



1 **Q Please state your name, position, and business address.**

2 **A** My name is Brian Rahman. I am the Program Manager for the Market Redesign  
3 and Technology Upgrade (“MRTU”) project at the California Independent  
4 System Operator Corporation (“CAISO”). My business address is 151 Blue  
5 Ravine Road, Folsom, California 95630.

6 **Q Please describe your professional background.**

7 **A** I have over fourteen years experience in evaluating, planning, coordinating, and  
8 managing electric systems, projects and markets. I have been with the CAISO  
9 since before it began operations, and my responsibilities throughout that time  
10 have included software design and development. I have worked on MRTU since  
11 2002 and assumed my present position in July 2005. My resume is attached as  
12 Appendix 1.

13 **Q What is the purpose of your testimony?**

14 **A** I am testifying regarding the status of the development of the software required to  
15 implement the policy decisions incorporated in “Release 1” of MRTU and the  
16 impact on the implementation date of MRTU that could occur if any significant  
17 policy decisions are modified. I will also testify regarding the plans and schedule  
18 for the development of Business Practice Manuals that are intended to provide  
19 implementation detail and additional information consistent with the MRTU  
20 tariff.

1 **Q Please summarize your conclusions.**

2 **A** After undertaking a review to determine whether any discrepancies exist between  
3 the MRTU tariff language and policy decisions, on the one hand, and the status of  
4 software development, on the other hand, the CAISO has concluded that certain  
5 adjustments in software development must occur to reflect policy decisions that  
6 are fundamental to Release 1 of MRTU. The changes in software to be consistent  
7 with policy, together with an earlier reevaluation of the MRTU schedule, have  
8 caused the CAISO to revise the implementation date for MRTU Release 1 to  
9 November 2007. It is critical for the Commission and stakeholders to understand  
10 that the delay in implementation of Release 1 of MRTU does not create any  
11 opportunity to expand the scope of Release 1. Moreover, the November 2007  
12 date is only achievable if there are no other significant changes to the components  
13 included in Release 1.

14 **Q For background purposes, please describe the software development process**  
15 **for projects such as MRTU.**

16 **A** The software development and implementation process comprises seven major  
17 steps that begin with the preparation of the package for the vendor. It involves  
18 development of the software, testing, and integration. The seven steps are (1) the  
19 documentation of software requirements; (2) vendor design and coding of  
20 software; (3) factory acceptance test; (4) site acceptance test; (5) integration  
21 testing; (6) market test; (7) production release. It is important to recognize that  
22 these steps only commence after the project sponsor has made the necessary

1 policy decisions and determined the nature of the necessary software. In the case  
2 of MRTU, of course, that process has involved years of effort.

3 Part of that process has included dividing MRTU into Release 1 and  
4 Release 2. In some cases, as I will discuss later, components were included in  
5 Release 2 for schedule reasons. For the most part, however, Release 1 reflects  
6 those components of MRTU that need to be put in place and tested in the real  
7 world markets to ensure that they are working properly and efficiently before the  
8 refinements of Release 2 are added.

9 **Q What is the importance of this software development and implementation**  
10 **process to projects such as MRTU?**

11 **A** In an ideal world, one would finalize all policy decisions before beginning  
12 software development. In projects such as MRTU, however, in order to minimize  
13 the overall project schedule, policy decisions and software development often  
14 must proceed on parallel tracks. As should be apparent from the length of time  
15 involved, software development is usually, if not always, on the critical path for  
16 market modifications, and particularly so for a major market redesign such as  
17 MRTU. The impact on the overall project schedule of new policy decisions is  
18 thus largely driven by the impact of these changes on the software development  
19 and implementation process. A change to even one component of the MRTU  
20 market design may have a very significant impact on the overall project schedule.

1 **Q What is the current status of the development of MRTU software?**

2 **A** Two of the three original vendor software packages (the Market and Bidding  
3 System-Siemens and the Congestion Revenue Rights) are in the Site Acceptance  
4 Test step of program implementation. The internally developed systems are all in  
5 the final stages prior to system integration. As I will describe below, however,  
6 the need to accommodate the reconciliation of inconsistencies between the  
7 software and policy decisions into these packages will delay the progress of the  
8 software development through the final steps of development.

9 **Q You mentioned that policy decisions and software development proceed on**  
10 **parallel tracks. Could you describe the recent policy work on MRTU?**

11 **A** On May 13, 2005, the CAISO made a conceptual filing with the Commission on  
12 MRTU, addressing a number of issues and incorporating the work of the  
13 CAISO's consultants, the Law and Economic Consulting Group. The CAISO  
14 conducted a two-day stakeholder meeting the following week, and a three-day  
15 stakeholder meeting in June. The Commission issued a guidance order regarding  
16 the CAISO's filing on July 1, 2005, which affected a number of policy issues.

17 The CAISO held eight additional days of stakeholder meetings in July and  
18 August to resolve outstanding MRTU issues and respond to comments regarding  
19 proposed MRTU tariff language. On September 19, 2005, the Commission issued  
20 an order on rehearing regarding the CAISO's May 13 filing, providing additional  
21 guidance. Two additional days of stakeholder meetings occurred in the beginning  
22 of October.

1           At its October meeting, the CAISO Board of Governors approved a  
2           number of management proposals regarding MRTU policy that had been  
3           developed based on stakeholder input and Commission guidance.

4           In October, November and December, the CAISO held fifteen days of  
5           meetings to review the proposed MRTU tariff language with stakeholders.

6   **Q    How did this policy work affect the software development and**  
7   **implementation process?**

8   **A**After the CAISO’s internal reorganization, during which I assumed my current  
9           position, we initiated a complete status review of MRTU, reevaluating the logical  
10          scheduling progression and determining the critical path. It became apparent at  
11          that time that the then-projected February 2007 implementation date was not  
12          achievable. Eliminating all contingencies, we thought that implementation in late  
13          Spring 2007 remained a responsible goal.

14          Next, following the public review of the MRTU tariff language, and as a  
15          result of this continued refinement of MRTU, the CAISO undertook a review to  
16          reconcile the status of software development with tariff and policy decisions,  
17          including the additional policy decisions that had already been implemented in  
18          response to the Commission and stakeholders. The purpose of the review was  
19          first to identify discrepancies between the software development and the then-  
20          existing tariff and policy decisions; it did not evaluate the addition of new  
21          components to Release 1. Except with regard to minor discrepancies that could  
22          be addressed by tariff adjustments, the review then served to identify those  
23          capabilities that needed to be included in Release 1 despite the need to modify the

1 software to include these capabilities – the “must have” requirements – and those  
2 that could be delayed until Release 2. The term “must have” thus does not refer  
3 to all critical components of Release 1, but to those capabilities that were not  
4 consistent with the status of software development and which the CAISO  
5 concluded could not be delayed until Release 2.

6 **Q What criteria did the CAISO use to identify “must have” requirements?**

7 **A** A requirement was considered “must have” if (1) its functionality was necessary  
8 to resolve a critical defect in MRTU’s mechanisms for ensuring reliability; (2) its  
9 functionality was necessary to resolve a critical defect in the markets established  
10 in MRTU; or (3) Market Participants had insisted on the inclusion of the  
11 component and the CAISO agreed to include the component.

12 **Q What “must have” requirements did the CAISO identify?**

13 **A** The CAISO identified eleven areas in which the software needed to be modified  
14 in Release 1:

- 15 (1) Revisions necessary to eliminate the potential for improper mitigation of  
16 resources used to resolve non-competitive constraints;
- 17 (2) Applications to support the use of a conduct test for all resources in a  
18 Designated Constraint area in case the CAISO needs to modify the mitigation  
19 approach from a PJM-style mitigation to a NYISO-style mitigation;
- 20 (3) Incorporation of capability to model adjacent and embedded Control  
21 Areas properly in order to prevent infeasible Integrated Forward Market (“IFM”)  
22 solutions because of inaccurate modeling;

- 1 (4) Software to fulfill the CAISO’s commitment to stakeholders to support
- 2 partial Resource Adequacy resources;
- 3 (5) Additional validation rules for Existing Contract and Transmission Owner
- 4 Rights schedules to ensure consistency with Existing Contracts and Transmission
- 5 Ownership Rights;
- 6 (6) Rules to eliminate problems with the IFM when supply resources submit
- 7 infeasible schedules;
- 8 (7) Functionality to implement settlement on “sellers choice” bilateral Energy
- 9 contracts;
- 10 (8) Software to implement the policy regarding the calculation of Trading
- 11 Hub Prices in the IMF and Real-Time Market that was adopted by the CAISO
- 12 Board;
- 13 (9) Additional rules for the Scheduling Infrastructure Business Rules to
- 14 ensure the feasibility of the optimization solution;
- 15 (10) Modifications to implement Metered Subsystem Requirements, such as
- 16 Load-following; and
- 17 (11) Verification that the Pumped Storage Data Model will perform as
- 18 required.

19 **Q How has the inclusion of the “must have” requirements affected the software**  
20 **development?**

21 **A** The vendors will have to resume development at the factory and integrate the new  
22 software with the software that has been developed. The changes will require  
23 additional testing, integration work, and training across the program. It bears

1 repeating that these changes were necessary to bring software closer to policy  
2 because we discovered that the lower level detail implementation of software was  
3 not consistent with the overall policy.

4 **Q Have you estimated the impact on the schedule?**

5 **A** Yes. The CAISO has concluded that, because of the necessary software  
6 development, late Spring 2007 is no longer a reasonable goal for implementing  
7 MRTU. The CAISO has thus revised the implementation date of MRTU to  
8 November 2007.

9 **Q How would major steps of software development apply to substantive**  
10 **additions or modifications to the planned scope of the MRTU Release 1**  
11 **project?**

12 **A** The duration of each of the steps depends on the magnitude of the software  
13 package. At this stage of Release 1, our concern is the impact of additions or  
14 modifications to the original packages. In describing the seven steps, therefore, I  
15 will discuss the time involved for additions or modifications to the software  
16 packages.

17 As I noted, Step 1 of the software development process involves the  
18 documentation by the project sponsor of the requirements for the software. This  
19 process, which generally takes six to eight weeks, is necessary for dealing with  
20 the vendor and for addressing program impacts.

1                   In Step 2, the vendor designs and codes the software at its development  
2 location. Although the duration will vary according to the magnitude of the  
3 changes to existing software, this phase usually lasts 16 to 24 weeks.

4                   Step 3 is the Factory Acceptance Test, in which the vendor tests the  
5 software at its development location. This includes full impact regression testing  
6 (which requires repeating a significant number of tests) to insure software  
7 integrity, that is, the ability of the various components of the software to work  
8 together without interference. These tests consume another 16 to 24 weeks.

9                   The software is then tested onsite in Step 4, the Site Acceptance Test, to  
10 ensure the integrity of the software and the customer environment. Such testing  
11 lasts six to ten weeks.

12                   The last three steps involve system integration, combining the various  
13 software packages that will be implemented together. Step 5, which lasts 10 to 16  
14 weeks, is Integration Testing, in which the packages are assembled into the final  
15 product, in this case for the MRTU Release.

16                   In Step 6, the software undergoes an eight to twelve week Market Trial.  
17 The software is made available for trial use by market participants. Market output  
18 is generated and mock billing statements are generated.

19                   Finally, the software is deployed to trained personnel and Market  
20 Participants over a four to eight week period in Step 7, Production Release. At  
21 the end of this step, the software may be put into operation.

1 **Q Inasmuch as you are stating that implementation must be delayed anyway,**  
2 **can you now include additional components in Release 1?**

3 **A** Not without even further delay. All schedule contingencies had been consumed  
4 prior to the addition of the “must have” requirements, and the November 2007  
5 date includes no additional time for contingencies. For example, as discussed  
6 below, implementation of virtual bids could require an additional 12-months on  
7 top of the revised implementation date of November 2007.

8 **Q Could you provide examples of how a market design change could affect the**  
9 **overall project schedule?**

10 **A** Yes. The estimated delay, for example, of the development of the software for  
11 the bid submission and settlement system that would be caused by a decision to  
12 implement submission of virtual bids in Release 1 could be an additional 12  
13 months on top of the revised implementation date of November 2007. Such a  
14 change would modify all downstream data stores as well as the integration of all  
15 major systems. It would require significant testing, market trials, and training to  
16 insure proper implementation. Significant training for Market Participants would  
17 be required as well.

18 **Q Can you provide an additional example?**

19 **A.** Yes. The CAISO originally proposed to base the Day-Ahead market power  
20 mitigation run on forecasted Load as opposed to bid-in Load. In its July 1, 2005  
21 Market Design Order, the Commission approved the CAISO’s market power  
22 mitigation proposal, which included this approach. However, in response to a

1 rehearing request, the Commission reversed course and directed the CAISO to  
2 base the Day-Ahead LMPM procedures on bid-in Load. The CAISO requested  
3 rehearing of this issue.

4 As discussed in the CAISO's rehearing request, the CAISO cannot  
5 incorporate this change into MRTU Release 1 without substantially delaying  
6 MRTU implementation. This change affects the foundational database of the  
7 MRTU market systems and alters the objective function of the Market Power  
8 Mitigation and Reliability Resource Determination runs of the market prior to the  
9 IFM. The CAISO has begun considering possible software changes to implement  
10 this market design change and has discussed the matter with its software vendor,  
11 but has not discussed these options with stakeholders. One potential solution  
12 would be to move Reliability Resource Determination pre-Dispatch identification  
13 out of the pre-IFM market power mitigation and reliability determination process  
14 and into the Residual Unit Commitment process, thereby allowing the mitigation  
15 and reliability determination to be based on bid-in Load. This option would  
16 require multiple changes to the existing market software as well as development  
17 of an additional pass in the Residual Unit Commitment process whereby  
18 competitive transmission constraints would first be applied in the Residual Unit  
19 Commitment, followed by all transmission constraints, in order to identify which  
20 Residual Unit Commitment "dispatches" were required for local reliability.  
21 Implementation of this change would require changes in all parts of the software  
22 development cycle. This change would require additional time and resources to  
23 be allocated for testing, training and market trials. Vendor estimates of the impact

1 of this change on the overall MRTU project schedule are between 10 and 14  
2 months.

3 **Q Besides significant policy changes, are there other factors that could affect**  
4 **the critical path?**

5 **A** Yes. The timing of the Commission's order on the MRTU filing could also affect  
6 implementation. As I have discussed, any significant policy changes would likely  
7 prevent implementation of Release 1 by November 2007. Moreover, changes  
8 which may appear minor from a policy perspective could be substantial from a  
9 software development and implementation perspective. Nonetheless, it may be  
10 possible to incorporate some truly minor changes to the MRTU proposal and still  
11 implement Release 1 by November 2007. In order to incorporate such changes  
12 into the software and still meet that implementation date, however, the CAISO  
13 would need a Commission order by early June 2006.

14 **Q Are there additional reasons why a Commission order by June 2006 would**  
15 **be helpful?**

16 **A** Yes. This timing would also be important for Market Participants, who have  
17 informed the CAISO that they will need substantial time – in some cases more  
18 than a year – to make the commitments necessary to develop appropriate business  
19 practices to accommodate MRTU.

1 **Q Why does the CAISO believe further delays to Release 1 of MRTU should be**  
2 **avoided?**

3 **A** As explained in the testimony of Lorenzo Kristov (Exhibit No. ISO-1 ), the  
4 existing CAISO market design has a number of flaws which expose customers to  
5 risks associated with the exercise of market power, and the new CAISO market  
6 design should be put into place as soon as it can be reasonably implemented,  
7 taking into account the need to develop and test the new market software. In  
8 addition, the CAISO's existing market software systems have not been  
9 substantially updated for many years. This is the reason for the "Technology  
10 Upgrade" portion of MRTU. This upgrade should not be delayed any longer than  
11 necessary.

12 **Q You also mentioned Business Practice Manuals. What is the purpose of**  
13 **Business Practice Manuals?**

14 **A** The Business Practice Manuals ("BPMs") will document the manner in which the  
15 CAISO conducts its operations consistent with the MRTU Tariff. They will both  
16 serve as guides for internal operations and inform Market Participants regarding  
17 the CAISO's practices. The BPMs will thus provide consistency and  
18 transparency in the implementation of MRTU. The CAISO has attempted to  
19 include in the MRTU tariff provisions a level of detail similar to that in the tariffs  
20 of other independent system operators, like PJM and MISO. Like the manuals  
21 and procedures adopted by such other independent system operators, these BPMs  
22 will include more detail, including examples and timelines, than will be found in  
23 the MRTU tariff provisions.

1 **Q What subjects does the CAISO currently plan to cover in the BPMs?**

2 **A** The CAISO will develop BPMs in all areas of the CAISO's business. The  
3 MRTU-specific BPMs that I anticipate will be of greatest interest to parties to this  
4 proceeding include the following subject areas:

- 5 • Settlements
- 6 • Bid Submission Process
- 7 • Mitigation
- 8 • Integrated Forward Market
- 9 • Residual Unit Commitment
- 10 • Hour-Ahead Scheduling Process
- 11 • Real-Time Market
- 12 • Congestion Revenue Rights
- 13 • Billing
- 14 • Resource Adequacy
- 15 • Load Forecasting

16 **Q How does the CAISO plan to develop the BPMs?**

17 **A** The CAISO plans to develop the BPMs from its business units with the assistance  
18 of an outside vendor. At each stage of the development, the CAISO expects to  
19 provide the opportunity for, and to respond to, stakeholder input.

20 **Q Please describe the planned schedule and process for the development of the**  
21 **BPMs.**

22 **A** In April 2006, the CAISO would release Initial Drafts of the information to be  
23 incorporated into the BPMs, which would comprise raw draft materials regarding  
24 the business rules and would explain the processes involved.

25 In July 2006, the CAISO would release Initial Versions of the BPMs. At  
26 that point, all releases would be identified by version and subject to change  
27 control, but would not be operational.

1                   The CAISO would provide revised versions of the BPMs for a Market  
2                   Simulation Release by November 2006. Those versions would be sufficiently  
3                   close to final to allow market simulation testing.

4                   The Market Launch Release would occur in May 2007. These would  
5                   constitute the first operationally effective versions of the BPMs. New versions  
6                   would be issued, subject to stakeholder input and change control, as necessary.

7   **Q    Thank you. I have no further questions.**

UNITED STATES OF AMERICA  
BEFORE THE  
FEDERAL ENERGY REGULATORY COMMISSION

California Independent System Operator )      Docket No. ER06-\_\_\_-000  
Corporation )

I, Brian Rahman, declare under penalty of perjury, that the foregoing questions and answers labeled as my testimony were prepared by me, with the assistance of others working under my direction and supervision; and that the facts contained in my answers are true and correct to the best of my knowledge, information and belief.

Executed on: 2-6-06  
Date

  
\_\_\_\_\_  
Brian Rahman

# BRIAN S. RAHMAN

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## EDUCATION / REGISTRATION

- Bachelor of Science in Electrical Engineering, August 1991 from Washington State University
- Registered Professional Engineer in the State of California. Registration No. E 014914

## PROFESSIONAL EXPERIENCE

### **MRTU Program Manager and Manager of Program Office, California ISO 7/00 - Present**

Responsibilities include overall management of the Market Redesign and Technology Upgrade program. This program includes the wholesale replacement of all Market Systems, Settlement systems and modifications to approximately 15 supporting applications. Additionally, the program includes the deployment of an open architecture (SOA) technology to support future flexibility and corporate needs. This is a \$140 M program with contract and staff headcount of 160 people.

### **Manager, Market Operations, California ISO 7/00 – July 05**

During this period I held several Manager position within the Market Operations Department as described below. Additional responsibilities include Department Capital and O&M Budget development, department and corporate representative for market design and technical implementation expert.

- Manager of Market Redesign and Technology Update, Special Projects (9/03 – present) – Technical lead for the specification, design, procurement, and testing of the Forward, Real-time, and Residual Unit Commitment Markets. Responsible for the management of a team of 15 staff and contractors dedicated to the implementation of the CAISO's future market applications. Additionally, I am the overall program technical lead with primary responsibilities to insure all corporate business unit needs are met from a "bid to bill" perspective. This effort encompasses resolution of program level policy and technical issues and the overall coordination of 5 main systems and 12 supporting applications.
- Manager of Market Engineering (7/01 – 9/03) – Manage staff of 10 to 15 design engineers and 5 to 6 contract staff responsible for design, implementation, testing, and support of market software applications. Primary responsibilities: Provide management, leadership, and coordinate for multiple project groups engaged in the design and implantation of market applications and supporting systems. Responsible for project requests, budgets, staffing, design documents, and contract negotiations. Responsible to insure Tariff and FERC order requirements are represented in market applications and operating procedures.
- Manager of Markets (7/00 – 7/01) - Oversee the Day-Ahead, Hour-Ahead, and Real-Time energy, transmission, and ancillary service markets. Primary responsibilities: Manage staff of 18 shift and 3 senior operators, insure close coordination with grid operations concerning system load forecast, energy and reserve procurements, insure accuracy of all published prices and settlement quality data.

### **Senior Market Design Engineer, Market Operations, California ISO 9/97– 7/00**

- Market Software Design, Testing, and Project Management – Responsibilities include development of detailed design documents for vendor and internally developed software, coordination of software testing and deployment with Market Participants. Project Management responsibilities consist of overall project development including budget, design, staffing, inter-departmental and vendor coordination, testing, and deployment
- Technical Support for Real-Time Operations – Duties included 24 x 7 support for real-time personnel operating market applications and software. Requires detailed understanding of grid operations and the impacts of "The Markets" on these operations as well as precise knowledge of the integrated computer systems, which support "The Markets".

- Real-Time Market Operations – Responsible for processing the Day Ahead, Hour Ahead, and Real-Time Markets. Operated markets in real-time, environment ensuring enforcement of market rules and procedures. Responsible for Real-Time Market functions as part of 12 person operations shift working 12 hour rotating shifts in a 24 x 7 control room environment.
- Start-Up Team – Duties included market software acceptance testing, operational dry run and market simulation operations. Provided training for market participants in the use of scheduling applications and functionality of Real-Time energy market.

**Lead Electrical Engineer, Hydro Generation, Pacific Gas & Electric Co. 5/97-9/97**

- Project Engineering – Prepared job proposals that included cost estimates, engineering calculations, studies, and design. Developed equipment and consulting specifications, procurement documents, and evaluated proposals for electrical equipment and system revisions and upgrades. Provided engineering guidance and technical support to engineering designers and drafters. Planned, designed and developed routine work plans needed to maintain and improve PG&E hydro facilities.

**Distribution Engineer, North Bay Division, Pacific Gas & Electric Co. 4/96-5/97**

- Provided electric planning and operations support for 12kV distribution network. Performed load growth studies and developed capacity increase projects as needed for future growth. Provided protection settings for distribution breakers and line equipment to insure coordination of protective devices. Investigated and resolved power quality and voltage complaints. Served as on-call supervisor during off-hour emergencies.

**Electrical Engineer, Hydro Generation, Pacific Gas & Electric Co. 1/94-4/96**

During this period I worked out of PG&E's Corporate Headquarters for only 12 months with the rest of my time actually located in the field as various hydro facility field locations. Primarily responsible for the facilities located on the Mokelumne and Stanislaus watersheds consisting of 9 powerhouses and a variety of extensive water conveyance systems.

- Provided construction, maintenance, and operations engineering support for PG&E hydro facilities. Identified equipment problems and developed scope, cost, design, and procurement documents. Provided technical support for maintenance activities, operational constraints, and construction projects.
- Provided budget input including project alternatives, economic evaluations, and justification. Served as project manager, providing project estimating, justification, schedule and cost tracking. Provided construction coordination and on site engineering. Served as on-call supervisor.
- Applied Reliability Center Maintenance practices to PG&E hydro facilities. Responsibilities included: Comprehensive review of hydro generation equipment maintenance practices and detailed reviews with maintenance staff, documentation of existing time based practices, and recommended condition based analysis used to trigger maintenance.
- Project Coordination - Prepared job proposals that included cost estimates, engineering calculations, studies, and design. Developed equipment/consulting specifications, procurement documents, and evaluated proposals for electrical equipment/system revisions and upgrades. Provided engineering guidance and technical support to engineering designers and drafters. Planned, designed, and developed routine hydro work needed to maintain and improve PG&E hydro facilities.
- Engineering Consulting - Solved electrical engineering problems, evaluated and recommended alternative solutions, evaluated equipment and engineering service bids and assisted in the project scope, evaluation and justification.

**Power System Engineer, Pacific Gas & Electric Co., San Francisco, CA 8/91-12/93**

- Performed contingency studies, analyzed system disturbances and coordinated switching and clearances for transmission and relay protection maintenance. Monitored system performance and developed Dispatch Operating Instructions.

- Reviewed transmission and generation planning projects for operational capability, relay coordination and determined impact to generation resources.

## **INTERNSHIPS**

**Pacific Gas & Electric Co.**

**5/90-8/90 and 5/89-12/89**

- Performed transformer evaluation studies for use in transformer bank re-rating project and station capability report for planning studies.
- Developed qualifying facility database and PG&E winter electric system base-case. Worked on procedure for Diablo Canyon Power Plant black-start.

## **TRAINING**

- Extensive 1 year training in power systems, encompassing Transmission and Distribution Operations, Power Plant Operations (Thermal and Hydro), Protection, Planning, Forecasting and System Dispatching.
- Rotation - Transmission Planning (5 months), focusing on electric planning and system modeling.
- Seminars & Classes:
  - Stationery Battery Maintenance and Testing (Alber Co.)
  - Protective Relay Coordination (GE)
  - Power Systems Fault Analysis (Power Systems Analysis)
  - Generator Control and Protection (Basler)

***add management classes from iso***

## **AWARDS**

- 1992 Power Control Department's Performance Recognition Award for dedication, innovation, and teamwork
  - 1994 Hydro Generation Department's Performance Recognition Award for Philadelphia Fish-Screen Project
- need to add the ISO recognition awards look for certificates in office***

## **ACTIVITIES**

- IEEE Member
- Power Engineering Society (San Francisco Chapter) - Membership Chairman 1992-93
- Power Engineering Society (San Francisco Chapter) - Student Activities Co-Chair 1994-95