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SACRAMENTO AREA RATINGS

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PREFACE

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program, managed by the California Energy Commission (Commission), annually awards up to \$62 million to conduct the most promising public interest energy research by partnering with Research, Development, and Demonstration (RD&D) organizations, including individuals, businesses, utilities, and public or private research institutions.

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- Buildings End-Use Energy Efficiency
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy
- Environmentally-Preferred Advanced Generation
- Energy-Related Environmental Research
- Strategic Energy Research

What follows is the final report for the "Sacramento Area Ratings" project, #500-02-018, conducted by The Valley Group, Inc. The report is entitled "Sacramento Area Ratings: Final Report". This project contributes to the Strategic Energy Research program.

For more information on the PIER Program, please visit the Energy Commission's Web site at: <http://www.energy.ca.gov/research/index.html> or contact the Energy Commission's Publications Unit at 916-654-5200.

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ABSTRACT

Transmission line monitoring equipment was installed on four lines of WAPA in the Sacramento Area. Data from the WAPA and PG&E lines has been collected and archived.

Initial algorithms for ratings forecasts have been studied. The studies indicate that two separate algorithms are likely to be required, one for near-term operational use and another one for daily dispatch purposes.

The evaluation of the roles and interactions of thermal and voltage constraints in Sacramento areas was concluded on a reduced scope, a/o lack of SMUD data. It indicated substantial potential benefits from use of dynamic ratings, including reduced need of runbacks of Sutter plant as well as future opportunities of increased contingency limits. The financial benefits could not be quantified because of lack of SMUD information.

EXECUTIVE SUMMARY

Transmission line monitoring equipment was installed on four lines of WAPA in the Sacramento Area. After substantial delays in installation, the equipment has been calibrated and has been operating since July 2004. Data from the equipment has been collected, as well as similar systems at two PG&E lines for time period July 2004-January 2005.

The collected data has been archived and is available for future studies on line capability forecasting. Initial algorithms for ratings forecasts have been studied. The studies indicate that two separate algorithms are likely to be required, one for near-term operational use and another one for daily dispatch purposes.

The evaluation of the roles and interactions of thermal and voltage constraints in Sacramento areas was concluded on a reduced scope, a/o lack of SMUD data. It indicated substantial potential benefits from use of dynamic ratings, including reduced need of runbacks of Sutter plant as well as future opportunities of increased contingency limits. The financial benefits could not be quantified because of lack of SMUD information.

The project recommendations include future use of ICW software for operator displays as well as development of operational and dispatch software for ratings prediction purposes.

1.0 Introduction

The commission has funded two earlier projects investigating the feasibility of tension monitoring for providing real time ratings for a line and a path. The objectives of this project were to:

1. Evaluate interrelationship of voltage and thermal constraints and study new approaches;
2. Investigate the feasibility of forecasting of line ratings and circuit capabilities, and;
3. To investigate economic benefits in rating lines over a region and to recommend software approaches for such purposes.

1.1. Project Approach

1. The initial phase of the project (Task 2) consisted of ordering and installing monitoring equipment for four lines of WAPA and SMUD, as well as arranging data collection from three lines of PG&E (for Task 4 only). This task experienced extensive delays beyond prime contractor's control, necessitating readjustment of project goals and scope.
 - 1.1 The installation at WAPA was delayed eight months because of lack of installation manpower. As a result, funds intended for other Tasks had to be redirected towards equipment lease extension. Eventually, WAPA installed the equipment and actually purchased it for remaining lease value, thus fulfilling their funding commitment. The equipment is installed and data has been collected since July 2004. The equipment is fully functional. Measurements were field verified by survey in September 2004.
 - 1.2 SMUD purchased the needed equipment, fulfilling their funding commitment, but has not installed any of it, because of their management requirement has redirected the needed manpower to other tasks. This has significantly restricted the scope and performance of Tasks 3 and 5, as described below.
 - 1.3 PG&E has cooperated and started providing data for their lines starting May 2004 and with regular monthly data sets starting July 2004. All equipment is fully functional. Recorded and analyzed data has been sent to PG&E for their engineering analysis.
2. Task 3 has been redefined because of the lack of data at SMUD and because of subsequent findings, discussed in the Draft Final Findings report of the Task. Lack of SMUD data and limited cooperation in the operator interviews have made the conclusions on this Task less substantive than expected.
 - 2.1 Regarding the four monitored WAPA lines, data indicated that under the loading conditions of Summer 2004, only one of the monitored lines (O'Banion-

Elverta) was heavily loaded, and actually required operator actions to prevent overloads. The other three lines did not reach any heavy loading conditions and were thus not operationally restricted during the study period.

2.2 Among important findings, discussed in the Draft Final Findings report, are the following:

- Of the four events requiring runback of Sutter plant, use of real time ratings would have eliminated the need in three cases and limited the fourth to a smaller amount;
 - If the planned double circuit addition to the O'Banion-Elverta line is made, dynamic ratings can increase the single contingency limits substantially;
 - There are potentially additional benefits for the planned Cosumnes plant from dynamic line rating.
 - Addition of shunt capacitors to control the voltage related import limits would improve benefits derived from dynamic rating.
3. Task 4 has been delayed substantially because its completion requires essentially one full year of data from the monitored sites. The PG&E lines and the O'Banion-Elverta line have high enough loads to make the collected data suitable for an analysis of the forecasting methods. The following work has been accomplished:
- 3.1 Early data from O'Banion-Elverta line has been used to screen the available algorithms, as reported in the Available Forecasting Algorithms report.
- 3.2 Data from O'Banion-Elverta, Metcalf-El Patio, and Henrietta-Gregg lines has been preprocessed and filed for use in Interim Screening. This data has been archived by The Valley Group.
4. There has been no activity on Task 5, because it requires conclusions of Tasks 3 and 4 for integration of findings and development of constraint management. Thus, no work has been done by subcontractor Stanfield Systems, who were to provide assistance with this Task.

2.0 Project Outcomes

Task 2

- Equipment was installed and calibrated for the PG&E and WAPA lines.

All equipment has been operating without any significant problems since July 2004. Some issues regarding data collection occurred initially in the PG&E main SCADA system. These issues have now been resolved by installation of IntelliCAT data processor, funded by CIEE Subcontract C-04-09. The Final report on Installation and Calibration of Monitoring Systems is attached.

- SMUD equipment has not been installed.

Task 3

- Full interviews were conducted with WAPA operators and planners, supported by data supplied by CAISO and Commission Staff. Interviews with SMUD personnel were limited.

The staff of WAPA, CAISO, and the Commission were extremely helpful in supporting the interviews. A summary of the interviews has been made. Certain materials and documents supporting the interviews are confidential and will not be reproduced. The interview summary is presented in Appendix A of the Draft Final Findings Report.

- Nomograms and tables on the impact of dynamic ratings on import limitations were developed and are presented in Sections 4-9 in the Draft Trial Findings Report of Task 3.
- Real Time Management of combined network limitations is analyzed and discussed in the Draft Trial Finding Report.

The lack of participation of SMUD seriously impacts the completeness of the conclusions of the study. Nevertheless, the conclusions based on the analysis indicate that real time monitoring of dynamic ratings can mitigate present and future import constraints and reduce runbacks of the local generation. The financial impacts and benefits are difficult to quantify without access to SMUD data.

- Functional software specification was not developed.

WAPA has been evaluating real time data from the present monitoring systems and plans to begin applying the system operationally later in 2005. Initial discussions have been held about using a modified version of ICW software which is being developed under CIEE subcontract C-04-09.

Task 4

- Draft Available Forecasting Algorithms report has been completed and sent for comments.

All work on forecasting algorithms has been conducted based on archived data, because real time systems are not yet operational. The evaluations show that data from monitoring systems is suitable for the intended purpose, but that no single algorithm can provide answers both for the short-term and long-term operational needs. Furthermore, the most sophisticated algorithms are very computation-intensive and may not be practical for cases where data is received from a large number of monitors.

It appears that the most practical solution is to find a short term algorithm to support transient capability calculations under contingency situations (dealing with the persistence of present ratings) and another (e.g. Probabilistic Rating Pattern method) to support the daily energy dispatch functions. See "Recommendations" on the subject.

- Draft Interim Screening task is incomplete.

Preliminary work on this subject has been archived, especially regarding Probabilistic Rating patterns in the monthly reports for August 2004-January 2005.

Task 5

- No work has been done on this task.

3.0 Conclusions and Recommendations

1. Monitoring equipment is functionally very reliable and accurate. Collected data has met expectations and has shown substantial operational opportunities for real time applications. It has also identified conditions in which present static ratings may be risky.
2. The combined constraint study has yielded valuable insights towards potential use of dynamic rating in mitigating present and future import constraints and generation curtailments in the Sacramento area. Unfortunately, the results will be difficult to quantify in economic terms without cooperation of SMUD. The main findings have been made available to WAPA which will need to evaluate the reports for possible operational applications.
3. The data from the monitoring systems appears to be very applicable for forecasting purposes. The main difficulty lies in identifying robust algorithms which are not overly sophisticated and calculation intensive. If continued, the forecasting task should be subdivided into different methods for different operational needs.
4. As a general conclusion, the main contractor has found that a project where close cooperation between several utilities (including many departments within each utility) is essential, is extremely difficult to manage within allocated budgets and fixed time schedules. Different entities have different priorities, which makes it very difficult or impossible to meet overall objectives.

3.1. Recommendations For Future Work

1. Review the Draft Final report of Task 3 and incorporate reviewers' comments into a Final Report.
2. Use results from the modified version of ICW software (which is being developed under CIEE subcontract C-04-09) for WAPA's real time monitoring and make arrangements to transmit this data to CAISO as well.
3. Develop and incorporate algorithms for the Probabilistic Rating Pattern forecasting and short term rating persistence forecasting into ICW software. Short term rating persistence, in particular, could be very useful in support of transient rating calculations.
4. Reevaluate the needs and merits for an area-wide application of combined constraint mitigation methods.