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DOCKET
08-AFC-1
DATE Nov 21 2008
RECD. Nov 21 2008

November 21, 2008

Mr. Christopher Meyer
Project Manager
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814-5512

Via E-Mail

Re: System Impact Study Supplement for Avenal Energy (08-AFC-1)

Dear Mr. Meyer:

On behalf of Avenal Power Center, LLC, please find attached a copy of a System Impact Study Supplement (SISS) report for Avenal Energy. The SISS was performed by Navigant Consulting at the request of Avenal Power Center, LLC to address certain CEC staff comments to the System Impact Study.

Electronic copies of the enclosed SISS report, along with proof of service declaration, are being concurrently sent to each of the individuals on the attached proof of service list.

If you have any questions regarding the enclosed report, please call me at the phone number in the letterhead, or Jim Rexroad at (713) 275-6147.

Sincerely,

Joseph L. Stenger

Joseph L. Stenger, PG, REA
Project Director

Attachments: Proof of Service
SISS Report

cc. Jim Rexroad
Proof of Service

BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT
COMMISSION OF THE STATE OF CALIFORNIA
1516 NINTH STREET, SACRAMENTO, CA 95814
1-800-822-6228 – WWW.ENERGY.CA.GOV

**APPLICATION FOR CERTIFICATION**
***For the AVENAL ENERGY PROJECT***

**Docket No. 08-AFC-1**
**PROOF OF SERVICE**
**(revised 10/27//2008)**

**INSTRUCTIONS: All parties shall either (1) send an original signed document plus 12 copies or (2) mail one original signed copy AND e-mail the document to the address for the Docket as shown below, AND (3) all parties shall also send a printed or electronic copy of the document, which includes a proof of service declaration to each of the individuals on the proof of service list shown below:**

CALIFORNIA ENERGY COMMISSION
Attn: Docket No. **08-AFC-1**
1516 Ninth Street, MS-**4**
Sacramento, CA 95814-5512
docket@energy.state.ca.us

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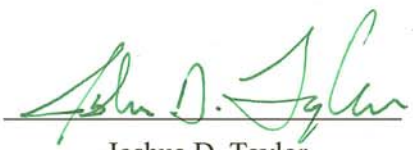
**DECLARATION OF SERVICE**

I, Joshua D. Taylor, Declare that on November 21, 2008, I deposited one copy of the attached **System Impact Study Supplement** at the Federal Express Hub on Barranca Parkway in Irvine, California, with waybills fully prepaid and addressed to those individuals identified on the Proof of Service list above.

**OR**

Transmission via electronic mail was consistent with the requirements of the California Code of Regulations, Title 20, Sections 1209, 1209.5, and 1210. All electronic copies were sent to all those identified on the Proof of Service list above.

I declare under penalty of perjury that the foregoing is true and correct.



Joshua D. Taylor

# System Impact Study Supplement

Generation Interconnection

Avenal Power Center, LLC

Avenal Project

November 12, 2008

## 1. INTRODUCTION

Avenal Power Center, LLC (Avenal), proposes to interconnect the 600 MW Avenal Energy Project (Project) with Pacific Gas and Electric Company's (PG&E) Gates Substation in Fresno County, California. The planned operation date for the proposed Project is June 1, 2012.

The California ISO (CAISO) and PG&E had completed an Interconnection Feasibility Study (IFS) for the Project and had determined that a System Impact Study (SIS) was needed to determine the impact of the Avenal Project on PG&E's transmission grid. However, as a result of the CAISO's Generator Interconnection Process Reform (GIPR) activities, the Project has been placed in the "transition cluster" and, as a result, work had ceased on the SIS being performed by PG&E. As a result Avenal had retained Navigant Consulting Inc. (NCI) perform a System Impact Study (SIS) for the Project so that the Project could proceed through the California Energy Commission's (Energy Commission) Application for Certification (AFC) process on a timely basis. The SIS prepared by NCI was finalized on September 18, 2008 and was docketed with the Energy Commission on September 19, 2008.

The Avenal Project SIS:

- Identified the transmission system impacts caused solely by the addition of the proposed Project based on studies of 2013 Summer Peak, 2013 Summer Off-Peak, and 2013 Spring Peak system conditions. The studies performed included:
  - Steady State Power Flow
  - Governor Power Flow
  - Dynamic Stability Analysis
  - Short Circuit Analysis
  - Reactive Margin Analysis
- Identified the system reinforcements necessary to mitigate the adverse impacts of the proposed Project under various system conditions, and
- Provided preliminary cost estimates for the above system reinforcements.

In summary the Avenal Project SIS noted that the addition of the Project:

- Would not result in any new Category A overloads.
- Would result in new Category B overloads on two 230-kV lines and one 70-kV line which could be mitigated by reconductoring the lines (at an estimated cost of approximately $29 Million)1.
- Would result in new Category C overloads on four 230-kV lines which could be mitigated by reconductoring the lines (at an estimated cost of approximately $69 Million)

[1] Reconductoring the impacted lines or using SPS to mitigate overloads on certain lines would require the approval of both PG&E and the ISO.

or by using special protection schemes (SPS)1 which would curtail portions of the Project generation for four different Category C contingencies.
- Would result in new Category C overloads on one 115-kV line and one 70-kV line which could be mitigated by reconductoring the lines (at an estimated cost of approximately $17 Million).

The Avenal Project SIS also noted that the addition of the Project:
- Would not result in any transient stability concerns for the system.
- Would tend to increase the reactive margin on the transmission system for Summer Off-Peak system conditions.
- Would increase the short circuit duty at the Gates 230-kV bus by approximately 13% ; however, the post-Project short circuit duty at this bus would still be approximately 3% lower than the minimum breaker rating at the Gates 230-kV bus.
- Would increase the short circuit duty at other busses in the area in amounts ranging from 0.4% to 2.4%.

This Avenal Project SIS Supplement has been prepared to address certain items that resulted from discussions with Energy Commission staff regarding the Avenal Project SIS. Specifically this SIS Supplement discusses:
- Other options for mitigation of the Category B and Category C overloads discussed above.
- The Project-related impacts on reactive margins for both Summer Off-Peak and Summer Peak conditions.
- The Project-related impacts on voltage deviations for both Summer Off-Peak and Summer Peak conditions.
- The Project-related impacts on fault duties at select busses in the Project area.
- The estimated costs associated with interconnecting the Project to the existing grid and with mitigation of overloads.

## 2. SUMMARY OF FINDINGS

### Mitigation of Overloads

As discussed in Section 3 the analyses associated with this SIS Supplement indicate that:
- The new post-Project Category B overloads on two 230-kV lines and one 70-kV line could potentially be mitigated by reconductoring or re-rating the impacted lines; either of which would have to be approved by PG&E and the CAISO. Approval of the potential re-rates by PG&E and the CAISO would reduce the Project-related mitigation costs by approximately $29 Million.

- The new post-Project Category C overloads on four 230-kV lines could potentially be mitigated by re-rating the impacted lines or by using SPS or operating procedures to mitigate the overloads; any of which would have to be approved by PG&E and the CAISO. Approval of the potential re-rates or use of operating procedures by PG&E and the CAISO would reduce the Project-related mitigation costs by approximately $4 Million.
- The new post-Project Category C overloads on one 115-kV line and one 70-kV line could potentially be mitigated by re-rating the impacted lines or the use of operating procedures; either of which would have to be approved by PG&E and the CAISO. Approval of the potential re-rates or the use of operating procedures by PG&E and the CAISO would reduce the Project-related mitigation costs by approximately $17 Million.

**Project Impacts on Reactive Margins**

As discussed in Section 4 reactive margin studies on both the 2013 Summer Off-Peak case and the 2013 Summer On-Peak case indicate that:

- The minimum reactive margins for all of the contingencies studied on both of the pre-Project cases would be in excess of 400 MVAR (WECC criteria require that they only be greater than 0 MVAR), and
- The addition of the Project would increase the reactive margin at the critical bus for all of the outages simulated.

**Project Impacts on Post-Contingency Voltages**

As discussed in greater detail in Section 5, governor powerflow studies on the 2013 Summer Off-Peak cases showed that the addition of the Project:

- Tended to increase the post-contingency voltages at the various 500-kV busses in the Project area, and
- Had little impact on the post-contingency voltages at 500-kV busses elsewhere in northern California.

Similar studies on the Summer On-Peak cases indicated that:

- The lowest post-Category B contingency voltages occurred at Los Banos and were approximately 525-kV in the pre-Project case and approximately 522-kV in the post-Project case.
- The lowest post-Category C contingency voltages also occurred at Los Banos and were approximately 517-kV in the pre-Project case and approximately 508-kV in the post-Project case. However, as discussed above, there were still significant amounts of reactive margin on the system for the most critical outage.

**Project Impacts on Fault Duties**

As discussed in Section 6 pre- and post-Project three-phase short circuit studies indicate that, if PG&E's breaker replacement policy is applied, the Project should not be responsible for replacing any breakers on the PG&E system because the addition of the Project:

- Does not result in an overstressed condition on any breakers.
- Does not increase the stress on a pre-Project overstressed breaker by more than 1%.

**Project-Related Interconnection and Mitigation Costs**

As discussed in Section 7 the estimated costs (exclusive of ITCC) for interconnecting the Project with the Gates 230-kV substation total $5.3 million and include costs associated with:

- Adding one 230-kV line breaker and associated equipment (such as switches, bus work, dead-end structures, and relays) for the line termination, and
- Engineering support related to land and permitting activities.

In addition, and as discussed in Section 7, the estimated costs (exclusive of ITCC) for the Project-related upgrades to existing transmission lines and SPS-related equipment would range from approximately $50 million (if SPS or operating procedures are used to mitigate the Category C overloads on four 230-kV lines and all of the other impacted lines are reconductored) to no cost if all of the impacted lines were re-rated.

## 3. MITIGATION OF OVERLOADS

**Findings in Avenal Project SIS**

Section 10 of the Avenal Project SIS summarized the alternatives that had been identified to mitigate three new Category B overloads and six new Category C overloads. The potential mitigation for these overloads discussed in the Avenal Project SIS included:

- Reconductoring three lines (at an estimated cost of approximately $28.8 million) to mitigate Category B overloads. The pertinent lines and the worst case post-Project overload on each were as follows:
  - Melones-Cottle 230-kV - 1.4%
  - Panoche-Dos Amigos 230-kV - 3.4%
  - Mendota-Tomatak 70-kV - 2.7%
- Reconductoring four 230-kV lines (at an estimated cost of approximately $69 million)2 to mitigate Category C overloads. The pertinent lines and the worst case post-Project overload noted on each were as follows:

[2] Overloads on these lines could also be mitigated by using SPS or operating procedures that would curtail portions of the Project output for the critical outages if both PG&E and CAISO approve the use of such SPS.

- Gates-Panoche #1 230-kV - 6.7%
- Los Banos-Dos Amigos 230-kV - 1.4%
- Panoche-Los Banos #1 and #2 230-kV - 7.2%
- Panoche-Los Banos #2 230-kV - 7.9%

- Reconductoring two lower voltage lines (at an estimated cost of approximately $17.3 million) to mitigate Category C overloads. The pertinent lines and the worst case post-Project overload noted on each were as follows:
  - Oro Loma-El Nido - 4.4%
  - Coppermine-River Rock - 0.4%

With respect to the above lines:

- The Melones-Cottle, Panoche-Dos Amigos, Gates-Panoche, Los Banos-Dos Amigos, and Panoche-Los Banos #2 230-kV lines utilize 795 MCM ACSR conductor and have existing ratings of 742 amps (normal) and 850 amps (emergency).
- The Panoche-Los Banos #1 230-kV line utilizes 1113 AAL conductor and has existing ratings of 825 amps (normal) and 975 amps (emergency).
- The Oro Loma—El Nido 115-kV line utilizes 397.5 AAL conductor and has existing ratings of 440 amps (normal) and 512 amps (emergency).
- The Mendota-Tomatak and Coppermine-River Rock 70-kV lines both utilize 266.8 AAL conductor. The existing ratings of the Mendota-Tomatak line are 338 amps (normal) and 396 amps (emergency) while those of the Coppermine-River Rock 70-kV line are 379 amps (normal) and 437 amps (emergency).

**Potential Re-Rates of Impacted Lines**

As a result of discussions with Energy Commission staff additional investigations were undertaken to determine if the Category B and Category C overloads discussed above could potentially be mitigated by re-rating the pertinent lines. This may be a mitigation option because the new overloads are relatively small in magnitude and because PG&E has, in recent years, re-rated several lines based on an assumed wind speed of 4 feet-per-second (fps) rather than the standard assumed wind speed of 2 fps.

Re-rating of 230-kV Lines

Review of available information on 230-kV lines using 795 MCM ACSR conductors which PG&E has re-rated or plans to re-rate indicates that the normal and emergency ratings for the Melones-Cottle and Panoche-Dos Amigos 230-kV lines applied in the Avenal Project SIS studies are based on a wind speed of 2 fps. This information also indicates that PG&E has re-rated or plans to re-rate at least four 230-kV lines using similar conductors to:

- Increase their normal ratings to as much as 886 amps (a 19% increase), and

- Increase their emergency ratings to as much as 1,000 amps (an increase of 18%)

Re-rates of similar magnitudes on the Melones-Cottle, Panoche-Dos Amigos, Gates-Panoche, Los Banos-Dos Amigos, and Panoche-Los Banos #2 230-kV lines would mitigate the new post-Project Category B and Category C overloads noted on these lines.

Re-rating of 115-kV Lines

Review of available information on PG&E 115-kV lines using 397.5 MCM ACSR conductors indicates that the normal and emergency ratings for the Oro Loma-El Nido 115-kV line applied in these studies are based on a wind speed of 2 fps. This information also indicates that PG&E has re-rated at least one 115-kV line using this conductor to:

- Increase its normal rating to 487 amps (based on a wind speed of 3 fps)
- Increase its emergency rating to 608 amps (based on a wind speed of 4 fps)

Re-rates of a similar magnitude on the Oro Loma-El Nido 115-kV line would mitigate the new post-Project Category C overload noted on this lines.

Re-rating of 70-kV Lines

Review of available information on 70-kV lines using 266.8 AAL conductors which PG&E has re-rated indicates that:

- The normal and emergency ratings for the Mendota-Tomatak 70-kV line applied in these studies are based on a wind speed of 2 fps.
- The normal and emergency ratings for the Coppermine-River Rock 70-kV line applied in these studies are based on a wind speed of greater than 2 fps.
- PG&E has re-rated at least two such lines to:
    - Increase their normal ratings to as much as 411 amps, and
    - Increase their emergency ratings to as much as 474 amps

Re-rates of similar magnitudes on the impacted 70-kV lines would mitigate the new post-Project Category B and Category C overloads noted on them.

## 4. REACTIVE POWER DEFICIENCY ANALYSIS

### Summer Off-Peak Cases

The Avenal Project SIS presented the results of reactive power deficiency studies that were performed on the 2013 Summer Off-Peak case due to the fact that the critical transfer path in the Project area (Path 15) was highly stressed in this case (the south-to-north flows over this Path were modeled at over 99% of the Path's 5,400 MW rating). The results of these studies

are summarized in Table 4-1 and indicate that:

- The minimum reactive margins for all fifteen contingencies studied on the pre-Project case were in excess of 400 MVAR (WECC criteria require that they be greater than 0 MVAR), and
- The addition of the Project increased the reactive margin at the critical bus for all of the outages simulated.

**Table 4-1: Reactive Margin Results – Summer Off-Peak Cases**

| Contingency | Bus with Lowest Reactive Margin | Reactive Margin (MVAR) | | |
|---|---|---|---|---|
| | | Pre-Project | Post-Project | Change |
| **Category B – Path 15 Flows Increased by 5%** | | | | |
| Diablo-Midway 500-kV | Arco 230-kV | 483 | 509 | 26 |
| Gates-Midway 500-Kv | Arco 230-kV | 431 | 478 | 47 |
| Los Banos-Gates #1 500-kV | Arco 230-kV | 454 | 486 | 32 |
| Los Banos-Gates #3 500-kV | Arco 230-kV | 471 | 499 | 28 |
| Los Banos – Midway 500-kV | Arco 230-kV | 426 | 470 | 44 |
| Moss Landing-Los Banos 500-kV | Arco 230-kV | 467 | 497 | 30 |
| Tracy-Los Banos 500-kV | Arco 230-kV | 457 | 489 | 32 |
| Tesla-Los Banos 500-kV | Arco 230-kV | 455 | 487 | 33 |
| **Category C – Path 15 Flows Increased by 2.5%** | | | | |
| Diablo-Midway #1 & #2 500-kV | Arco 230-kV | 475 | 500 | 25 |
| Los Banos-Tesla & Los Banos-Tracy 500-kV [3] | Arco 230-kV | 463 | 489 | 26 |
| Los Banos-Midway & Los Banos-Gates 500-kV [3] | Arco 230-kV | 427 | 462 | 35 |
| Midway-Gates & Midway-Los Banos 500-kV [3] | Arco 230-kV | 420 | 478 | 58 |
| Gates-Gregg & Gates McCall 230-kV | Arco 230-kV | 474 | 503 | 29 |
| Gates-Panoche #1 & #2 230-kV | Arco 230-kV | 466 | 495 | 29 |
| **Two Unit Outage – No Path 15 Increase** | | | | |
| Diablo 2-Unit Trip | Arco 230-kV | 566 | 578 | 12 |

### Summer On-Peak Cases

As a result of discussions with Energy Commission staff reactive power deficiency studies were also performed on the 2013 Summer On-Peak case which modeled high north-to-south flows over Path 26 (the flows in the case were equal to approximately 99% of the 4,000 MW rating of the Path). The results of these studies are summarized in Table 4-2 and indicate that, as was the situation for the Summer Off-Peak cases:

[3] Includes Path 15 RAS.

- The minimum reactive margins for all fifteen contingencies studied on the pre-Project case were in excess of 400 MVAR (WECC criteria require that they be greater than 0 MVAR), and
- The addition of the Project increased the reactive margin at the critical bus for all of the outages simulated.

**Table 4-2: Reactive Margin Results – Summer On-Peak Cases**

| Contingency | Bus with Lowest Reactive Margin | Reactive Margin (MVAR) | | |
|---|---|---|---|---|
| | | Pre-Project | Post-Project | Change |
| **Category B – Path 15 Flows Increased by 5%** | | | | |
| Diablo-Midway 500-Kv | Arco 230-kV | 431 | 511 | 80 |
| Gates-Midway 500-kV | Arco 230-kV | 503 | 510 | 7 |
| Los Banos-Gates #1 500-kV | Arco 230-kV | 498 | 506 | 8 |
| Los Banos-Gates #3 500-kV | Arco 230-kV | 501 | 509 | 8 |
| Los Banos - Midway 500-kV | Arco 230-kV | 500 | 507 | 7 |
| Moss Landing-Los Banos 500-kV | Arco 230-kV | 505 | 513 | 8 |
| Tracy-Los Banos 500-kV | Arco 230-kV | 502 | 510 | 8 |
| Tesla-Los Banos 500-kV | Arco 230-kV | 504 | 512 | 8 |
| **Category C – Path 15 Flows Increased by 2.5%** | | | | |
| Diablo-Midway #1 & #2 500-kV | Arco 230-kV | 472 | 483 | 11 |
| Los Banos-Tesla & Los Banos-Tracy 500-kV | Arco 230-kV | 494 | 502 | 8 |
| Los Banos-Midway & Los Banos-Gates 500-kV | Arco 230-kV | 477 | 484 | 7 |
| Midway-Gates & Midway-Los Banos 500-kV | Arco 230-kV | 495 | 505 | 10 |
| Gates-Gregg & Gates McCall 230-kV | Arco 230-kV | 494 | 507 | 13 |
| Gates-Panoche #1 & #2 230-kV | Arco 230-kV | 488 | 499 | 11 |
| **Two Unit Outage – No Path 15 Increase** | | | | |
| Diablo 2-Unit Trip | Arco 230-kV | 510 | 519 | 9 |

## 5. POST-TRANSIENT POWERFLOW VOLTAGE ANALYSIS

As the result of discussions with Energy Commission staff post-transient powerflow studies were performed to assess Project-related impacts on post-contingency voltages on the 500-kV busses in northern California when the 500-kV Category B and C line outages listed in Tables 4-1 and 4-2 were simulated on the pre- and post-Project Summer Peak and Summer Off-Peak cases. The results of these studies were then reviewed to:

- Identify the 500-kV bus(es) at which the largest decrease in post-contingency voltages occurred between the pre- and post-Project cases.
- Document the post-contingency voltages at these busses for both the pre- and post-Project cases.

**Summer Off-Peak Cases**

Table 5-1 summarizes the results of this analysis for the Summer Off-Peak cases. The information in Table 5-1 shows that:

- The Malin 500-kV bus was the most impacted for all of the contingencies studied.
- The addition of the Project had very little impact on the post-contingency voltages at the Malin 500-kV bus for all outages.

**Table 5-1: Post-Transient Powerflow Voltage Analysis – Summer Off-Peak Cases**

| Contingency | Bus With Largest Voltage Decreases | Post-Outage Voltage (kV) | | |
|---|---|---|---|---|
| | | Pre-Project | Post-Project | Change |
| **Category B** | | | | |
| Diablo-Midway 500-kV | Malin 500-kV | 537.8 | 537.7 | (0.1) |
| Gates-Midway 500-kV | Malin 500-kV | 537.6 | 527.7 | 0.1 |
| Los Banos-Gates #1 500-kV | Malin 500-kV | 536.6 | 536.6 | 0.0 |
| Los Banos-Gates #3 500-kV | Malin 500-kV | 536.9 | 536.8 | (0.1) |
| Los Banos – Midway 500-kV | Malin 500-kV | 537.2 | 537.3 | 0.1 |
| Moss Landing-Los Banos 500-kV | Malin 500-kV | 536.1 | 536.1 | 0.0 |
| Tracy-Los Banos 500-kV | Malin 500-kV | 536.8 | 536.7 | (0.1) |
| Tesla-Los Banos 500-kV | Malin 500-kV | 536.6 | 536.5 | (0.1) |
| **Category C** | | | | |
| Diablo-Midway #1 & #2 500-kV | Malin 500-kV | 538.2 | 538.1 | (0.1) |
| Los Banos-Tesla & Los Banos-Tracy 500-kV | Malin 500-kV | 550.3 | 550.0 | (0.3) |
| Los Banos-Midway & Los Banos-Gates 500-kV | Malin 500-kV | 539.3 | 539.2 | (0.1) |
| Midway-Gates & Midway-Los Banos 500-kV | Malin 500-kV | 548.2 | 548.1 | (0.1) |

These studies also showed that the addition of the Project increased both the pre- and post-contingency voltages at the 500-kV busses in the Project area. For example, the lowest Category B post-contingency voltage at Gates (resulting from an outage of the Los Banos-Midway line) was approximately 503-kV in the pre-Project case and was approximately 508-kV in the post-Project case.

**Summer On-Peak Cases**

Table 5-2 summarizes the results of a similar analysis for the Summer Peak cases. The information in Table 5-2 shows that:

- The greatest decreases in post-contingency voltages occurred at the Vaca-Dixon and Los Banos 500-kV busses.

- The post-Category B contingency voltage at Los Banos (resulting from an outage of the Los Banos-Gates #1 line or the Los Banos-Gates #3 line) was approximately 525-kV in the pre-Project case and was approximately 522-kV in the post-Project case.
- The post-Category C contingency voltage at Los Banos (resulting from an outage of the Los Banos-Midway and Los Banos-Gates lines) was approximately 517-kV in the pre-Project case and was approximately 508-kV in the post-Project case. However, as shown in Table 4-2 there was still significant amounts of reactive margin on the system after this outage.
- The post-Category C contingency voltages at all of the other busses for both the pre- and post-Project cases were well in excess of 520-kV.

**Table 5-2: Post-Transient Powerflow Voltage Analysis – Summer Peak Cases**

| Contingency | Bus With Largest Voltage Decreases | Post-Outage Voltage (kV) | | |
|---|---|---|---|---|
| | | Pre-Project | Post-Project | Change |
| **Category B** | | | | |
| Diablo-Midway 500-kV | Vaca Dixon 500-kV | 528.8 | 526.3 | (2.5) |
| Gates-Midway 500-kV | Los Banos 500-kV | 528.6 | 526.0 | (2.6) |
| Los Banos-Gates #1 500-kV | Los Banos 500-kV | 525.3 | 522.2 | (3.1) |
| Los Banos-Gates #3 500-kV | Los Banos 500-kV | 524.9 | 522.2 | (2.7) |
| Los Banos – Midway 500-kV | Los Banos 500-kV | 529.6 | 526.7 | (2.9) |
| Moss Landing-Los Banos 500-kV | Vaca Dixon 500-kV | 526.9 | 523.9 | (3.0) |
| Tracy-Los Banos 500-kV | Vaca Dixon 500-kV | 528.1 | 525.4 | (2.7) |
| Tesla-Los Banos 500-kV | Vaca Dixon 500-kV | 527.1 | 524.2 | (2.9) |
| **Category C** | | | | |
| Diablo-Midway #1 & #2 500-kV | Vaca Dixon 500-kV | 526.4 | 524.0 | (2.4) |
| Los Banos-Tesla & Los Banos-Tracy 500-kV | Vaca Dixon 500-kV | 526.0 | 522.4 | (3.6) |
| Los Banos-Midway & Los Banos-Gates 500-kV | Los Banos 500-kV | 516.5 | 508.1 | (8.4) |
| Midway-Gates & Midway-Los Banos 500-kV | Los Banos 500-kV | 531.2 | 527.7 | (3.5) |

## 6. SHORT CIRCUIT STUDY RESULTS

Table 6-1 contains information on the minimum ratings of breakers interconnected with nine busses in the area of the Project as well as information on the available pre- and post-Project short circuit duty at the buses. As shown in Table 6-1:

- The three-phase pre-Project short circuit duty at the McCall 230-kV Bus Section B1 exceeds the minimum breaker rating at this bus by approximately 64%; the addition of the Project increases the fault duty at this bus by less than 0.5%
- The three-phase pre-Project short circuit duty at the Midway 230-kV Bus Section D exceeds the minimum breaker rating at this bus by approximately 0.4%; the addition of the Project increases the short circuit duty at this bus by less than 0.5%.

- The addition of the Project increases the short circuit duty at the Gates 230-kV bus by approximately 13%; however, even with this increase, the post-Project fault duty is approximately 3% lower than the minimum rating of the Gates 230-kV breakers.
- The addition of the Project increases the short circuit duty at the other six busses by 2.4% or less.

**Table 6-1: Short Circuit Study Results**

| Fault Location | Minimum Breaker Rating (Amps) | Pre-Project | | Post-Project Fault Current (Amps) | Increase in Fault Current (%) |
|---|---|---|---|---|---|
| | | Fault Current (Amps) | % of Minimum Rating | | |
| **Overstressed Breakers** | | | | | |
| McCall 230-KV Bus B1 | 12,551 | 20,566 | 163.8 | 20,636 | 0.34 |
| Midway 230-KV Bus D | 63,000 | 63,267 | 100.4 | 63,573 | 0.48 |
| **Other Breakers** | | | | | |
| Gates 230-kV Bus | 39,500 | 33,947 | <90 | 38,443 | 13.24 |
| Henrietta 230-KV Bus | 40,000 | 14,175 | <90 | 14,514 | 2.39 |
| Gates 500-kV Bus | 40,000 | 26,252 | <90 | 26,721 | 1.79 |
| Gregg 230-kV Bus | 40,000 | 22,895 | <90 | 22,921 | 0.11 |
| Arco 230-kV Bus | [4] | 8,000 | | 8,084 | 1.05 |
| Gates 70-kV Bus | [4] | 12,430 | | 12,499 | 0.56 |
| Gates 115-kV Bus | [4] | 8,474 | | 8,553 | 0.93 |

PG&E uses the following policy to allocate breaker replacement responsibility for projects that overstress or increase the level of overstress on existing circuit breakers:

- If a breaker is not overstressed before the project, and the project results in an overstressed condition of the breaker, then the project is responsible for the cost of replacement.
- If a breaker is already overstressed, and a project increases the overstress by 5% or more, or the post-project overstress level exceeds 25%, then the project is responsible for the cost of replacement.
- If the overstress level exceeds 25% before the project, and for all other circumstances, PG&E or other generation projects will be responsible for any replacement costs.

Applying the above policy results in the conclusion that the Project should not be responsible for replacing any breakers on the PG&E system because the addition of the Project:

- Does not result in an overstressed condition on any breakers

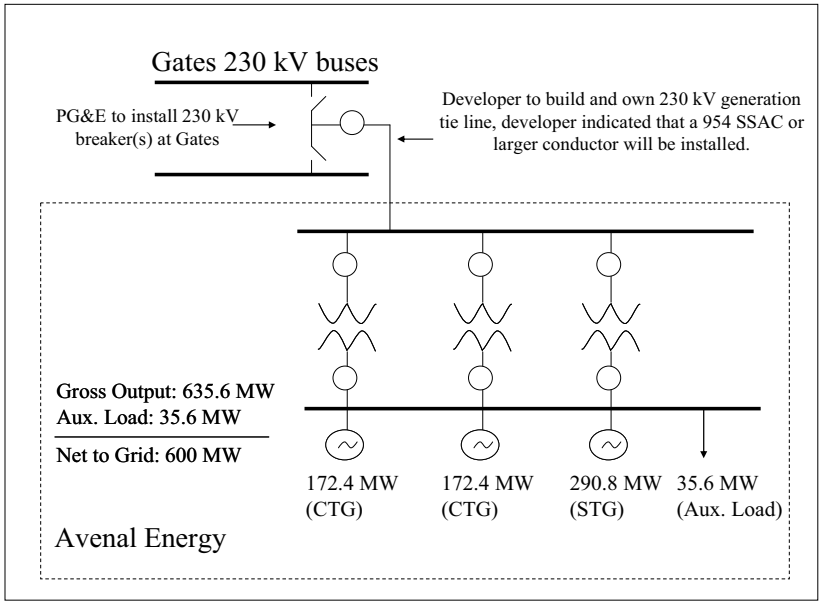
[4] Information not yet provided by PG&E.

- Does not increase the stress on a pre-Project overstressed breaker by more than 0.5%

## 7. COST ESTIMATES FOR INTERCONNECTION AND SYSTEM UPGRADES

Review of satellite imagery of the Gates 230-kV substation indicates that there is sufficient space within the existing switchyard footprint to add the circuit breaker and associated equipment (such as switches, bus work, dead-end structures, and relays) required to terminate the tie line from the Project as generally depicted in Figure 7-1.

**Figure 7-1 – Project Interconnection at Gates**




The estimated costs associated with adding these facilities (exclusive of ITCC) presented in the March 24, 2008 Interconnection Feasibility Study Report completed by the CAISO for the Project are summarized in Table 7-1. Table 7-1 also summarizes estimated Project-related system upgrade costs for three different mitigation scenarios, as follows:

**Scenario 1**

- SPS or an operating procedure is used to mitigate the Category C impacts on the Gates-Panoche, Los Banos-Dos Amigos, and Panoche-Los Banos #1 and #2 230-kV lines, and
- The other impacted lines are reconductored.

**Scenario 2**

- SPS or an operating procedure is used to mitigate the Category C impacts on the four 230-kV lines discussed above,

- The Category B overload on the Melones-Cottle A 230-kV line is mitigated by re-rating the line,
- The Category C overloads on the Oro Loma-El Nido and Coppermine-River Rock 70-kV lines are mitigated by re-rating the lines or by use of operating procedures, and
- The other impacted lines are reconductored.

**Scenario 3**

- All of the impacted lines are re-rated.

**Table 7-1 – Estimated Interconnection and Upgrade Costs**

| Description | Estimated Costs ($Millions) | | |
|---|---|---|---|
| | Scenario 1 | Scenario 2 | Scenario 3 |
| **Interconnection Facilities** | | | |
| Provide support for one line position at Gates and general support at the Project site | 2.0 | 2.0 | 2.0 |
| Land engineering support and permitting activities | 0.1 | 0.1 | 0.1 |
| Expand Gates substation (add buswork and line termination) [5] | 3.2 | 3.2 | 3.2 |
| *Total Estimated Cost for Interconnection* | *5.3* | *5.3* | *5.3* |
| **Upgrades to Mitigate Category B Impacts** | | | |
| Melones-Cottle A 230-kV line | 12.0 | 0.0 | 0.0 |
| Panoche-Dos Amigos 230-kV line | 12.0 | 12.0 | 0.0 |
| Mendota-Toamtak 70-kV line | 4.8 | 4.8 | 0.0 |
| *Subtotal – Category B Mitigation* | *28.8* | *16.8* | *0.0* |
| **Upgrades to Mitigate Category C impacts** | | | |
| Gates-Panoche #1 230-kV line [6] | 0.0 | 0.0 | 0.0 |
| Los Banos-Dos Amigos 230-kV line [6] | 0.0 | 0.0 | 0.0 |
| Panoche-Los Banos #1 230-kV line [6] | 0.0 | 0.0 | 0.0 |
| Panoche-Los Banos #2 230-kV line [6] | 0.0 | 0.0 | 0.0 |
| Oro Loma-El Nido 115-kV line | 14.0 | 0.0 | 0.0 |
| Coppermine-River Rock 70-kV line | 3.3 | 0.0 | 0.0 |
| *Subtotal – Category C Mitigation* | *17.3* | *0.0* | *0.0* |
| **Costs for SPS Equipment** | 4.0 | 4.0 | 0.0 |
| *Total Estimated Costs for Upgrades* | *50.1* | *20.8* | *0.0* |
| *Total Estimated Costs* | *55.4* | *26.1* | *5.3* |

As shown in Table 7-1:

[5] As discussed above there is sufficient space within the existing switchyard footprint to accommodate these additions.

[6] Overloads mitigated by SPS in Scenarios 1 and 2; by re-rates in Scenario 3.

- The total estimated interconnection and upgrade costs for Scenario 1 would be $55.4 million.
- The total estimated interconnection and upgrade costs for Scenario 2 would be $26.1 million.
- The total estimated interconnection and upgrade costs for Scenario 3 would be $5.3 million.

This Supplement and additional analysis, prepared to address certain items that resulted from discussion with Energy Commission staff regarding the Avenal Project SIS, should be taken in conjunction with the System Impact Study performed by Navigant Consulting Inc. and docketed with the Energy Commission on September 19, 2008.