Docket No.: R.12-03-014

Exhibit No.: ____________________

Date: July 23, 2012

Witness: ________________________

TRACK 1 REPLY TESTIMONY
OF CALPINE CORPORATION

DWT 19983163v1 0041036-000401

Q. Please state your name and title.

A. My name is Ron Calvert, P.E. I am a Senior Power Systems Engineer at Utility System Efficiencies, Inc. ("USE"), a power system engineering consulting firm based in Carmichael, California.

Q. Please describe your professional background.

A. I have over 20 years of experience in transmission system operations and planning in the Western Electricity Coordinating Council ("WECC") Region, including work experience with the Pacific Gas and Electric Company and the California Independent System Operator Corporation ("CAISO"). More detailed information about my professional background is provided in Attachment A.

Q. What does your reply testimony address?

A. My reply testimony addresses issues raised in direct testimony regarding the need to procure new generation resources to meet local capacity requirements ("LCR") in the Big Creek/Ventura area and Moorpark sub-area, located in southern California. On behalf of Calpine Corporation ("Calpine"), USE performed a preliminary power flow analysis of the Moorpark sub-area. My testimony demonstrates that there are potential transmission solutions that may reduce or eliminate the need for new generation to satisfy LCR needs associated with the retirement of once-through-cooling ("OTC") units.

In its direct testimony, the Division of Ratepayer Advocates ("DRA") states that there is no immediate need for new LCR generation in the Big Creek/Ventura area and that ongoing review of LCR needs in the Moorpark sub-area is necessary.[1] Southern California Edison ("SCE") further recommends that the Commission defer authorizing the procurement of new generation in the Big Creek/Ventura area.[2]

While I believe it is likely that the California Public Utilities Commission ("Commission") and CAISO will need to take action at some point in the future to address reliability needs in response to OTC retirements, I agree with DRA that, at a minimum, further analysis of the Moorpark sub-area is needed before authorization to procure new generation in the Big Creek/Ventura area is granted. My analysis suggests that there are potential transmission upgrades that may reduce or eliminate the need for OTC replacement generation in the Big Creek/Ventura area. Adoption of SCE's recommendation to defer authorizing the procurement of new LCR generation in the Big Creek/Ventura area should provide the Commission, the CAISO, and SCE with sufficient time to further evaluate the effectiveness of these upgrades (either individually or some combination thereof) and/or develop additional alternatives.

Q. Please describe the analysis you have undertaken.

A. I performed a series of power flow analyses for the Moorpark LCR sub-area, similar to the analyses supporting the testimony of the CAISO's Robert Sparks. I reviewed the inputs used in the CAISO's analysis and, to the best of my knowledge, my analysis is

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[1] *See* Testimony of Robert M. Fagan on Behalf of DRA at 27.

[2] *See* 2012 Long-Term Procurement Plan – Testimony of Southern California Edison Company on Local Capacity Requirements (Minick) at 10-11.

based on the same inputs used by the CAISO in its Trajectory Case scenarios.[3] In addition, my analysis uses the same or similar tools and examines reliability under the same set of contingencies examined by the CAISO.

Although the CAISO's analysis and my analysis use similar inputs, our respective studies sought different objectives. The purpose of the CAISO's analysis is to identify the potential "need" to retain existing local OTC generation capacity for forecasted system conditions.[4] The objective of my analysis is to identify non-generation alternatives that would yield a similar level of system performance and reliability as retaining/replacing 430 MW of OTC generation in the Moorpark sub-area.

As a starting point, I sought to replicate the results achieved in the CAISO's OTC analysis of the Moorpark sub-area. I then developed and simulated several transmission reinforcement alternatives by modifying the representation of the transmission system in the power flow model, and tested the performance of these alternatives by analyzing various sets of contingencies (*e.g.*, outages of different combinations of transmission lines and resources).

As discussed below, I identified three potential transmission upgrades that may reduce or eliminate the need for OTC replacement generation in the Big Creek/Ventura area. I

[3] USE's analysis primarily utilized a 2021 (RPS) Trajectory scenario power flow case ("2021_peak_traj_moorpark_sav.sav") available through the CAISO's Market Participant Portal website: https://portal.caiso.com/TP/Pages/default.aspx. This power flow case was downloaded from the Transmission Planning page under the directory "Studies: 2011/2012 ISO Transmission Planning Process, OTC Basecases."

[4] Testimony of Robert Sparks on Behalf of the California Independent System Operator Corporation ("Sparks Testimony") at 2.

have not, however, examined in detail the feasibility and/or cost effectiveness of each of these options. As would be the case for any proposed new resource addition or transmission upgrade, detailed evaluations and analyses should be performed to determine feasibility and cost effectiveness before moving ahead with specific procurement or projects.

Q. Please describe the relationship between the Moorpark sub-area and the Big Creek/Ventura local area.

A. The Moorpark sub-area is located within the larger Big Creek/Ventura local area. As discussed in Mr. Sparks' Testimony, "[t]he need for replacement OTC units in the overall Big Creek/Ventura area is established specifically by the Moorpark sub-area."[5] In other words, the need for OTC replacement generation in the Big Creek/Ventura local area is driven by the need to support sub-area reliability requirements in the Moorpark sub-area, not reliability requirements for the LCR area as a whole.

Figure 1 shows the Moorpark sub-area of the Big Creek/Ventura local area.

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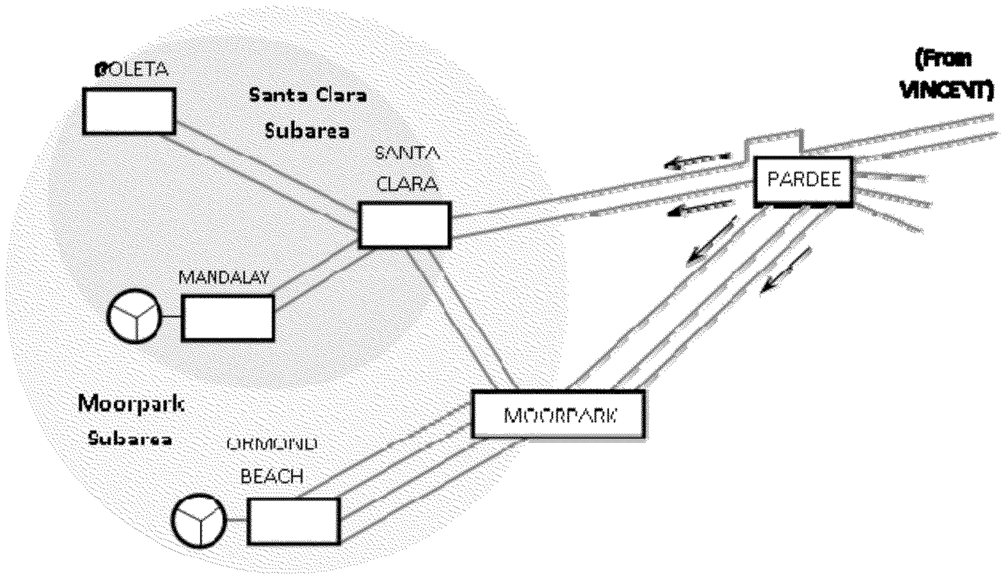
[5] Sparks Testimony at 14.

Figure 1: Moorpark Sub-Area[6]



As shown in Figure 1, the Moorpark sub-area is served by five 230 kV lines. Four of these lines originate at the Pardee substation and one originates at the Vincent substation. The Moorpark subarea is primarily defined by several contingencies involving the simultaneous loss of more than one of these five lines. Presently, OTC generating units in this sub-area consist of Mandalay Units 1 & 2 (combined 430 MW) and Ormond Beach Units 1 & 2 (combined 1,516 MW).

Q. What are the results of your analysis?

A. My analysis identifies three potential transmission upgrades that may reduce or eliminate the need for OTC replacement generation in the Big Creek/Ventura area. Table 1 summarizes the results of my analysis:

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[6] Figure 1 also shows the Santa Clara sub-area, a smaller sub-area nested within the Moorpark sub-area.

Table 1: Summary of Results

Option		OTC Replacement Generation (MW)	Post-Contingency Load Shedding (MW)	Estimated Transmission Cost
	CAISO OTC Study	430	340	
1	Vincent-Santa Clara Loop-in	215	390	$9 Million
2	Vincent/Pardee-Santa Clara Series Capacitors	0	590[7]	$28 Million
3	New Pardee-Moorpark Line	0	300	$32-40 Million

The columns in Table 1 show the simulated scenario, the assumed amount of OTC replacement generation, the amount of post-contingency load shedding needed to respond to extreme contingencies, and a rough cost estimate for each of the transmission upgrades considered.[8]

Similar to the CAISO's analysis, I assumed that any OTC replacement generation would be located at the site of the current Mandalay OTC units or at electrically equivalent locations. My analysis indicated that for the Moorpark sub-area's critical contingency (loss of all three Pardee-Moorpark 230 kV lines) all the alternatives considered would avoid voltage collapse for the Moorpark sub-area. However, for the post-contingency condition, all the alternatives – including adding 430 MW of OTC replacement generation as described in the CAISO's testimony – would require some amount of post-contingency load shedding to maintain/restore the system within applicable thermal limits.

[7] For Option 2, the additional retirement of Mandalay Unit 3 (130 MW combustion turbine) may be accommodated with additional shunt capacitor installations of 50 MVAR each at the Goleta and Santa Clara substations, along with a post-contingency load shedding expectation of 725 MW.
[8] SCE and/or the CAISO would be better positioned to provide more detailed cost estimates.

Q. What is post-contingency load shedding?

A. Transmission Planning standards established by the North American Electric Reliability Corporation and the WECC are designed to ensure the development of a reliable bulk transmission system which meets specified operational/performance requirements. For contingencies involving multiple elements, these standards allow for the temporary controlled interruption of electric supply to customers (*i.e.*, load shedding) to avoid uncontrolled/cascading outages (such as voltage collapse) and/or to maintain and restore the system's thermal loading and voltage conditions within applicable limits and equipment ratings.

Q. Did you consider the cost of generation in your modeling?

A. I did not consider the cost of new generation in my modeling but it is my understanding from talking with Dr. Barmack[9] that the cost to develop and build 430 MW of new generation capacity would be approximately $500 Million.

Q. Please describe each of the three potential transmission upgrades identified in Table 1 above.

A. Option 1: Vincent-Santa Clara Loop-in

Currently, the Vincent-Santa Clara 230kV line bypasses the Pardee substation (*see* Figure 1). Connecting this line through the Pardee substation should yield additional reliability benefits. For the most extreme contingency considered in both the CAISO's analysis and my analysis (outage of all three Pardee-Moorpark lines), this option provides a better

[9] Dr. Barmack provided Opening Testimony on behalf of Calpine in this proceeding.

balance of flows (and better reactive support) on the surviving import lines into the Santa Clara substation.[10] To further mitigate voltage collapse concerns, this option includes 100 MVAR of shunt reactive support (shunt capacitors, Static VAR Devices, or Static VAR Compensation) at the Goleta substation to offset/replace the reactive support formerly provided by local generation. This reinforcement would involve adding two 230 kV circuit breakers at the Pardee substation, and 100 MVAR shunt capacitors at the Goleta 230 kV substation. The estimated cost of these upgrades would be approximately $9 Million.

Option 2: Vincent/Pardee-Santa Clara Series Capacitors

The Vincent-Santa Clara and Pardee-Santa Clara circuits exhibit large reactive losses (*i.e.*, MVAR consumption) during post-contingency conditions. For this option, 230 kV series capacitors would be added to the existing Vincent-Santa Clara and Pardee-Santa Clara 230 kV lines to reduce the net series impedance/inductive reactance on these circuits. This option assumes that the Pardee-Santa Clara 230 kV line would be 45% series-compensated, while the Vincent-Santa Clara 230 kV line would be 63% series-compensated. To further mitigate against voltage collapse, 230 kV shunt capacitors would be added at the following substations: Goleta (50 MVAR), Santa Clara (100 MVAR), and Moorpark (50 MVAR). To further avoid emergency thermal overloads of the Vincent/Pardee-Santa Clara 230 kV lines during an N-2 outage of two Pardee-Moorpark 230 kV lines (the Moorpark subarea's next most-limiting contingency

[10] Similarly, this alternative would help meet the reliability needs of the Santa Clara sub-area, providing a stronger surviving Santa Clara source and helping to avoid voltage collapse for the Santa Clara sub-area's limiting contingency (loss of the two Santa Clara-Moorpark 230 kV lines combined with an outage of the Pardee-Santa Clara 230 kV line).

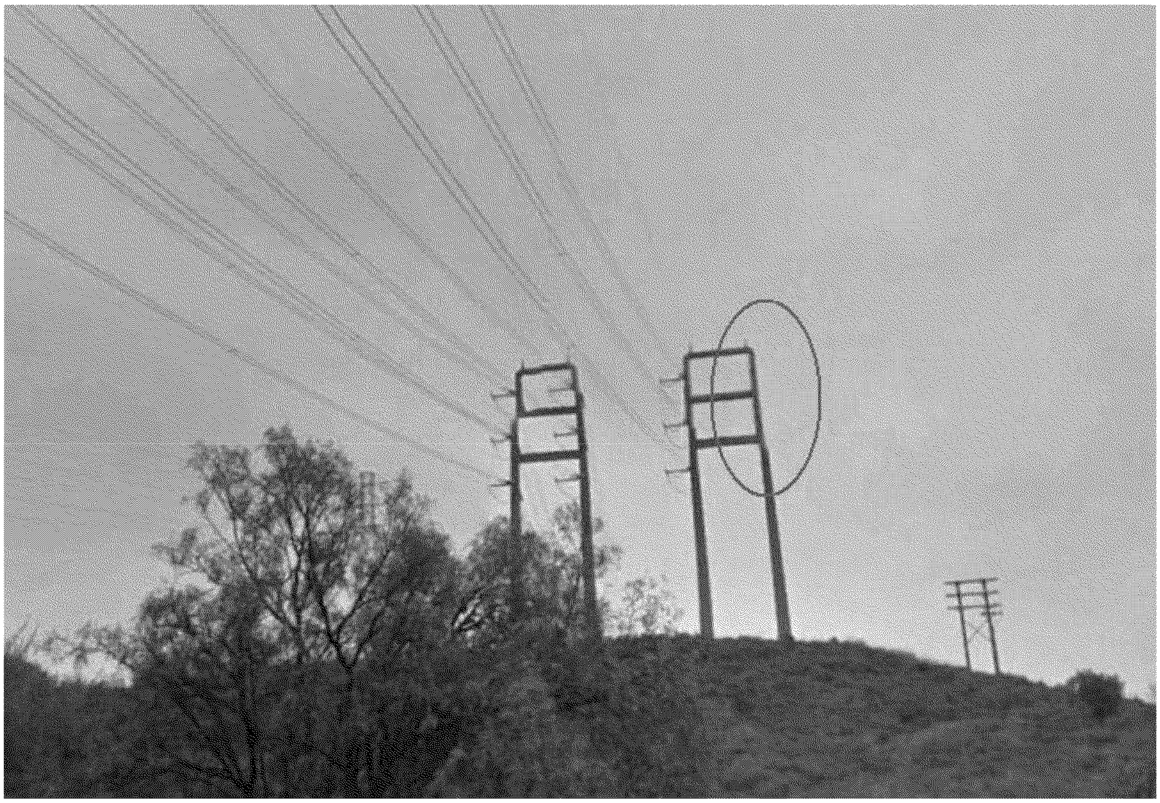
examined by the CAISO), this option assumes that restrictive circuit elements (*e.g.*, terminal equipment, switches, wave traps, line sag) in the Vincent/Pardee-Santa Clara 230 kV lines would be upgraded to provide a higher emergency rating for these circuits.[11] The combined cost for all these upgrades is roughly estimated at $28 Million.[12]

<u>Option 3: New Pardee-Moorpark Line</u>

This option includes construction of a fourth Pardee-Moorpark circuit, to mitigate the outage of the existing three Pardee-Moorpark lines (the contingency upon which the CAISO's estimate of the need for OTC replacement generation is predicated). As shown in Figure 2, Google Street View images show that a vacant circuit position appears to be available on the two tower lines which run between Moorpark and Pardee. In addition to adding a fourth Pardee-Moorpark circuit, shunt capacitors would be added at the Goleta (100 MVAR) and Santa Clara (100 MVAR) substations.[13] The estimated cost of this reinforcement would be approximately $32-40 Million.

[11] Currently, the "normal" and "emergency" ratings for these circuits are the same.
[12] As a placeholder to account for the upgrade of restrictive circuit elements in the Vincent/Pardee-Santa Clara 230 kV lines, this cost estimate assumes the replacement of four circuit breakers.
[13] These capacitor additions are needed to help avoid voltage collapse for the loss of the two Santa Clara-Moorpark 230 kV lines combined with an outage of the Pardee-Santa Clara 230 kV line.

Figure 2: Vacant Circuit Position on a Pardee-Moorpark 230 kV Tower



Q. Are there other potential options that you believe may reduce or eliminate the need for OTC replacement generation in the Moorpark sub-area that would provide levels of reliability similar to adding 430 MW of new generation?

A. Yes. Options such as upgrading elements that limit the normal and emergency ratings on the Pardee-Moorpark #2 and #3 lines, converting existing OTC units to synchronous condensors, reconductoring the Vincent-Santa Clara/Pardee-Santa Clara 230 kV lines, and/or installing a new 230 kV line between the Ormond Beach and Mandalay substations could (also) potentially help reduce or eliminate the need for OTC replacement generation in the Moorpark LCR sub-area. Because of time limitations, I was not able to more fully study these other options, but I believe they merit further analysis.

Q. In its testimony, SCE states that "[t]here are a limited number of non-generation options to meet LCR need" in the LA Basin. Did you consider the ability of transmission upgrades to reduce the need for OTC replacement the LA Basin?

A. I have not undertaken a similar analysis of the LA Basin LCR area. However, as is the case with the Big Creek/Ventura local area, I believe there could also be transmission upgrades in the LA Basin that potentially could reduce the need for OTC replacement generation. As would be the case for any proposed new resource addition or transmission upgrade, more detailed evaluations and analyses should be performed to determine feasibility, cost effectiveness and overall benefit before moving ahead with specific procurement or projects.

Q. Does this conclude your Track 1 reply testimony?

A. Yes.

ATTACHMENT A

Ron R. Calvert, P.E.
Senior Electrical Power Systems Engineer

Academic Background

- B.S. Electrical & Electronic Engineering, with a specialty in Power Systems Engineering, Washington State University, Pullman, WA 1991

Professional Experience

Ron Calvert has worked in the electric utility industry since 1991 – spanning both transmission system planning & operations engineering. He is proficient in the use of analytic tools for evaluating system performance and is well-versed in the capital planning processes used by electric utilities. In recent years as an Operations Engineering Manager at the California ISO (CAISO), he has also mentored and coached other engineers in power engineering analysis. Mr. Calvert joined Utility System Efficiencies, Inc. (USE) in October 2005.

As an Engineer-in-Training for Pacific Gas and Electric Company's (PG&E) Power Control Operations Management department, Mr. Calvert helped evaluate Energy Management System (EMS) Network Model database and Real Time Sequence functions. Mr. Calvert assisted in cross-comparing PG&E's PTI power flow model with validated EMS telemetry, and reviewed Substation Demand Logs and other sources of operational information to discern database errors and anomalies.

As a Transmission Engineer in PG&E's East Bay Region, Mr. Calvert played a key role in coordinating meetings, monitoring project status, and preparing costs to provide transmission service at three different sites for the expanding Bay Area Rapid Transit system. This work also included developing and evaluating several different transmission service alternatives, which provided experience in interacting on technical, land/environmental, and EMF issues.

As a Transmission Planning Engineer with PG&E, Mr. Calvert was responsible for planning the long and short-range 60-500kV transmission needs of the San Francisco Bay Area, as well as other parts of the PG&E system. This work included load forecasting, and performing steady state and transient power flow analysis, voltage and reactive margin analysis, under both deterministic and probabilistic contingency planning. Part of this work also included coordinating and planning new Transmission Customer connections (Independent Power Producers and Industrial Loads) for customers seeking "direct access." Mr. Calvert translated study results into recommended transmission projects, which were then approved and budgeted for accurately-timed system improvements to reliably and economically serve local customers.

At the advent of industry restructuring in 1996-7, understanding PG&E's electrical transmission system became a critical factor in developing policies around reliability must-run generation. Because of his familiarity with the system and ability to provide technical guidance and clear explanations regarding PG&E transmission constraints, Mr. Calvert helped co-author "Appendix B: PG&E Must-Run Requirements" for PG&E's July 19, 1996 FERC Filing on Market Power. Mr. Calvert was also selected as one of PG&E's key Task Force members to participate and contribute to the first "California ISO Transmission Reliability Study" to determine must-run generation requirements (also known as the PTI Must-Run Study).

In 1997, Mr. Calvert's PG&E experiences led him to a new career with the CAISO. As a CAISO Grid Planning Engineer, Mr. Calvert was responsible for defining the San Francisco Bay Area Reliability Must-Run requirements in the first ISO-sponsored (RMR) assessment. Mr. Calvert was also responsible for reviewing the long-term transmission/generation needs for San Diego Gas & Electric's service territory, and providing technical review to new SCE/ISO-connecting generation projects such as the El Dorado Merchant combined cycle plant.

As an Operations Engineer for the CAISO Operations Engineering group, Mr. Calvert performed GE PSLF power flow and transient stability analysis, mentored new Operations Engineers, and provided training in the CAISO's Operations Support and Training's "Summer Seminars" for the CAISO Dispatchers, highlighting potential summer problems and solutions for the Bay Area. In order to ensure reliable system operation of these regions, Mr. Calvert was responsible for the development, review and revision of operating procedures, and engineering evaluation of system clearances and outages. Sometimes this support and expertise was called upon during real-time emergencies: during a Bay Area heat wave in June 2000, Mr. Calvert was one of a handful of engineers responsible for assessing the system's reliability under stressed conditions of potential voltage collapse, and helped determine load-shedding requirements. Mr. Calvert's Operations Engineer responsibilities also included composing Western System Coordinating Council (WSCC) disturbance reports in the wake of events such as the August 1999 Moss Landing Disturbance, evaluating recoded data, piecing together contributing factors and formulating future recommendations. Mr. Calvert was later promoted to Manager, overseeing CAISO's Operations Engineering staff for the PG&E/Northern Area.

In August 2003, Mr. Calvert began managing the CAISO's Loads & Resources/Network Applications group. Mr. Calvert helped lead Loads and Resources staff members in the timely and accurate development of seasonal Assessments of Resource Adequacy for the CAISO Area, evaluating the forecasted acceptability of system operating reserves. This work included developing load forecasts, evaluating system generating capacity, monitoring resource-related environmental issues, and tracking new generation additions/retirements. Mr. Calvert helped compose and present report findings for internal use and for submittal to regulatory agencies, including the North American Electric Reliability Corporation (NERC), Western Electricity Coordinating Council (WECC), Federal Energy Regulatory Commission (FERC), California Energy Commission (CEC), California Public Utilities Commission (CPUC), and the California State Senate, Legislature, and Governor's Office.

In his responsibilities managing the Network Applications group, Mr. Calvert supported 3-8 engineers in the technical design and start-up development of the CAISO's ABB Ranger EMS State Estimator, Advanced Applications, and the Network Model. Mr. Calvert helped facilitate internal and external communication: developing and actively promoting a vision for the EMS State Estimator and Advanced Applications, including managing expectations of how these new tools might change the roles of various CAISO departments. Deployment of the CAISO Network Model required coordination with and cross-checking of, the various power flow models and contingency definitions used by the CAISO engineering staff, California utilities, and WECC. This work also included managing complexities of several different aspects of the project, including: real-world experience in the feasibility and use of Common Information Model (CIM) format, CIM model usage by other software vendors (Siemens, Areva), support of the WECC West-Wide Model vision, and future uses of the Network Model and SE solution in the CAISO's future Market Redesign and Technology Upgrade (MRTU) effort.

References from any existing or previous client of USE may be made available upon request.

Utility System Efficiencies, Inc. **October 2005-Present**

- **Utility Transmission Power System Analysis.** Conduct transmission assessments and system impact studies for utility systems within and outside Arizona and California, including simultaneous import limit (SIL) studies and interconnection studies for proposed generation and transmission projects. Breadth of technical investigations performed included traditional power flow analysis (under normal and/or emergency system conditions), post-transient analysis, and transient stability evaluations. Also develop and evaluate transmission system mitigation alternatives ranging from operator actions to implementation of special protection schemes (SPS), and/or capital additions. Compose technical reports summarizing study results, including FERC-filed testimony. Actively participate in and advise Clients in managing large planned projects through the WECC Project Rating Review Process.

California ISO Operations Engineering **Apr. 1999-Sept. 2005**

August 2003 – Sept. 2005: **Operations Engineering Manager, Loads & Resources / EMS Network Applications**

- Manage 1-2 staff members to ensure the timely and accurate production of Load and Resource Assessments for the ISO Area, for internal use and for submittal to regulatory agencies [NERC, WECC, FERC, CEC, and CPUC]. Develop load forecasts, evaluate resource adequacy, monitor resource-related environmental issues, and provide related data and reports.
- Supervise and support 3-8 staff members in the technical design and development of supporting processes for the CAISO's ABB Ranger EMS State Estimator, Advanced Applications, and the Network Model. Help facilitate internal and external communication: develop and actively promote a vision for the State Estimator and Advanced Applications, including possible changes in ISO departments' roles. Provide operational perspective and technical support for the Market Redesign and Technology Upgrade effort, particularly aspects with dependencies on the Network Model and the EMS State Estimator.

Nov. 2000 – July 2003: **Operations Engineering Manager, Northern Area**

- Support and lead 8 Operations Engineers in the fulfillment of Area Operations responsibilities for Northern California (write operating procedures, evaluate maintenance clearances, support area transmission plans). Set goals and deadlines, evaluate employee performance and growth. Identify and help mend, policy gaps and broken processes.

April 2000 – Oct. 2000: **Senior Operations Engineer**

- Provide guidance and problem-solving support to the Operations Engineering (OE) group, while continuing to carry out previous OE responsibilities. Coordinate and communicate OE interests for Advanced Applications in the ISO's EMS Replacement Project.

April 1999 – March 2000: **Operations Engineer**

- Fulfill Area Operations responsibilities. Anticipate and review the immediate and longer-term needs of PG&E's San Francisco Bay Area transmission system, 60-500kV. Write operating procedures, evaluate transmission maintenance clearances, and determine RMR generators' selection/commitment/dispatch. As an on-call engineer, respond to Operator inquiries and evaluate real-time emergencies. Conduct load forecasting, steady state, and transient power flow analysis. Investigate system events, and compose summary reports and recommendations.

- Manage generation-related issues. Improve System Operating Reserve calculation and supporting tools. Work with Client Services, to help shape contractual agreements and new concepts for Participating Generators and Loads. Perform and provide training in, Reliability Must-Run (RMR) Pre-scheduling. Build consensus among disagreeing parties during the startup operation of the El Dorado Energy Merchant power plant.

California ISO Grid Planning **Nov. 1997-Mar. 1999**

Nov. 1997 – March 1999: **Grid Planning Engineer**

- Supervise and support 3-8 staff members in the technical design and development of processes for the EMS State Estimator, Advanced Applications, and the Network Model. Help facilitate internal and external communication: develop and actively promote a vision for the State Estimator and Advanced Applications, including possible changes in ISO departments' roles. Provide operational perspective in supporting the Market Redesign and Technology Upgrade effort, particularly aspects with dependencies on the Network Model and the EMS State Estimator.
- Anticipate and review the long and short-range needs of the SDG&E transmission system, 69-500 kV. Conduct load forecasting, steady state and transient power flow analysis, deterministic and probabilistic contingency planning. Evaluate and approve SDG&E-recommended system improvements.
- Assess the reliability and impacts of new generator interconnections. Contribute to development of study plans, review interconnection studies, and enhance/approve proposed interconnections.
- Analyze, explain clearly, and reduce the needs for Reliability Must-Run (RMR) generation within the Cal-ISO Grid, particularly the SF Bay Area. Conducted Cal-ISO 5-year RMR Technical Study, translating technical analysis into 1999 list of RMR units. Prepare presentations and documentation for ISO Board of Governors.

Pacific Gas & Electric Company **Jun. 1991-Oct. 1997**

June 1993 – Oct. 1997: **Transmission Planning Engineer**

- Provide during industry restructuring, technical guidance and clear explanations of the PG&E transmission system, its constraints, and required must-run generation. Task Force Member, PTI's California ISO Transmission Reliability Study. Co-author of Appendix B to PG&E's July 19, 1996 FERC Filing on Market Power: PG&E Must-Run Requirements.
- Plan for the long and short-range transmission needs of the San Francisco Bay Area, 60-500kV. Conduct load forecasting, steady state and transient power flow analysis, voltage and reactive margin analysis, deterministic and probabilistic contingency planning. Budget and prepare recommendations for accurately-timed system improvements to reliably and economically serve local customers.
- Plan and analyze long-range needs and costs for Bay Area voltage support. Verify loads and power factor through historic SCADA trends; run voltage collapse studies and "nose curves"; study sensitivity to local generation dispatch, seasonal differences, and future uncertainty (deregulation, generation retirements). Defer synchronous condenser retrofits for less costly

voltage support measures (distribution capacitors, conversion of retired generators into synchronous condensers, reconfiguration of the transmission system).

- Coordinate and plan new Transmission Customer connections (IPPs & E20Ts). Respond quickly and clearly to customer concerns and technical questions. Perform power flow and fault study analysis, prepare interconnection reports, estimate project costs. Lead team meetings and manage projects, communicate and build agreement.
- Author and edit for PG&E, documents of agreement and liability with external parties. Compose, edit, and/or issue Interconnection Reports, memos of understanding, liability waivers, transmission customer maintenance and operating agreements.

Oct. - Dec. 1996: **Rotation, PG&E Distribution Planning Engineer**
Diablo Division (Contra Costa County)

- Plan and prepare recommendations for distribution capacity increase projects (transformer banks, feeders, new customer connections). Perform area deficiency studies, area load growth calculations. Respond directly, clearly, and quickly to customer service complaints. Prepare letters of outages and service reliability. Analyze and solve voltage problems. Emergency On-call Supervisor for winter storms; assess outages and dispatch crews.

May 1992 - May 1993: **East Bay Region Transmission Engineer**

- Coordinate meetings, monitor project status, and prepare costs for three expansion sites for Bay Area Rapid Transit. Team support in forming and reviewing transmission service alternatives. Interact on technical, land/environmental, and EMF issues.
- Respond directly and quickly to customer concerns and technical questions, regarding transmission EMF. Measure and record EMF levels, prepare summary reports, and maintain in-house EMF database.

June 1991 - May 1992: **Operations Management Engineer-in-Training**

- Evaluate Energy Management System (EMS) Network database and Real Time Sequence functions. Align PTI Powerflow models with validated EMS telemetry, Substation Demand Logs, and other sources of operational information.

Power Systems Analysis Tools

- General Electric PSLF/PSDS – Since 1997
- WSCC Interactive Power Flow System (IPS) and WSCC Stability - *2 Years*
- Power Technologies, Inc. PSS/E - 6 *Years*
- Also use of the following software programs:
  - ABB Ranger EMS Network Applications (State Estimator, Dispatcher Load Flow)
  - TCAP (Transformer Capability software)
  - AMPS (Transmission Line rating software)
  - ASPEN Line Construction / One-liner
  - PowerWorld TransCalc (impedance calculation)
  - SLIC (Scheduled Outage & Logging for Cal-ISO)

Relevant Course Work & Training

- Mechanics of Running GE PSLF - General Electric
- Mechanics of Running PSLF Dynamics – General Electric
- Mechanics of Using EPCL - General Electric

- Voltage Control & Reactive Power - Power Technologies, Inc.
- Transmission Access and Power Wheeling - Power Technologies, Inc.
- Power System Planning Techniques - Power Technologies, Inc.
- Collaborative Negotiations and Cooperative Problem Solving, National Center Associates
- PI-Systems Training - OSI Software, Inc.
- Electronic Data Management Systems - Documentum

Activities and Organizations

- Engineer-in-Training Certificate (EIT), Washington State (#16874, June 1991)
- Professional Engineer (License #E-14728, October 1994)
- Institute of Electrical & Electronic Engineers and Power Engineering Society