Commonwealth Energy Biogas/PV Mini-Grid Renewable Resources Program

Making Renewables Part of an Affordable and Diverse Electric System in California

Contract No. 500-00-036

Development of Local Area Mini-Grid T&D Model

Project No. 1.1 Program Planning and Analysis

Task 1.1.9a Final Report

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California Energy Commission
Public Interest Energy Research - Renewables Program

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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 is managed by the California Energy Commission (Commission) and 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. PIER funding efforts are focused on the following six RD&D program areas:

- 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

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

For Commonwealth Program-specific information, please visit http://www.pierminigrid.org. What follows is the inventory report for the **California Energy Commission, Public Interest Energy Research Program, Contract Number 500-00-036,** conducted by the **Commonwealth Energy Team**. The report is entitled Development of Local Area T&D Power Flow Model. This project contributes to the **Renewable Energy** element of the Commission's PIER program.

1

Introduction

1.1 Commonwealth PIER Biogas/BI-PV Mini-Grid Program Overview

In June 2001, the Commonwealth Energy Team was awarded a programmatic contract under the California Energy Commission's Public Interest Energy Research (PIER) Program to conduct research on strategies for making renewable energy more affordable in California. The Commonwealth Energy approach involves assessing the combined potential of biogas and photovoltaic (PV) resources in a defined study area and identifying how these resources could be developed in a complementary and cost-effective manner. The Commonwealth Energy Team conducted this research in a real world setting so that the findings could be applied elsewhere in California and therefore benefits more California ratepayers. The local area Commonwealth Energy selected for its renewable energy research activities is the Chino Basin located southeast of Los Angeles, referred to in this report as the "study area."

The Chino Basin is rich in PV and biogas resources. Moreover, it is a rapidly growing area with substantial and yet increasing electrical loads. The underlying goal of the Commonwealth Energy Program is to identify potential Chino Basin Building-Integrated PV (BI-PV) and biogas energy projects, bring innovative technologies and business practices to these projects, assess the benefit to the local electricity distribution system (the "mini-grid"), and then use the findings to develop a business model for siting cost-effective, renewable energy projects.

This report summarizes the Transmission and Distribution (T&D) system power flow model developed for the Commonwealth PIER Program mini-grid area.

1.2 Planning and Analysis Project Objectives

The primary objectives of the Commonwealth PIER Program Planning and Analysis Project are to:

- Define the initial Program study area,

- Inventory the study area's potential photovoltaic and biogas resources to assess the potential of such resources and to identify potential demonstration projects,
- Identify a mini-grid where the potential impact of the development of such resources can be assessed,
- Conduct power flow studies to identify and quantify the benefits of renewable energy projects on the local electric distribution system,
- Identify and prioritize specific biogas and PV demonstration projects, and
- Identify cost savings and other benefits that would accrue by developing complementary renewable resources.

A multidisciplinary team led by Itron/RER and supported by CH2MHill, Zaininger Engineering Company (ZECO), and the Renewable Energy Development Institute (REDI), is responsible for meeting these program-planning objectives. CH2MHill is responsible for undertaking the various biogas resource inventory assessments. Itron/RER and REDI have jointly developed estimates of BI-PV technical potential while Itron/RER was responsible for developing the current and future projections of biogas and PV market potential in the mini-grid. These current power flow and other studies related to the electric system mini-grid are being undertaken by ZECO.

1.3 Purpose of Mini-Grid T&D Model Development

The purpose of this initial modeling effort (under Task 1.1.9a) is to develop a useful and fully functional power flow model of the Southern California Edison (SCE) electric transmission and distribution (T&D) systems within the Chino mini-grid area. The Commonwealth mini-grid power flow model employed in this effort will be used to compare a "base case" scenario to various estimates of expected penetration of renewable distributed generation based upon the market potential analyses performed under Task 1.1.7. This power flow analysis looks forward five years and ten years into the future of the Chino basin mini-grid.

1.4 Organization of Report

Both transmission and distribution system information have been developed for the local Chino Basin initial mini-grid area. The model development overview and a brief description of the mini-grid power flow model are discussed in Section 2, while the specifics of the base case model itself are covered in Section 3. A brief summary of the base case model results is provided in Section 4. Appendix A includes the Summer Peak Load branch load flow results for the mini-grid. Appendix B presents the projected peak load mini-grid feeder voltage profiles. Appendix C includes a Table summarizing the shunt capacitors added to maintain minimum system voltage.

2

T&D Model Development Overview

2.1 Goals and Objectives of Task 1.1.9(a)

Under this task effort, ZECO is to develop a useful *representative* local mini-grid electrical T&D system database using the best available information collected, and as needed, supplemented with appropriate assumptions. The goal of this task is to develop a base case T&D system model using the General Electric (GE) Positive Sequence Load Flow (PSLF) program suitable for expanding the local Chino Basin mini-grid out in time 5 and 10 years, and calculating T&D system impacts using steady state power flow analysis in Task 1.1.9b.

The objectives of this T&D model development task under the Planning and Analysis Project (Project 1.1, Task 1.1.9a) include:

- Develop a T&D "base case" model of the Chino basin mini-grid, which incorporates the mini-grid database developed in Task 1.1.6.
- Add appropriate transmission system *representation* to evaluate impacts on the local transmission system, as well as in the Chino mini-grid distribution system.

2.2 Transmission and Distribution System Aspects

The T&D assessment to be performed in Task 1.1.9b in this study (the next phase of this analysis) consists of a bottom-up impact evaluation of distributed renewable generation installed directly at loads within the 12 kV distribution systems in the mini-grid area. Clearly, the major impacts of installing renewable distributed generation within the mini-grid will be on the local mini-grid T&D facilities - first at the feeder level and then where significant market penetration increases, at the distribution substation level. Any large penetration of distributed renewable generation within a localized area will likely extend up to influencing power flows on the local 66 kV subtransmission systems serving the 66/12 kV systems in the mini-grid area. The degree of influence will not be as great as in the mini-grid system because flows on the 66 kV subtransmission systems are also influenced by other 66/12 kV substations outside the mini-grid area. Significantly large penetration of distributed renewable generation will probably have some measurable impact on power flows in the "local" bulk 500/230 kV transmission system, which serves southern California. In this study we therefore plan to model the transmission system, as well as the local Chino basin mini-grid system.

2.3 PSLF Description

The GE PSLF program can perform steady state load flow analysis, dynamic analysis and short circuit analysis calculations on electric power transmission and distribution systems. The program has the capability to model busses, lines, transformers, generation and loads, interchange areas and zones. The program can import and export data from and to other commercial load flow programs, and can be used to model the large interconnected electric power systems in the United States. GE's PSLF release No. 13.1 is being used for this study.

2.4 Intended Results

The intended result of this Planning and Analysis Project Task is the development of a base case power flow model in GE PSLF format containing the Chino basin mini-grid database developed under Task 1.1.6. In addition, we expect to incorporate a suitable representation of the local 66 kV subtransmission system serving the Commonwealth Renewables mini-grid area and the related 500/230 kV bulk power system, as required. This base case model will be used as the starting point for developing the future year 2007 and 2012 mini-grid model components, first without the mini-grid's renewable resources and then with various levels of renewable resource market potential added in the Task 1.1.9b effort.

3

Mini-grid T&D Model Development

3.1 Model Development

Adequate local transmission system data have been collected and when coupled with the local mini-grid distribution system data, can be used to develop a representative local Chino area T&D *base case* model for conducting a power flow analysis to evaluate the expected T&D impacts later under Task 1.1.9b of this project.

First, a publicly available Western System Coordinating Council (WSCC), (now called Western Electricity Coordinating Council (WECC)) bulk transmission system model was selected for use in developing the Chino area mini-grid T&D model. Every year since the early 1990s, the Federal Energy Regulatory Commission (FERC) has obtained bulk power system load flow cases from each of the North American Electric Coordinating Council (NERC) regions. These load flow cases are referred to as NERC 715 cases. These cases were used by power generation developers to make preliminary transmission system assessments of potential locations for new generation facilities.

During the early discussions with SCE, a WSCC heavy summer case for 2001 was selected for use in developing the base case T&D model for this project. This load flow case, 01hs4c.epc, was developed using the GE PSLF program and was in the GE PSLF load flow case import/export format. This bulk power system model contains a good representation of existing generation and bulk transmission facilities throughout the western United States WECC region. Note that potential new generators are not included in the bulk transmission system.

This WECC "01hs4c" bulk power system case contains about 13,227 busses, 11,622 lines, 5,489 transformers, 2,389 generators, and 7,778 loads. The local mini-grid area is served by three bulk power transmission substations in this case. The configuration of the first substation, Chino, is shown in Figure 3-1. The configuration of the second substation, Mira Loma, is shown in Figure 3-2. The configuration of the third substation, Etiwanda, is shown in Figure 3-3. Note that for bulk transmission studies, loads are generally lumped at the bulk power system substations as shown on these one-lines. In this case Chino serves 526 MW of load, Mira Loma serves 413 MW of load, and Etiwanda serves 373 MW of load.

During a meeting at SCE in September 2002, ZECO obtained proprietary SCE system detailed local subtransmission configuration and electrical data for the local Chino basin area suitable for performing the load flow studies in this project. These data include the following information for the local subtransmission system served by the Chino and Mira Loma bulk transmission substations, which are located within the Commonwealth Renewables mini-grid:

- 230/66 kV transformer impedance and ratings
- 66 kV subtransmission line configuration, impedance and ratings
- Local generation data including interconnection point to the SCE 66 kV subtransmission system, generation transformer impedance and rating, real (P) and reactive (Q) power generation characteristics
- Projected annual peak load P and Q levels at local Chino area 66/12 kV distribution substations for 2003
- Location and electrical characteristics of shunts connected to the local Chino area 66 kV system

These data were installed in the bulk power system model. Discussions with SCE indicated that since these local subtransmission data were proprietary, substation letters would be assigned to the distribution substations served by the local 66 kV system and minor changes made to the data in order to disguise the proprietary information, and yet provide a good representative local area T&D model.

This detailed local 66 kV subtransmission model serves mini-grid subs A, B, C, D, E, F and U, as well as several other 66/12 kV substations located in the vicinity, but that are outside the Commonwealth Mini-grid area. Figure 3-4 presents a one-line diagram of a portion of the local subtransmission showing some connections to the Chino 230 kV transmission system and to mini-grid subs A, B, C, and U. Figure 3-5 presents a one-line diagram of a portion of the local subtransmission system showing some connections to the Mira Loma 230 kV transmission system and mini-grid subs D, E, and F.

As the mini-grid system data were being developed last fall, the team decided to model 12 kV feeders out of 66/12 kV subs G and I. These two subs are served by a different 66 kV subtransmission system emanating out of the Etiwanda bulk transmission substation. An electrical one-line supplied by SCE showed two 66 kV lines feeding Substation G and three 66 kV lines feeding Substation I. Electrical configurations and ratings similar to the subtransmission data were assumed for these five 66 kV lines. Figure 3-6 presents a one-line diagram of these local subtransmission lines showing the assumed connections to the Etiwanda 230 kV transmission system and mini-grid subs G, and I.

3.2 PSLF Base Case Model

The PSLF *base case* model is contained in two files attached to this report – mg03pk5.sav and mg03pk5.epc. The ".sav" file can be read directly by those who have the GE PSLF program. The ".epc" file is an ASCII file, which is used to transmit load flow cases to users of other load flow programs. This file can be imported by the PSLF program as well. Also included is a file obtained from GE, dexm.htm, which describes the data format in the .epc file.

The major load flow case parameters are shown in Table 3-1 for the PSLF base case model, with the mini-grid and local subtransmission systems added (Case mg03pk5) and the original model (Case 01hs4c). With the mini-grid added, there are 559 busses, 564 lines and 498 loads added to the original WECC 01hs4c case.

Table 3-1: Major Load Flow Case Parameters

Case Parameter	Case "mg03pk5"	WECC "01hs4c"
Buses	13786	13227
Branch Sections	12186	11622
Transformers	5502	5489
Generators	2392	2389
Loads	8276	7778

The mini-grid database described in the Task 1.1.6 report has been inserted in the base case model. MW and MVAR flows from mini-grid substation A into each of its 10 feeders are shown in Figure 3-7. MW and MVAR flows from mini-grid substation B into each of its 12 feeders are shown in Figure 3-8. MW and MVAR flows from mini-grid substation C into each of its 10 feeders are shown in Figure 3-9. MW and MVAR flows from mini-grid substation D into each of its 7 feeders are shown in Figure 3-10. MW and MVAR flows from mini-grid substation E into each of its 4 feeders are shown in Figure 3-11. MW and MVAR flows from mini-grid substation F into each of its 14 feeders are shown in Figure 3-12. MW and MVAR flows from mini-grid substation G into each of its 10 feeders are shown in Figure 3-13. MW and MVAR flows from mini-grid substation U into the two of its feeders serving loads in the mini-grid are shown in Figure 3-14. The remaining Substation U load is modeled at the Substation U 12 kV bus. MW and MVAR flows from mini-grid substation I into the three of its feeders serving loads in the mini-grid are shown in Figure 3-15. The remaining Substation I load is modeled at the Substation I 12 kV bus.

The branch flow in MVA and amps, and percent of the feeder branch rating for each branch of all of the 72 – 12 kV mini-grid feeders are listed in Appendix A of this report at projected 2003 peak load conditions. Branch rating in amps is also listed for each feeder branch.

Ampere ratings for each branch correspond to the branch MVA ratings presented in Task 1.1.6, in which branch ratings are limited to 12 MVA or less, or less than 600 amps in each branch. Note that current flows account for changes in nominal voltage along the 12 kV feeders.

Feeder voltage profiles, in per unit nominal 12 kV voltage, for each bus in the 72 – 12 kV feeders are listed in Appendix B of this report for projected 2003 peak load conditions. These voltage profiles reflect the SCE distribution design policy assumption that feeder loads will be corrected to unity power factor.

The other voltage profile assumption in the base case is to maintain per unit voltage greater than 97% of nominal voltage, in order to be compatible with California Public Utility Commission regulations. This assumed voltage regulation limitation on feeder voltage allows for an additional 2% voltage drop in distribution laterals and distribution secondary circuits, to maintain customer voltage at the customer service panel of 95% or higher, or 114 V on a 120 V base within the distribution system.

In order to maintain the 97% voltage criteria, additional shunts were added at several busses on some of the feeders as shown in Appendix C. Shunt capacitors in typical 600 to 1200 kVAR sizes were applied at the busses, keeping resulting voltage rise at the applied bus to less than 2%. Appendix C shows the bus number, bus name, shunt identification number, and capacitive admittance on a 100 MVA base, where the capacitors were applied in the year 2003 peak load base case. All of these capacitors are assumed to be switched, and therefore can be turned off during light loads.

3.3 Local Mini-grid Model Expansion

The first step in Task 1.1.9b power flow analysis is to expand the local base case peak load mini-grid system out to 2007 using a projected peak load growth rate of about 3% per year based on forecasts from the Commission's 2002-2012 Energy Outlook Report. Substation transformers and 12 kV feeders will be added as necessary using representative SCE distribution design practices to meet projected peak load increases. For example, transformer banks in Substations A and E are fully loaded under peak load conditions in the base case. Transformers will likely have to be added to these two subs in the first 5 years. Also several 12 kV feeders are highly loaded and additional feeders will also be added when the new substation transformers are added to meet the peak loads.

A "light load" case in 2007 (5 years out) will then be developed from the initially developed peak load case. This light load case will be set up to reflect "light" utility loading and expected high renewable (PV) generation output. Light utility load levels will be determined from appropriate utility load shape information during light load spring conditions, when there is high solar insolation and relatively cool weather to ensure high PV system efficiencies coupled with low air conditioning loads.

The same procedure will then be repeated for the second 5 years, out to year 2012, using the 2002-2012 Energy Outlook projected peak load growth forecast of about 1.7% per year.

This base case mini-grid model will then be expanded as described above, only with the Commonwealth Energy mini-grid renewable resources added to the system, while maintaining appropriate SCE distribution design practices to determine the system impacts associated with employing the expected new renewable distributed generation resources.

Figure 3-1: Chino Bulk Transmission Substation Configuration

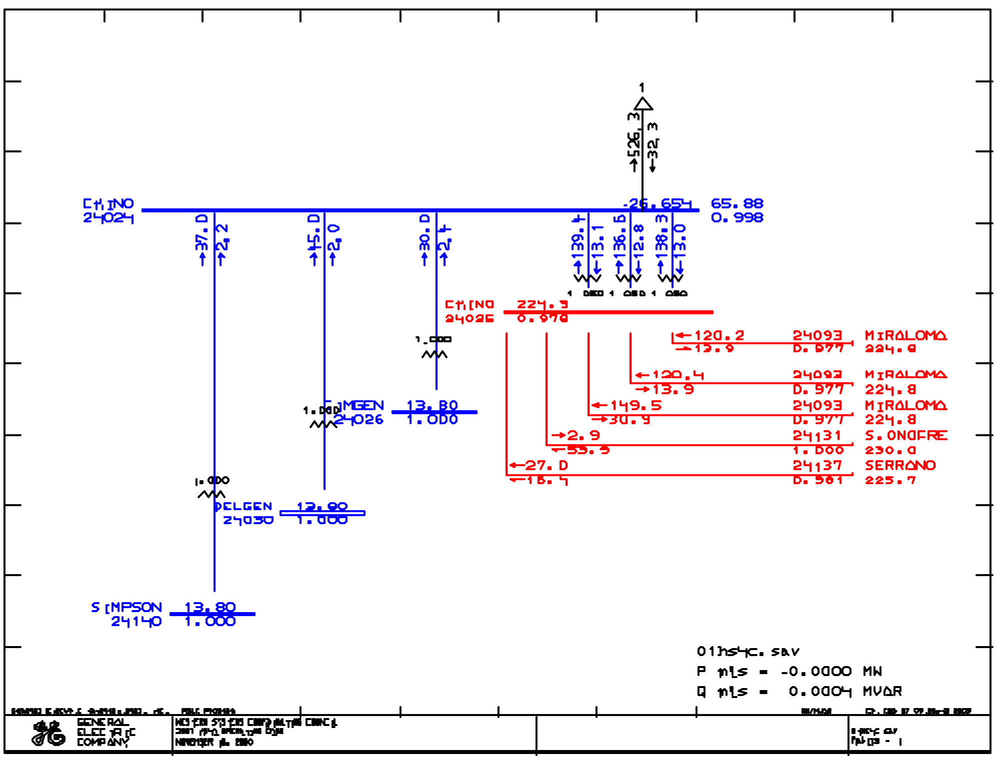


Figure 3-2: Mira Loma Bulk Transmission Substation Configuration

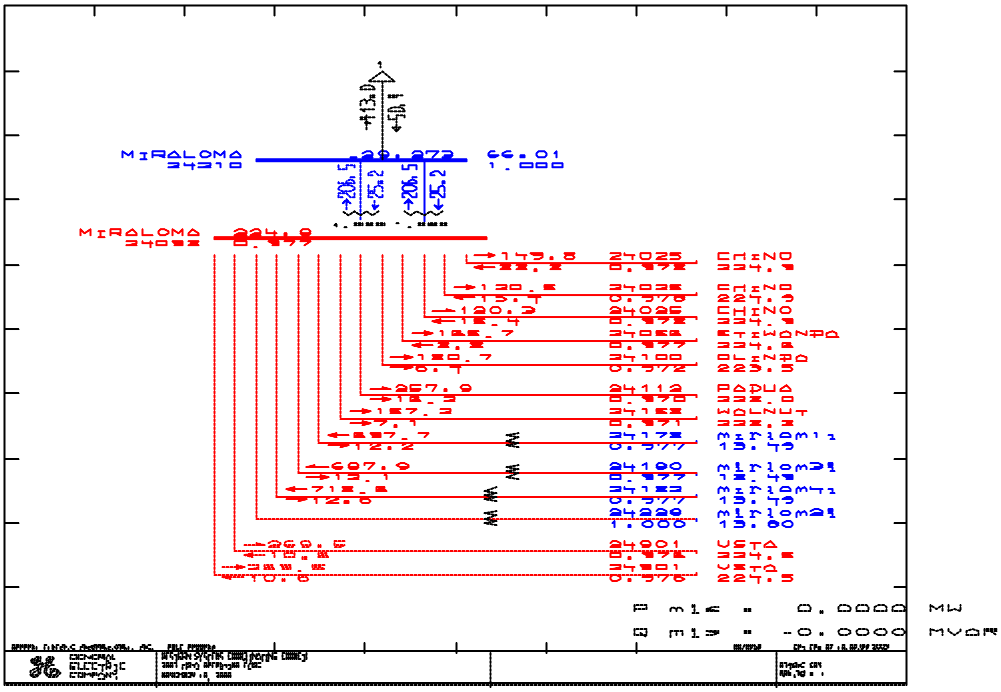


Figure 3-3: Etiwanda Bulk Transmission Substation Configuration

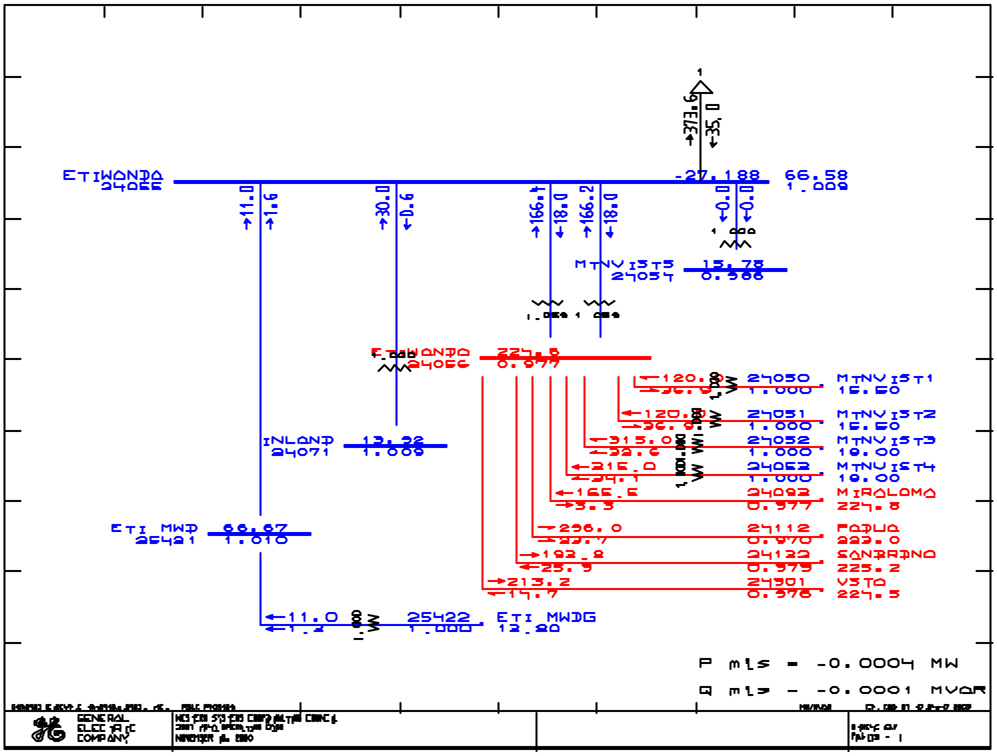


Figure 3-4: Portion of local 66 kV subtransmission serving Subs A, B, C & U

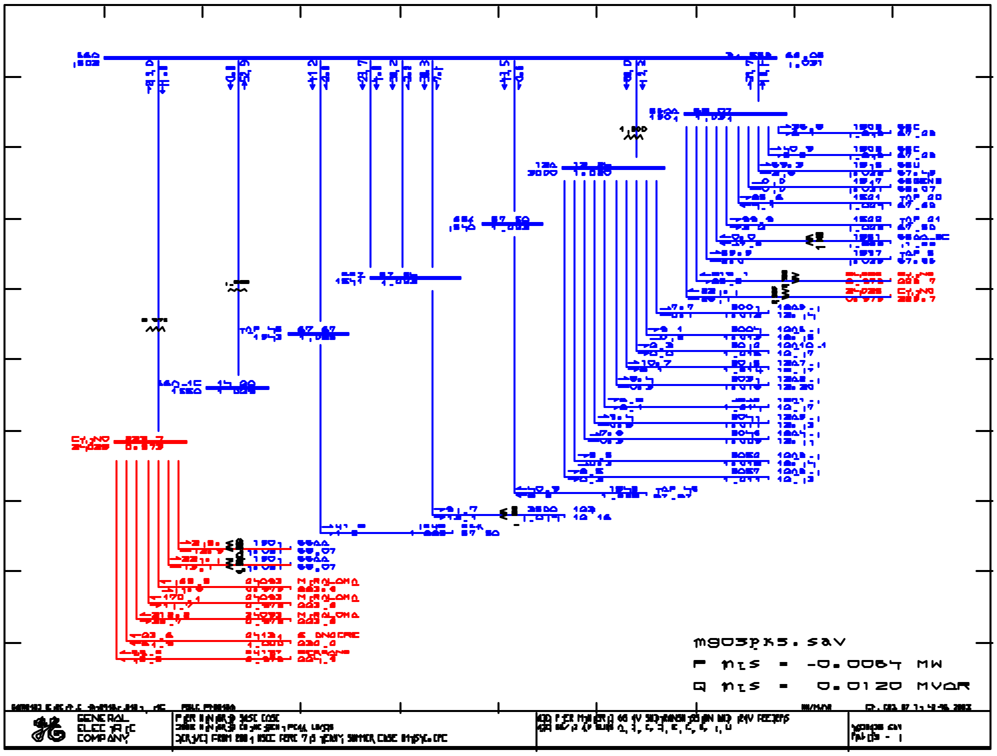


Figure 3-5: Portion of local 66 kV subtransmission serving Subs D, E & F

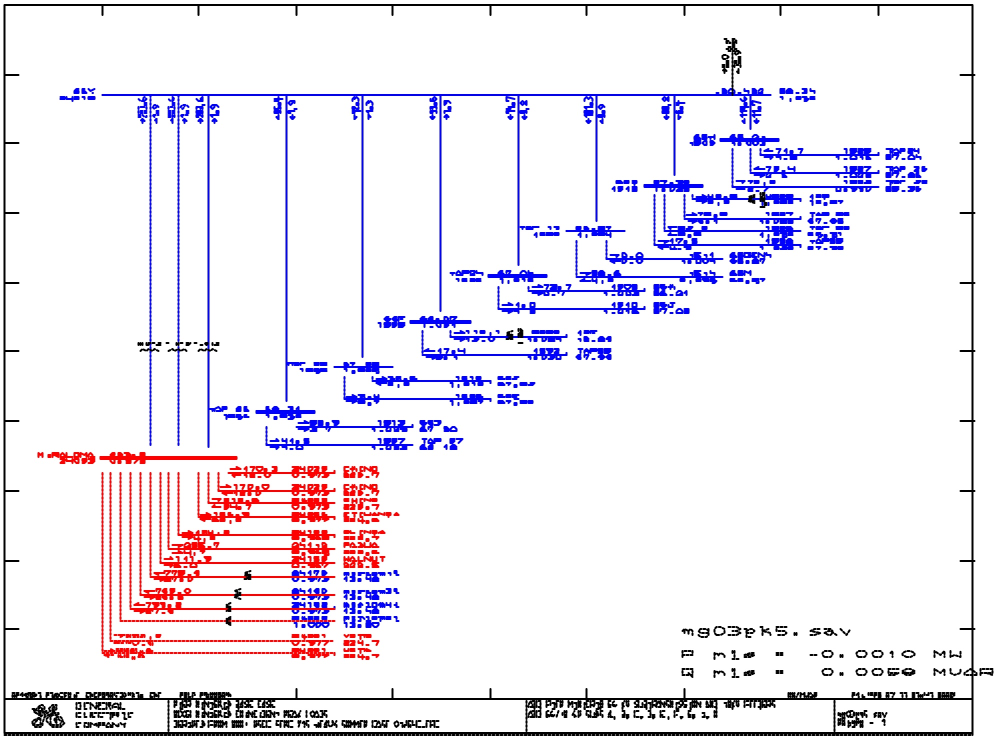


Figure 3-6: Assumed local 66 kV subtransmission serving Subs G & I

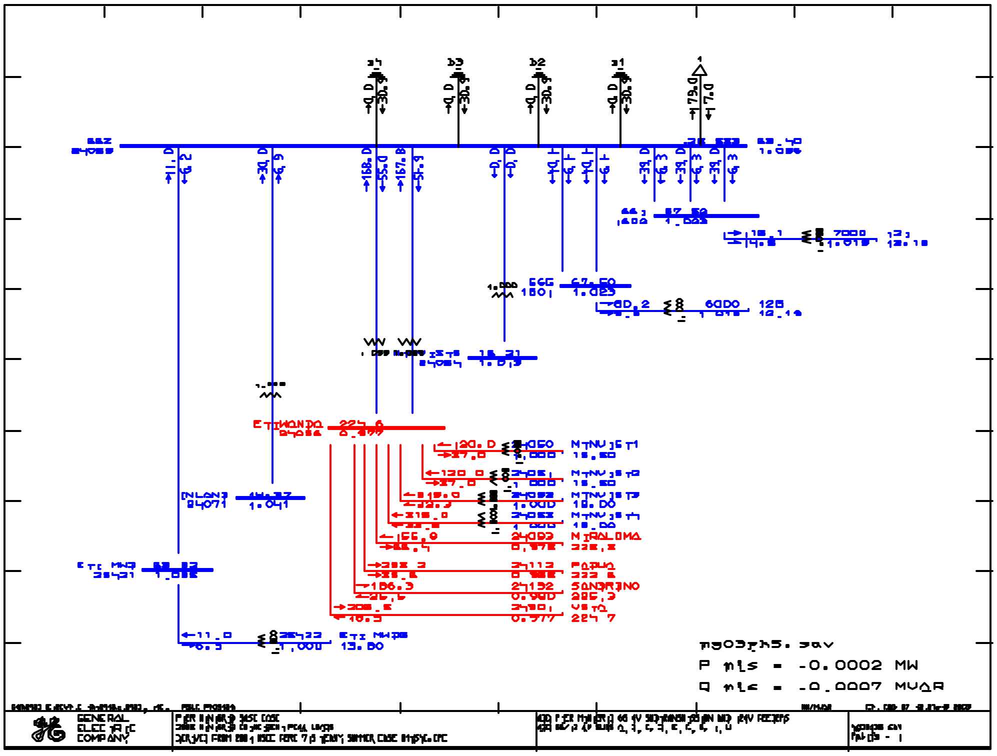


Figure 3-7: Base case MW and MVAR flows out of Substation A

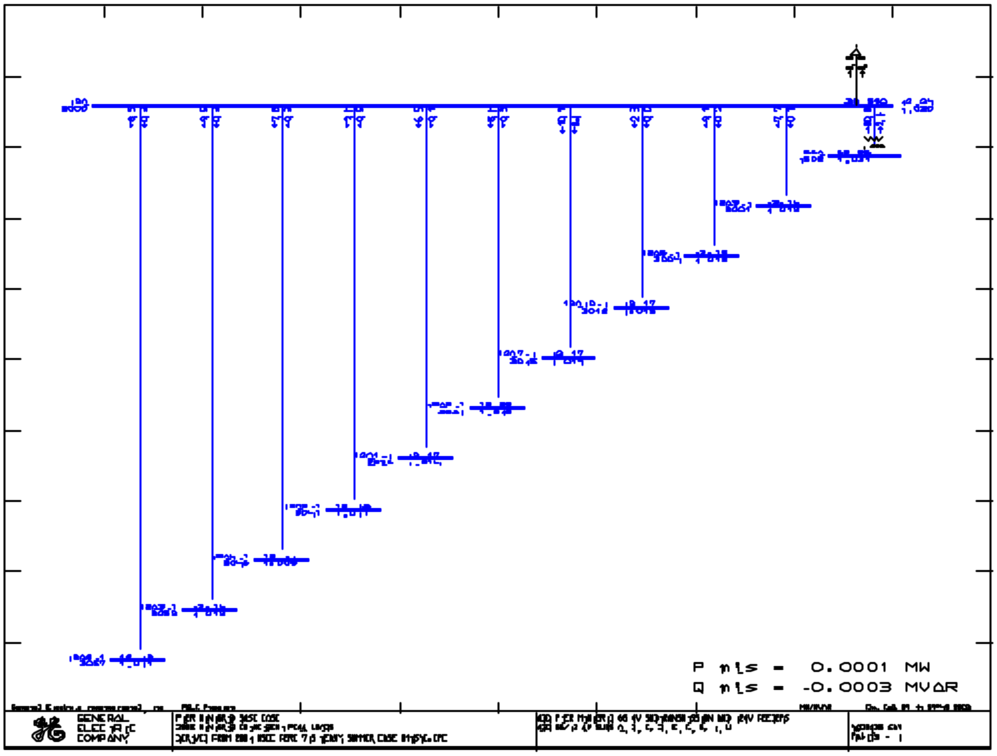


Figure 3-8: Base case MW and MVAR flows out of Substation B

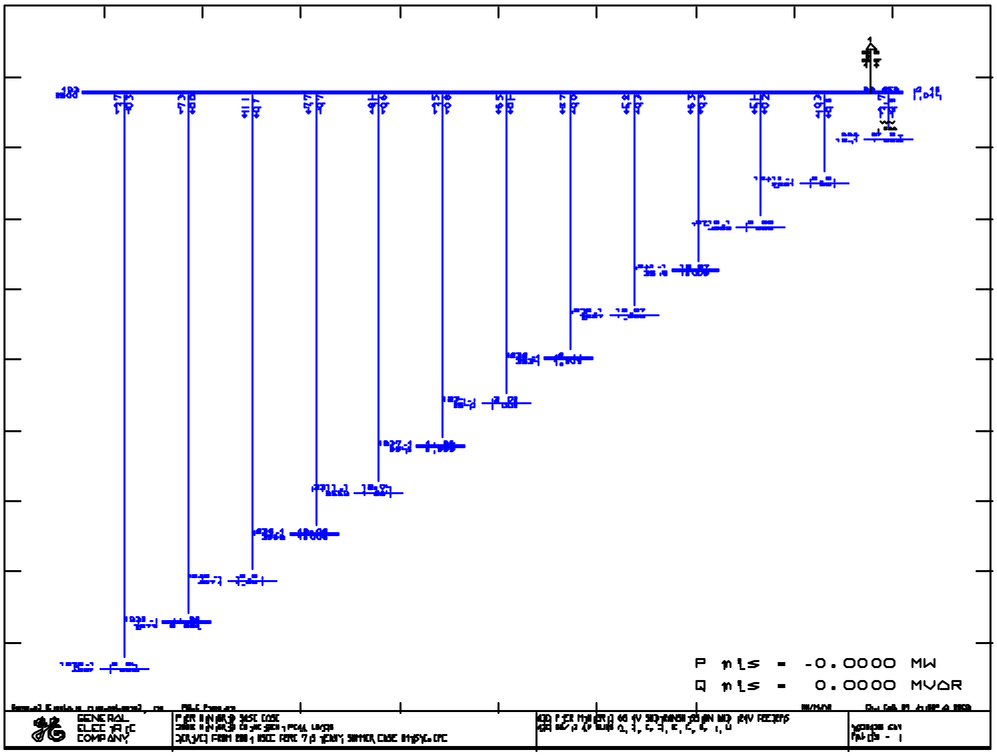


Figure 3-9: Base case MW and MVAR flows out of Substation C

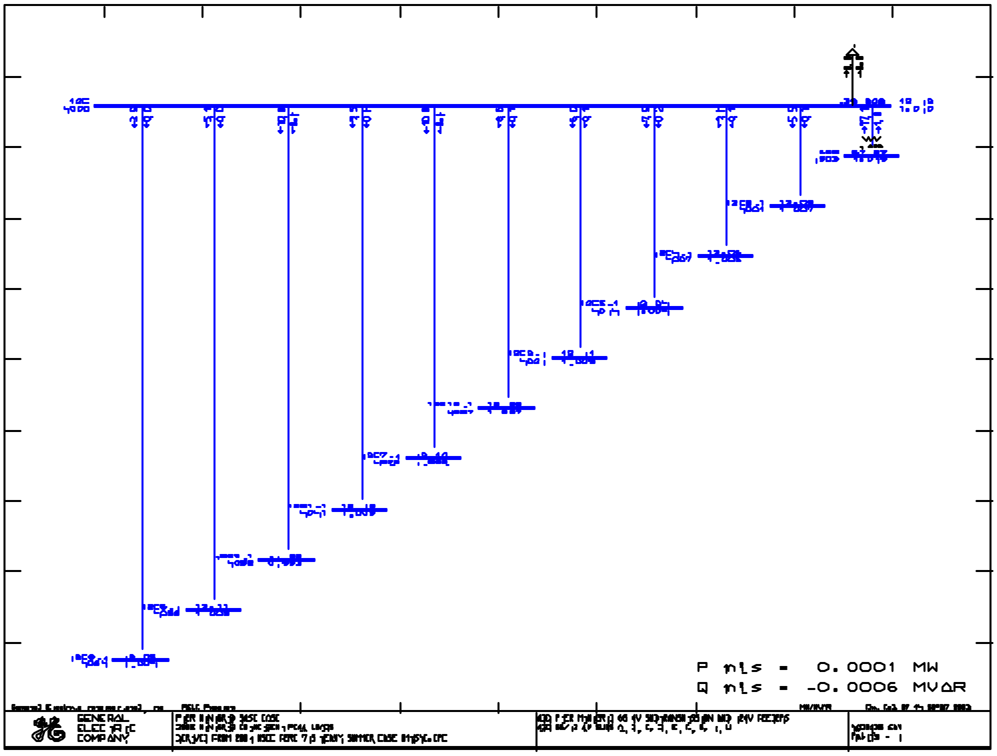


Figure 3-10: Base case MW and MVAR flows out of Substation D

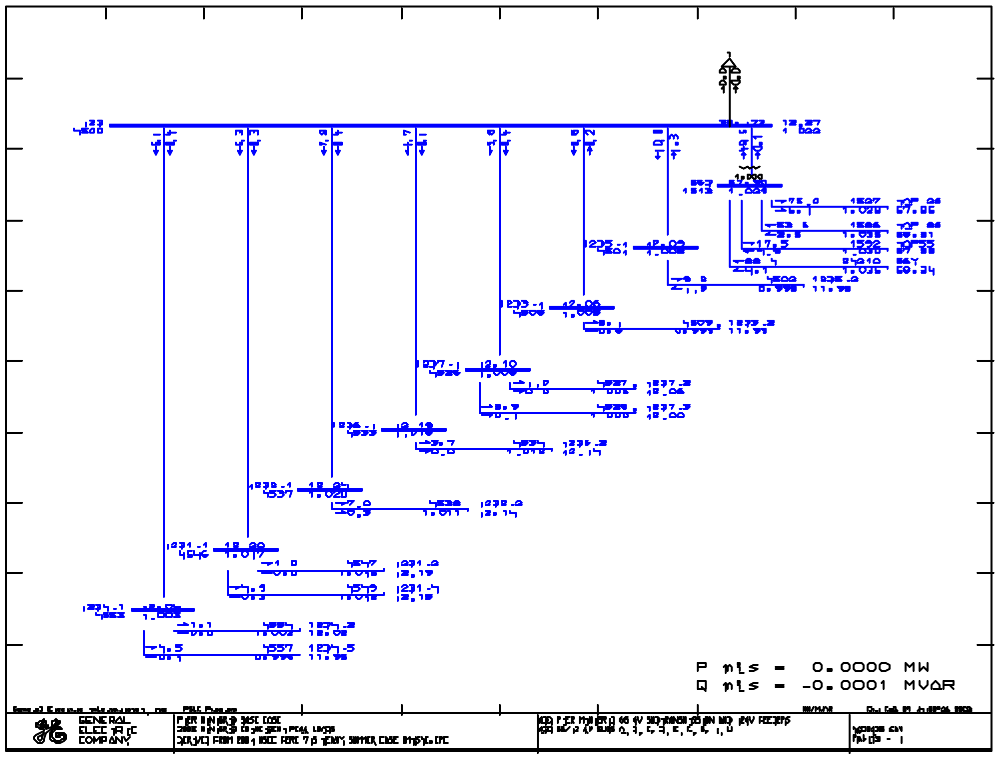


Figure 3-11: Base case MW and MVAR flows out of Substation E

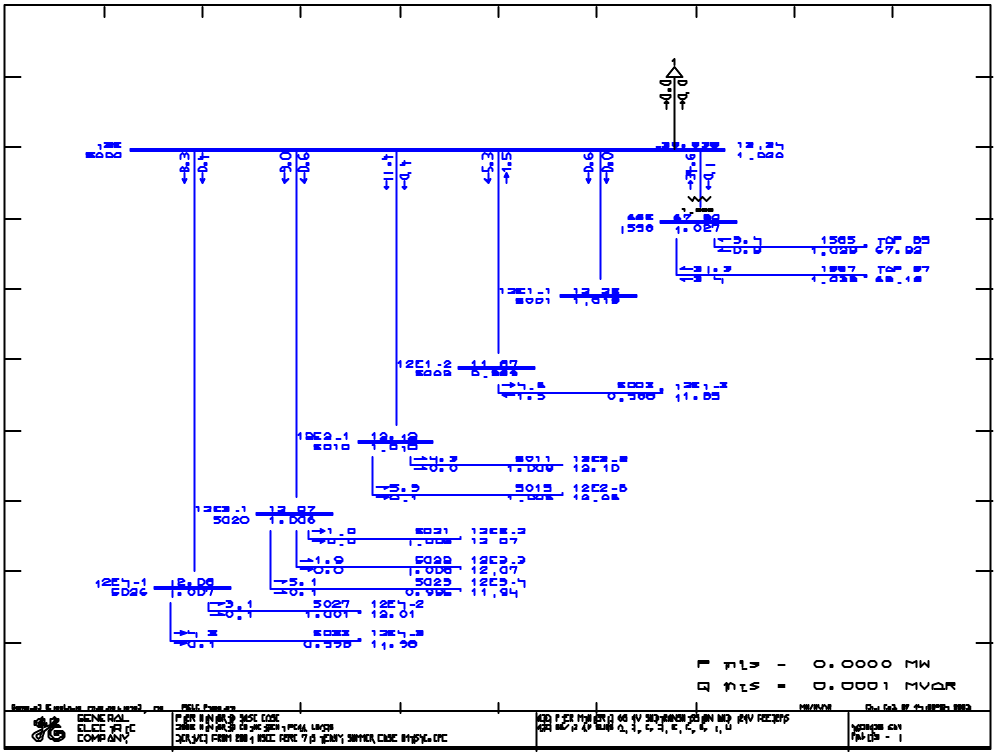


Figure 3-12: Base case MW and MVAR flows out of Substation F

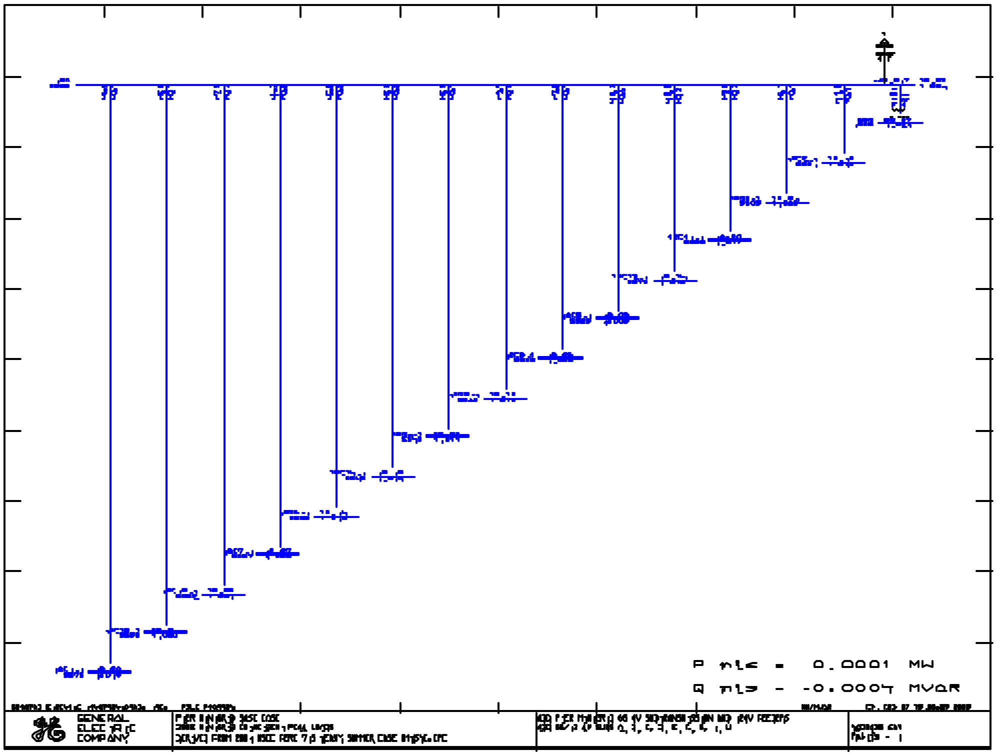


Figure 3-13: Base case MW and MVAR flows out of Substation G

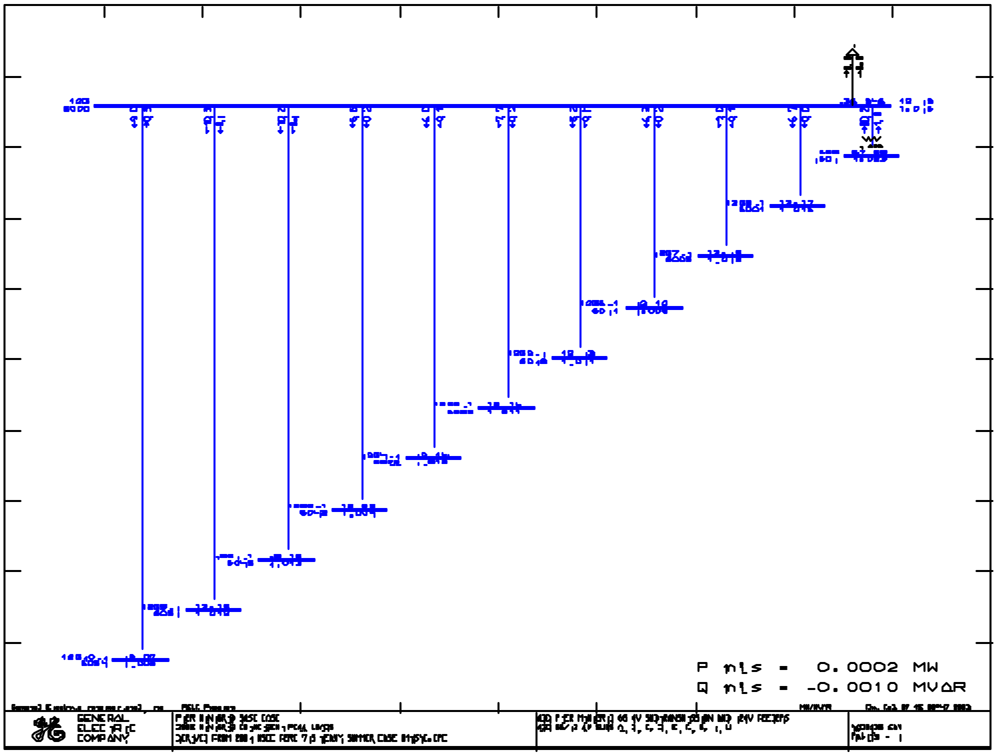


Figure 3-14: Base case MW and MVAR flows out of Substation U

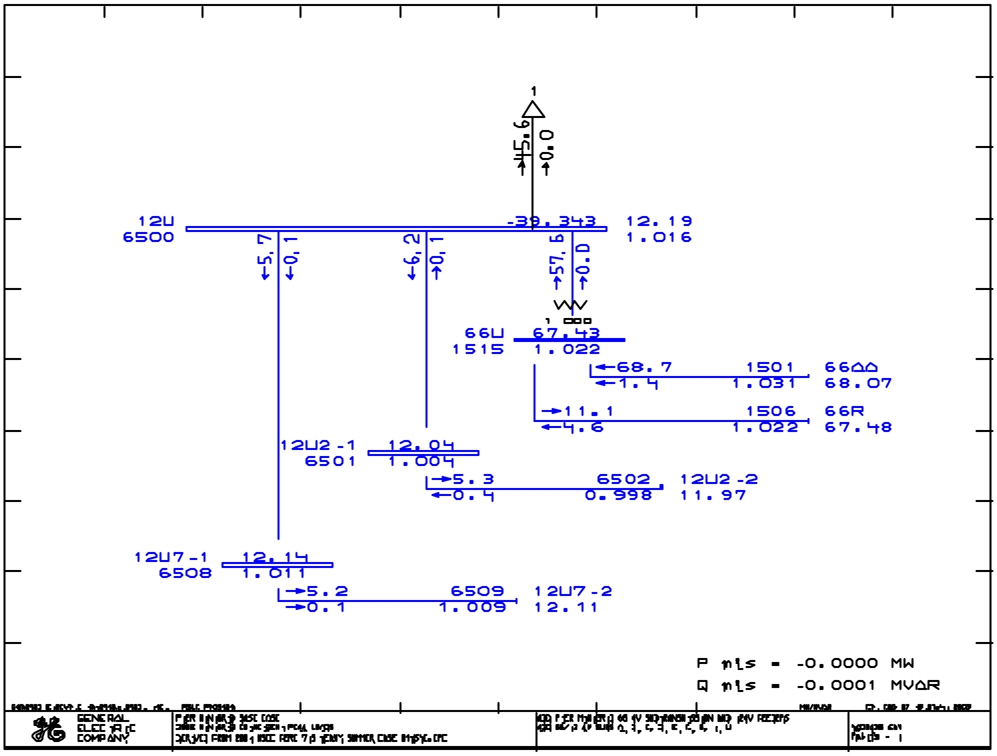
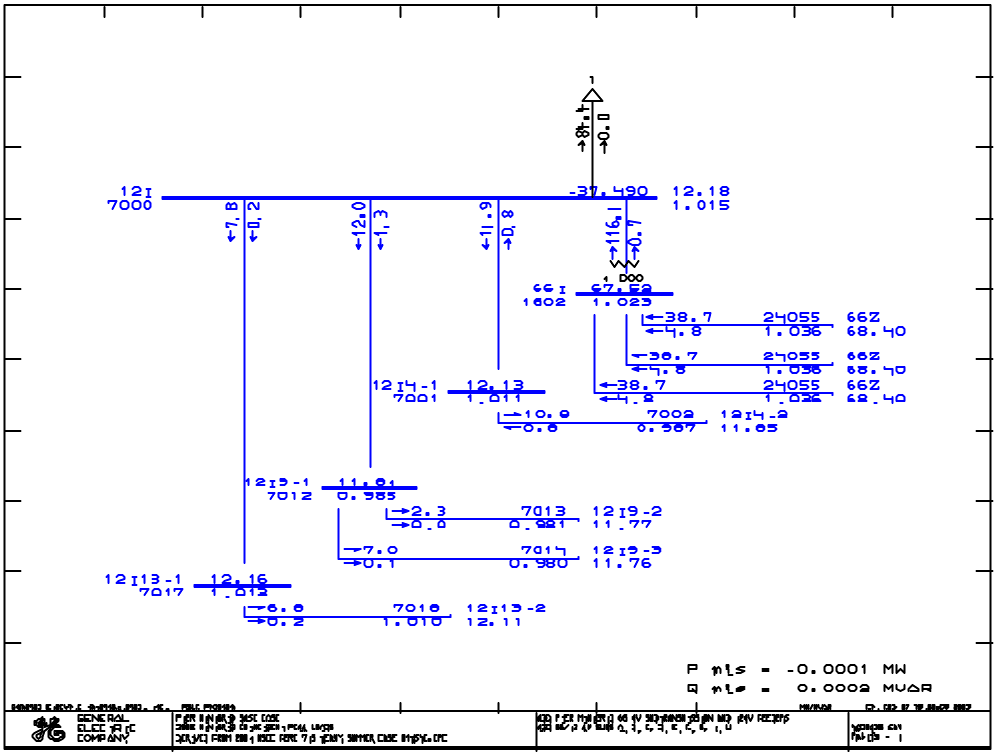


Figure 3-15: Base case MW and MVAR flows out of Substation I



4

Summary of Power Flow Model Development and Base Case Analysis

4.1 T&D Power Flow Model Development

The nine 66/12 kV substation and 72 - 12 kV feeder database and local 66 kV subtransmission system serving the local Chino basin mini-grid have been successfully incorporated and integrated with the GE PSLF Western Electricity Coordination Council bulk transmission model. The resulting *base case* T&D model is included in the attached PSLF "mg03pk5.sav" file for use with the GE PSLF load flow program, and associated "mg03pk5.epc" file for use in importing into other load flow programs. These two files are included in Appendix D as electronic attachments to this Task 1.1.9(a) report.

4.2 Mini-Grid Base Case Analysis

This resulting base case T&D model provides a good representation of the existing 500/230 kV bulk transmission facilities, and the local 66 kV subtransmission facilities supplying the local Chino basin mini-grid electric system developed under Task 1.1.6, as well as the mini-grid's power flows and voltage characteristics. This resulting base case T&D model provides a high-quality depiction of: 1) the local T&D facilities suitable for expanding the local mini-grid system out 5 and 10 years to 2007 and 2012, 2) developing appropriate peak and light load T&D detailed power flow models first without renewables, 3) then with the projected biogas and nonresidential PV renewable distributed generation added to the system, 4) to determine relative T&D impacts for the matrix of renewable resource cases to be studied next under Task 1.1.9b of this Commonwealth PIER Renewables Mini-grid Planning and Analysis Project.

Appendix A

Peak Load Mini-Grid Branch Flows

Table A-1: Projected 2003 Peak Load Mini-Grid Branch Flows

From Bus No.	From Bus Name	To Bus No.	To Bus Name	Branch Flow MVA	Branch Flow AMPS	% Rating	Rating AMPS
3000	12A	3036	12A1-1	6.5	305	57.6	529
3000	12A	3015	12A7-1	10.7	505	87.4	577
3000	12A	3052	12A3-1	9.5	447	77.3	577
3000	12A	3041	12A5-1	9.4	445	77.1	577
3000	12A	3004	12A6-1	9.1	431	81.5	529
3000	12A	3057	12A8-1	8.5	402	69.6	577
3000	12A	3031	12A2-1	8.4	396	68.6	577
3000	12A	3012	12A10-1	2.3	111	20.9	529
3000	12A	3046	12A4-1	7.8	369	63.9	577
3000	12A	3001	12A9-1	7.7	365	69.0	529
3001	12A9-1	3002	12A9-2	5.1	241	45.4	529
3002	12A9-2	3003	12A9-3	2.5	120	22.7	529
3004	12A6-1	3005	12A6-2	8.0	381	71.9	529
3005	12A6-2	3006	12A6-3	6.9	330	62.3	529
3006	12A6-3	3007	12A6-4	3.5	167	29.0	577
3006	12A6-3	3010	12A6-7	2.3	112	31.7	351
3007	12A6-4	3008	12A6-5	2.3	112	21.1	529
3008	12A6-5	3009	12A6-6	1.2	56	10.5	529
3010	12A6-7	3011	12A6-8	1.2	56	15.9	351
3012	12A10-1	3014	12A10-3	0.8	37	10.5	351
3012	12A10-1	3013	12A10-2	0.8	37	10.5	351
3015	12A7-1	3016	12A7-2	0.9	42	10.3	404
3015	12A7-1	3017	12A7-3	9.0	426	73.8	577
3017	12A7-3	3020	12A7-6	7.2	343	59.4	577
3017	12A7-3	3018	12A7-4	1.8	84	15.8	529
3018	12A7-4	3019	12A7-5	0.9	42	7.9	529

From Bus No.	From Bus Name	To Bus No.	To Bus Name	Branch Flow MVA	Branch Flow AMPS	% Rating	Rating AMPS
3020	12A7-6	3021	12A7-7	6.2	301	56.8	529
3021	12A7-7	3022	12A7-8	2.7	132	22.8	577
3021	12A7-7	3026	12A7-12	3.5	171	29.6	577
3022	12A7-8	3023	12A7-9	1.9	91	32.4	279
3022	12A7-8	3025	12A7-11	0.9	43	10.5	404
3023	12A7-9	3024	12A7-10	1.1	52	36.9	140
3026	12A7-12	3028	12A7-14	2.6	128	22.2	577
3026	12A7-12	3027	12A7-13	0.9	43	15.3	279
3028	12A7-14	3029	12A7-15	0.9	43	8.1	529
3028	12A7-14	3030	12A7-16	0.9	43	8.1	529
3031	12A2-1	3032	12A2-2	5.9	282	48.8	577
3032	12A2-2	3033	12A2-3	3.4	164	31.1	529
3033	12A2-3	3035	12A2-5	1.0	47	29.7	159
3033	12A2-3	3034	12A2-4	2.4	117	20.3	577
3036	12A1-1	3037	12A1-2	5.2	245	46.3	529
3037	12A1-2	3038	12A1-3	1.3	60	10.4	577
3037	12A1-2	3039	12A1-4	2.6	125	21.6	577
3039	12A1-4	3040	12A1-5	1.4	65	12.2	529
3041	12A5-1	3042	12A5-2	7.5	357	61.9	577
3042	12A5-2	3043	12A5-3	5.6	269	50.7	529
3043	12A5-3	3044	12A5-4	3.7	180	31.1	577
3044	12A5-4	3045	12A5-5	1.9	90	21.8	414
3046	12A4-1	3047	12A4-2	6.5	309	53.5	577
3047	12A4-2	3049	12A4-4	1.3	61	21.8	279
3047	12A4-2	3048	12A4-3	1.3	61	10.5	577
3047	12A4-2	3050	12A4-5	2.6	127	21.9	577
3050	12A4-5	3051	12A4-6	1.4	66	11.4	577
3052	12A3-1	3053	12A3-2	7.5	359	62.2	577
3053	12A3-2	3054	12A3-3	5.7	271	46.9	577
3054	12A3-3	3055	12A3-4	3.8	182	51.9	351
3055	12A3-4	3056	12A3-5	1.9	93	16.2	577
3057	12A8-1	3058	12A8-2	6.8	323	56.0	577
3058	12A8-2	3059	12A8-3	5.1	244	42.3	577
3059	12A8-3	3060	12A8-4	3.4	165	46.9	351
3060	12A8-4	3061	12A8-5	1.8	85	14.7	577
3500	12B	3579	12B3-1	7.3	344	59.6	577

From Bus No.	From Bus Name	To Bus No.	To Bus Name	Branch Flow MVA	Branch Flow AMPS	% Rating	Rating AMPS
3500	12B	3534	12B2-1	3.7	178	63.7	279
3500	12B	3527	12B5-1	5.8	276	47.8	577
3500	12B	3562	12B6-1	7.7	367	69.3	529
3500	12B	3571	12B8-1	11.1	527	91.2	577
3500	12B	3501	12B12-1	10.3	491	85.0	577
3500	12B	3545	12B7-1	9.5	453	78.5	577
3500	12B	3540	12B4-1	6.5	310	53.7	577
3500	12B	3509	12B10-1	5.4	257	44.4	577
3500	12B	3587	12B9-1	9.7	462	80.0	577
3500	12B	3518	12B1-1	6.3	299	51.7	577
3500	12B	3552	12B11-1	8.4	400	69.3	577
3501	12B12-1	3506	12B12-6	3.5	166	28.8	577
3501	12B12-1	3502	12B12-2	6.8	325	56.2	577
3502	12B12-2	3505	12B12-5	1.7	84	30.0	279
3502	12B12-2	3504	12B12-4	1.7	83	14.4	577
3502	12B12-2	3503	12B12-3	1.7	84	30.0	279
3506	12B12-6	3508	12B12-8	1.7	83	23.6	351
3506	12B12-6	3507	12B12-7	1.7	83	29.9	279
3509	12B10-1	3510	12B10-2	4.6	220	38.1	577
3510	12B10-2	3511	12B10-3	3.8	184	31.8	577
3511	12B10-3	3512	12B10-4	3.1	147	25.4	577
3512	12B10-4	3513	12B10-5	0.8	37	9.1	404
3512	12B10-4	3514	12B10-6	2.3	110	19.1	577
3514	12B10-6	3515	12B10-7	1.5	74	12.7	577
3515	12B10-7	3516	12B10-8	0.8	37	13.2	279
3515	12B10-7	3517	12B10-9	0.8	37	6.4	577
3518	12B1-1	3519	12B1-2	5.2	249	43.0	577
3519	12B1-2	3520	12B1-3	1.1	51	18.2	279
3519	12B1-2	3521	12B1-4	4.1	198	34.3	577
3521	12B1-4	3523	12B1-6	3.1	147	25.5	577
3521	12B1-4	3522	12B1-5	1.1	51	18.2	279
3523	12B1-6	3524	12B1-7	1.1	51	9.6	529
3523	12B1-6	3525	12B1-8	1.1	51	8.8	577
3523	12B1-6	3526	12B1-9	1.0	46	8.7	529
3527	12B5-1	3529	12B5-3	4.8	230	39.9	577
3527	12B5-1	3528	12B5-2	1.0	46	8.6	529

From Bus No.	From Bus Name	To Bus No.	To Bus Name	Branch Flow MVA	Branch Flow AMPS	% Rating	Rating AMPS
3529	12B5-3	3531	12B5-5	2.9	138	26.2	529
3529	12B5-3	3530	12B5-4	1.0	46	8.7	529
3531	12B5-5	3532	12B5-6	1.9	92	16.0	577
3532	12B5-6	3533	12B5-7	1.0	46	11.4	404
3534	12B2-1	3535	12B2-2	3.1	146	25.3	577
3535	12B2-2	3536	12B2-3	0.8	37	6.3	577
3535	12B2-2	3537	12B2-4	1.5	73	12.6	577
3537	12B2-4	3538	12B2-5	0.8	37	6.9	529
3537	12B2-4	3539	12B2-6	0.8	37	6.3	577
3540	12B4-1	3541	12B4-2	5.2	250	43.3	577
3541	12B4-2	3542	12B4-3	3.9	190	32.9	577
3542	12B4-3	3543	12B4-4	1.2	60	10.4	577
3542	12B4-3	3544	12B4-5	1.4	70	25.0	279
3545	12B7-1	3546	12B7-2	7.8	379	65.6	577
3546	12B7-2	3548	12B7-4	1.5	75	12.9	577
3546	12B7-2	3549	12B7-5	1.5	75	12.9	577
3546	12B7-2	3550	12B7-6	3.2	155	26.8	577
3546	12B7-2	3547	12B7-3	1.5	75	21.3	351
3550	12B7-6	3551	12B7-7	1.6	80	15.1	529
3552	12B11-1	3553	12B11-2	0.8	37	13.2	279
3552	12B11-1	3554	12B11-3	6.8	327	61.7	529
3554	12B11-3	3555	12B11-4	5.8	280	52.9	529
3555	12B11-4	3556	12B11-5	1.0	47	11.5	404
3555	12B11-4	3558	12B11-7	3.8	187	46.3	404
3558	12B11-7	3559	12B11-8	2.9	140	24.3	577
3559	12B11-8	3560	12B11-9	1.0	47	8.1	577
3559	12B11-8	3561	12B11-10	1.0	47	8.1	577
3562	12B6-1	3563	12B6-2	6.6	317	59.8	529
3563	12B6-2	3564	12B6-3	5.6	267	50.5	529
3564	12B6-3	3565	12B6-4	4.5	218	83.8	260
3565	12B6-4	3566	12B6-5	3.5	169	29.2	577
3566	12B6-5	3567	12B6-6	1.1	51	8.9	577
3566	12B6-5	3568	12B6-7	2.5	121	22.9	529
3568	12B6-7	3570	12B6-9	1.3	63	11.9	529
3568	12B6-7	3569	12B6-8	1.2	59	16.7	351
3571	12B8-1	3574	12B8-4	7.5	361	62.5	577

From Bus No.	From Bus Name	To Bus No.	To Bus Name	Branch Flow MVA	Branch Flow AMPS	% Rating	Rating AMPS
3571	12B8-1	3572	12B8-2	2.3	111	39.7	279
3572	12B8-2	3573	12B8-3	1.1	56	19.9	279
3574	12B8-4	3575	12B8-5	6.3	305	52.9	577
3575	12B8-5	3576	12B8-6	5.2	250	47.2	529
3576	12B8-6	3577	12B8-7	1.1	56	13.7	404
3576	12B8-6	3578	12B8-8	2.9	139	24.1	577
3579	12B3-1	3580	12B3-2	1.7	83	14.4	577
3579	12B3-1	3582	12B3-4	4.6	222	53.7	414
3580	12B3-2	3581	12B3-3	0.9	42	7.2	577
3582	12B3-4	3583	12B3-5	3.7	182	51.8	351
3583	12B3-5	3585	12B3-7	2.9	143	40.6	351
3584	12B3-6	3586	12B3-8	1.0	51	18.2	279
3585	12B3-7	3586	12B3-8	2.2	105	37.8	279
3587	12B9-1	3588	12B9-2	8.5	407	76.9	529
3588	12B9-2	3590	12B9-4	7.2	352	66.4	529
3588	12B9-2	3589	12B9-3	1.2	56	20.1	279
3590	12B9-4	3592	12B9-6	6.1	296	56.0	529
3590	12B9-4	3591	12B9-5	1.1	56	9.7	577
3592	12B9-6	3593	12B9-7	4.9	241	41.8	577
3593	12B9-7	3596	12B9-10	1.4	67	11.6	577
3593	12B9-7	3594	12B9-8	2.5	121	20.9	577
3594	12B9-8	3595	12B9-9	1.4	67	11.6	577
4000	12C	4032	12C7-1	10.8	513	88.9	577
4000	12C	4064	12C8-1	3.9	184	31.9	577
4000	12C	4014	12C5-1	7.5	356	61.7	577
4000	12C	4001	12C3-1	5.5	261	45.2	577
4000	12C	4041	12C1-1	9.5	454	78.7	577
4000	12C	4052	12C9-1	10.8	516	89.4	577
4000	12C	4007	12C4-1	9.4	450	77.9	577
4000	12C	4021	12C2-1	6.0	287	49.7	577
4000	12C	4027	12C10-1	8.6	409	70.9	577
4000	12C	4058	12C6-1	5.1	242	42.0	577
4001	12C3-1	4002	12C3-2	4.4	212	36.7	577
4002	12C3-2	4003	12C3-3	3.4	163	28.1	577
4003	12C3-3	4004	12C3-4	2.3	108	18.8	577
4004	12C3-4	4005	12C3-5	1.5	72	20.6	351

From Bus No.	From Bus Name	To Bus No.	To Bus Name	Branch Flow MVA	Branch Flow AMPS	% Rating	Rating AMPS
4005	12C3-5	4006	12C3-6	0.8	36	10.3	351
4007	12C4-1	4008	12C4-2	5.6	270	46.8	577
4008	12C4-2	4009	12C4-3	1.9	90	15.6	577
4008	12C4-2	4011	12C4-5	2.8	135	25.6	529
4009	12C4-3	4010	12C4-4	0.9	45	7.8	577
4011	12C4-5	4012	12C4-6	1.9	90	15.6	577
4012	12C4-6	4013	12C4-7	0.9	45	7.8	577
4014	12C5-1	4015	12C5-2	6.4	307	53.1	577
4015	12C5-2	4016	12C5-3	2.1	99	17.2	577
4015	12C5-2	4020	12C5-7	3.1	149	25.8	577
4016	12C5-3	4017	12C5-4	1.0	50	8.6	577
4018	12C5-5	4019	12C5-6	1.0	50	8.6	577
4019	12C5-6	4020	12C5-7	2.1	99	17.2	577
4021	12C2-1	4022	12C2-2	4.5	216	37.3	577
4022	12C2-2	4023	12C2-3	3.4	162	28.0	577
4023	12C2-3	4024	12C2-4	2.3	108	18.7	577
4024	12C2-4	4026	12C2-6	1.1	54	9.3	577
4024	12C2-4	4025	12C2-5	1.1	54	10.2	529
4027	12C10-1	4028	12C10-2	7.2	342	59.2	577
4028	12C10-2	4029	12C10-3	2.9	139	24.1	577
4028	12C10-2	4030	12C10-4	2.8	135	23.4	577
4030	12C10-4	4031	12C10-5	1.4	68	11.7	577
4032	12C7-1	4033	12C7-2	9.4	451	78.1	577
4033	12C7-2	4035	12C7-4	8.1	388	67.2	577
4033	12C7-2	4034	12C7-3	1.3	63	15.6	404
4035	12C7-4	4036	12C7-5	6.7	324	56.2	577
4036	12C7-5	4039	12C7-8	2.7	133	47.6	279
4036	12C7-5	4037	12C7-6	2.6	128	22.1	577
4037	12C7-6	4038	12C7-7	1.3	64	12.1	529
4039	12C7-8	4040	12C7-9	1.4	69	24.7	279
4041	12C1-1	4042	12C1-2	8.7	414	71.7	577
4042	12C1-2	4043	12C1-3	7.8	374	64.8	577
4043	12C1-3	4044	12C1-4	7.0	333	57.8	577
4044	12C1-4	4045	12C1-5	6.1	293	50.7	577
4045	12C1-5	4046	12C1-6	5.2	252	43.7	577
4046	12C1-6	4047	12C1-7	4.3	211	36.6	577

From Bus No.	From Bus Name	To Bus No.	To Bus Name	Branch Flow MVA	Branch Flow AMPS	% Rating	Rating AMPS
4047	12C1-7	4050	12C1-10	1.8	87	31.3	279
4047	12C1-7	4048	12C1-8	1.7	83	14.3	577
4048	12C1-8	4049	12C1-9	0.8	41	14.8	279
4050	12C1-10	4051	12C1-11	0.9	46	16.5	279
4052	12C9-1	4053	12C9-2	9.6	466	80.8	577
4053	12C9-2	4054	12C9-3	8.2	398	75.2	529
4054	12C9-3	4055	12C9-4	4.7	229	65.2	351
4054	12C9-3	4056	12C9-5	2.4	119	33.9	351
4056	12C9-5	4057	12C9-6	1.0	50	8.7	577
4058	12C6-1	4059	12C6-2	4.2	202	38.2	529
4059	12C6-2	4060	12C6-3	0.8	40	7.6	529
4059	12C6-2	4061	12C6-4	2.5	121	22.9	529
4061	12C6-4	4062	12C6-5	1.7	81	14.0	577
4062	12C6-5	4063	12C6-6	0.8	41	7.7	529
4064	12C8-1	4065	12C8-2	0.5	23	4.2	529
4500	12D	4501	12D5-1	10.1	476	82.4	577
4500	12D	4526	12D7-1	5.8	275	47.7	577
4500	12D	4553	12D4-1	6.1	287	49.7	577
4500	12D	4533	12D6-1	4.7	222	38.5	577
4500	12D	4508	12D3-1	8.6	406	70.3	577
4500	12D	4537	12D2-1	7.9	369	64.0	577
4500	12D	4546	12D1-1	6.4	299	51.8	577
4501	12D5-1	4502	12D5-2	9.4	449	77.8	577
4502	12D5-2	4503	12D5-3	8.8	422	73.2	577
4503	12D5-3	4504	12D5-4	2.2	109	18.8	577
4503	12D5-3	4506	12D5-6	6.6	319	55.2	577
4504	12D5-4	4505	12D5-5	1.1	54	9.4	577
4506	12D5-6	4507	12D5-7	5.9	286	49.5	577
4508	12D3-1	4509	12D3-2	8.1	388	67.1	577
4509	12D3-2	4511	12D3-4	7.3	351	60.8	577
4509	12D3-2	4510	12D3-3	0.4	18	4.6	404
4511	12D3-4	4512	12D3-5	1.1	56	9.7	577
4511	12D3-4	4515	12D3-8	5.0	246	46.4	529
4512	12D3-5	4513	12D3-6	0.4	19	6.7	279
4512	12D3-5	4514	12D3-7	0.4	19	6.7	279
4515	12D3-8	4516	12D3-9	4.0	196	55.8	351

From Bus No.	From Bus Name	To Bus No.	To Bus Name	Branch Flow MVA	Branch Flow AMPS	% Rating	Rating AMPS
4516	12D3-9	4524	12D3-17	0.8	38	13.5	279
4516	12D3-9	4518	12D3-11	2.6	126	21.8	577
4516	12D3-9	4517	12D3-10	0.4	19	13.4	140
4518	12D3-11	4519	12D3-12	0.4	19	13.4	140
4518	12D3-11	4520	12D3-13	2.2	109	18.9	577
4520	12D3-13	4522	12D3-15	1.0	47	8.1	577
4520	12D3-13	4521	12D3-14	1.3	63	15.5	404
4522	12D3-15	4523	12D3-16	0.7	34	24.4	140
4524	12D3-17	4525	12D3-18	0.4	19	7.2	260
4526	12D7-1	4527	12D7-2	1.0	46	11.3	404
4526	12D7-1	4528	12D7-3	3.9	184	31.9	577
4528	12D7-3	4530	12D7-5	1.9	92	22.3	414
4528	12D7-3	4529	12D7-4	1.0	46	8.0	577
4530	12D7-5	4531	12D7-6	1.0	46	13.1	351
4530	12D7-5	4532	12D7-7	1.0	46	8.0	577
4533	12D6-1	4534	12D6-2	3.7	177	30.7	577
4534	12D6-2	4535	12D6-3	1.0	45	7.9	577
4534	12D6-2	4536	12D6-4	1.8	86	24.6	351
4537	12D2-1	4538	12D2-2	7.0	329	57.0	577
4538	12D2-2	4539	12D2-3	0.9	41	7.1	577
4538	12D2-2	4540	12D2-4	5.2	247	42.8	577
4540	12D2-4	4541	12D2-5	0.9	41	29.6	140
4540	12D2-4	4542	12D2-6	3.5	165	31.2	529
4542	12D2-6	4543	12D2-7	2.6	124	21.5	577
4543	12D2-7	4544	12D2-8	1.7	83	14.3	577
4544	12D2-8	4545	12D2-9	0.9	41	7.2	577
4546	12D1-1	4549	12D1-4	4.9	231	40.1	577
4546	12D1-1	4547	12D1-2	1.0	45	8.5	529
4547	12D1-2	4548	12D1-3	0.5	23	4.3	529
4549	12D1-4	4550	12D1-5	4.4	209	36.2	577
4550	12D1-5	4551	12D1-6	3.9	186	32.2	577
4551	12D1-6	4552	12D1-7	3.4	163	30.7	529
4553	12D4-1	4557	12D4-5	4.5	214	52.9	404
4553	12D4-1	4554	12D4-2	1.1	55	9.5	577
4554	12D4-2	4555	12D4-3	0.8	37	6.4	577

From Bus No.	From Bus Name	To Bus No.	To Bus Name	Branch Flow MVA	Branch Flow AMPS	% Rating	Rating AMPS
4555	12D4-3	4556	12D4-4	0.4	18	4.5	404
4557	12D4-5	4561	12D4-9	2.9	140	34.6	404
4557	12D4-5	4558	12D4-6	1.2	56	13.8	404
4558	12D4-6	4559	12D4-7	0.8	37	9.2	404
4559	12D4-7	4560	12D4-8	0.4	19	13.3	140
4561	12D4-9	4562	12D4-10	2.5	121	21.0	577
4562	12D4-10	4564	12D4-12	1.7	84	20.8	404
4562	12D4-10	4563	12D4-11	0.4	19	3.5	529
4564	12D4-12	4566	12D4-14	0.5	23	16.8	140
4564	12D4-12	4567	12D4-15	0.5	23	5.8	404
4564	12D4-12	4565	12D4-13	0.4	19	5.3	351
5000	12E	5001	12E1-1	0.6	27	4.7	577
5000	12E	5002	12E1-2	5.5	261	45.3	577
5000	12E	5026	12E4-1	8.3	391	67.7	577
5000	12E	5020	12E3-1	9.1	427	74.0	577
5000	12E	5010	12E2-1	11.4	539	93.3	577
5002	12E1-2	5003	12E1-3	4.8	235	40.6	577
5003	12E1-3	5004	12E1-4	1.2	57	20.3	279
5003	12E1-3	5006	12E1-6	3.2	158	60.7	260
5004	12E1-4	5005	12E1-5	0.6	28	10.2	279
5006	12E1-6	5007	12E1-7	2.7	131	69.7	188
5007	12E1-7	5008	12E1-8	1.8	87	31.2	279
5008	12E1-8	5009	12E1-9	0.9	44	23.2	188
5010	12E2-1	5011	12E2-2	4.3	207	39.1	529
5010	12E2-1	5015	12E2-6	5.9	281	48.7	577
5011	12E2-2	5012	12E2-3	3.3	157	29.6	529
5012	12E2-3	5013	12E2-4	2.2	106	20.0	529
5013	12E2-4	5014	12E2-5	1.2	55	10.4	529
5015	12E2-6	5016	12E2-7	4.7	226	39.1	577
5016	12E2-7	5017	12E2-8	3.5	170	60.9	279
5017	12E2-8	5018	12E2-9	2.3	114	40.7	279
5018	12E2-9	5019	12E2-10	1.2	57	20.4	279
5020	12E3-1	5022	12E3-3	1.9	92	17.4	529
5020	12E3-1	5023	12E3-4	5.1	243	42.1	577
5020	12E3-1	5021	12E3-2	1.0	46	8.0	577
5023	12E3-4	5024	12E3-5	2.1	103	29.4	351

From Bus No.	From Bus Name	To Bus No.	To Bus Name	Branch Flow MVA	Branch Flow AMPS	% Rating	Rating AMPS
5024	12E3-5	5025	12E3-6	1.0	47	25.1	188
5026	12E4-1	5033	12E4-8	4.3	205	35.4	577
5026	12E4-1	5027	12E4-2	3.1	150	25.9	577
5027	12E4-2	5029	12E4-4	2.3	112	19.5	577
5027	12E4-2	5028	12E4-3	0.8	37	6.4	577
5029	12E4-4	5030	12E4-5	1.6	75	40.1	188
5029	12E4-4	5032	12E4-7	0.8	37	6.4	577
5030	12E4-5	5031	12E4-6	0.8	38	27.0	140
5033	12E4-8	5036	12E4-11	1.7	84	15.8	529
5033	12E4-8	5034	12E4-9	1.7	84	15.8	529
5034	12E4-9	5035	12E4-10	0.9	42	7.9	529
5036	12E4-11	5037	12E4-12	0.9	42	7.9	529
5500	12F	5557	12F7-1	4.3	204	35.4	577
5500	12F	5528	12F8-1	7.6	355	61.5	577
5500	12F	5519	12F13-1	10.6	498	86.2	577
5500	12F	5568	12F12-1	5.6	261	45.2	577
5500	12F	5563	12F10-1	7.5	351	60.7	577
5500	12F	5509	12F11-1	9.7	453	78.5	577
5500	12F	5505	12F2-1	6.7	317	54.8	577
5500	12F	5550	12F6-1	5.6	263	45.5	577
5500	12F	5523	12F5-1	10.7	504	87.3	577
5500	12F	5546	12F14-1	8.3	389	67.4	577
5500	12F	5575	12F1-1	6.9	322	55.8	577
5500	12F	5543	12F4-1	5.5	256	44.4	577
5500	12F	5535	12F9-1	9.7	457	79.2	577
5500	12F	5501	12F3-1	11.6	543	94.0	577
5501	12F3-1	5502	12F3-2	10.5	496	85.9	577
5502	12F3-2	5503	12F3-3	9.3	449	77.7	577
5503	12F3-3	5504	12F3-4	8.2	401	69.5	577
5505	12F2-1	5506	12F2-2	4.7	224	42.3	529
5506	12F2-2	5507	12F2-3	3.7	177	33.5	529
5507	12F2-3	5508	12F2-4	2.8	131	24.7	529
5509	12F11-1	5510	12F11-2	4.2	201	34.8	577
5509	12F11-1	5514	12F11-6	4.4	210	36.4	577
5510	12F11-2	5511	12F11-3	3.4	159	45.3	351
5511	12F11-3	5512	12F11-4	2.5	117	20.2	577

From Bus No.	From Bus Name	To Bus No.	To Bus Name	Branch Flow MVA	Branch Flow AMPS	% Rating	Rating AMPS
5512	12F11-4	5513	12F11-5	1.6	75	13.0	577
5514	12F11-6	5517	12F11-9	0.9	42	12.0	351
5514	12F11-6	5515	12F11-7	1.8	84	24.0	351
5514	12F11-6	5518	12F11-10	0.9	42	7.3	577
5515	12F11-7	5516	12F11-8	0.9	42	12.0	351
5519	12F13-1	5520	12F13-2	9.0	428	74.0	577
5520	12F13-2	5521	12F13-3	6.0	287	49.6	577
5520	12F13-2	5522	12F13-4	1.5	71	39.7	178
5523	12F5-1	5524	12F5-2	9.1	434	75.1	577
5524	12F5-2	5525	12F5-3	7.5	363	68.5	529
5525	12F5-3	5526	12F5-4	2.1	100	17.4	577
5525	12F5-3	5527	12F5-5	1.5	72	12.4	577
5528	12F8-1	5529	12F8-2	6.6	309	53.5	577
5529	12F8-2	5530	12F8-3	5.5	262	45.4	577
5530	12F8-3	5532	12F8-5	3.3	155	26.8	577
5530	12F8-3	5531	12F8-4	1.0	47	8.1	577
5532	12F8-5	5533	12F8-6	2.3	108	18.7	577
5533	12F8-6	5534	12F8-7	1.0	47	8.1	577
5535	12F9-1	5536	12F9-2	1.2	56	9.7	577
5535	12F9-1	5537	12F9-3	7.2	345	65.1	529
5537	12F9-3	5538	12F9-4	6.0	288	54.4	529
5538	12F9-4	5539	12F9-5	4.8	232	43.8	529
5539	12F9-5	5540	12F9-6	3.6	175	33.1	529
5540	12F9-6	5541	12F9-7	2.5	118	22.3	529
5541	12F9-7	5542	12F9-8	1.3	62	11.6	529
5543	12F4-1	5544	12F4-2	4.4	210	36.3	577
5544	12F4-2	5545	12F4-3	3.4	163	30.8	529
5546	12F14-1	5547	12F14-2	6.2	296	51.2	577
5547	12F14-2	5548	12F14-3	4.2	202	35.0	577
5548	12F14-3	5549	12F14-4	2.3	108	18.7	577
5550	12F6-1	5554	12F6-5	2.4	112	19.5	577
5550	12F6-1	5551	12F6-2	2.4	113	19.5	577
5551	12F6-2	5552	12F6-3	1.6	75	21.4	351
5552	12F6-3	5553	12F6-4	0.8	38	10.7	351
5554	12F6-5	5555	12F6-6	1.6	75	13.0	577
5555	12F6-6	5556	12F6-7	0.8	38	6.5	577

From Bus No.	From Bus Name	To Bus No.	To Bus Name	Branch Flow MVA	Branch Flow AMPS	% Rating	Rating AMPS
5557	12F7-1	5558	12F7-2	3.6	172	32.5	529
5558	12F7-2	5559	12F7-3	3.0	139	26.3	529
5559	12F7-3	5562	12F7-6	0.8	37	7.0	529
5559	12F7-3	5561	12F7-5	0.8	37	7.0	529
5559	12F7-3	5560	12F7-4	0.7	33	6.1	529
5563	12F10-1	5564	12F10-2	6.0	281	48.7	577
5564	12F10-2	5565	12F10-3	4.4	211	36.5	577
5565	12F10-3	5566	12F10-4	2.9	140	24.3	577
5566	12F10-4	5567	12F10-5	1.5	70	13.2	529
5568	12F12-1	5569	12F12-2	0.6	28	7.9	351
5568	12F12-1	5570	12F12-3	4.9	233	40.3	577
5570	12F12-3	5571	12F12-4	2.4	112	21.1	529
5571	12F12-4	5573	12F12-6	1.2	56	10.6	529
5571	12F12-4	5572	12F12-5	0.6	28	4.8	577
5573	12F12-6	5574	12F12-7	0.6	28	5.3	529
5575	12F1-1	5577	12F1-3	4.4	210	39.7	529
5575	12F1-1	5580	12F1-6	0.4	19	3.2	577
5575	12F1-1	5576	12F1-2	1.0	47	8.8	529
5577	12F1-3	5578	12F1-4	3.4	164	30.9	529
5578	12F1-4	5579	12F1-5	2.5	117	22.1	529
6000	12G	6045	12G1-1	10.2	482	83.5	577
6000	12G	6011	12G6-1	6.3	301	52.1	577
6000	12G	6051	12G5-1	10.3	490	84.8	577
6000	12G	6038	12G4-1	6.0	285	49.3	577
6000	12G	6005	12G7-1	9.0	428	74.1	577
6000	12G	6042	12G8-1	6.6	311	53.9	577
6000	12G	6054	12G10-1	9.0	428	74.2	577
6000	12G	6018	12G2-1	8.2	390	67.5	577
6000	12G	6025	12G9-1	7.8	367	63.6	577
6000	12G	6001	12G3-1	6.7	320	55.4	577
6001	12G3-1	6002	12G3-2	5.1	240	41.5	577
6002	12G3-2	6003	12G3-3	3.4	160	45.6	351
6003	12G3-3	6004	12G3-4	1.7	80	22.8	351
6005	12G7-1	6006	12G7-2	8.0	379	65.6	577
6006	12G7-2	6008	12G7-4	1.0	49	8.5	577
6006	12G7-2	6009	12G7-5	3.9	187	32.5	577

From Bus No.	From Bus Name	To Bus No.	To Bus Name	Branch Flow MVA	Branch Flow AMPS	% Rating	Rating AMPS
6006	12G7-2	6007	12G7-3	2.0	94	16.2	577
6009	12G7-5	6010	12G7-6	2.0	94	26.7	351
6011	12G6-1	6012	12G6-2	5.5	260	45.1	577
6012	12G6-2	6013	12G6-3	4.6	220	41.6	529
6013	12G6-3	6014	12G6-4	3.7	180	34.0	529
6014	12G6-4	6015	12G6-5	1.9	90	17.0	529
6014	12G6-4	6017	12G6-7	0.9	45	12.8	351
6015	12G6-5	6016	12G6-6	0.9	45	8.5	529
6018	12G2-1	6019	12G2-2	7.3	350	60.6	577
6019	12G2-2	6020	12G2-3	6.5	310	53.6	577
6020	12G2-3	6021	12G2-4	2.0	94	16.3	577
6020	12G2-3	6022	12G2-5	2.5	121	34.6	351
6022	12G2-5	6023	12G2-6	1.7	81	23.0	351
6023	12G2-6	6024	12G2-7	0.8	41	11.5	351
6025	12G9-1	6026	12G9-2	7.2	341	64.4	529
6026	12G9-2	6027	12G9-3	3.3	157	27.2	577
6026	12G9-2	6033	12G9-9	3.3	157	27.2	577
6027	12G9-3	6028	12G9-4	2.6	126	21.8	577
6028	12G9-4	6029	12G9-5	2.0	94	16.3	577
6029	12G9-5	6030	12G9-6	0.7	31	5.9	529
6029	12G9-5	6031	12G9-7	1.3	63	10.9	577
6031	12G9-7	6032	12G9-8	0.7	32	5.5	577
6033	12G9-9	6034	12G9-10	2.6	126	21.7	577
6034	12G9-10	6035	12G9-11	2.0	94	16.3	577
6035	12G9-11	6036	12G9-12	1.3	63	17.9	351
6036	12G9-12	6037	12G9-13	0.7	31	8.9	351
6038	12G4-1	6039	12G4-2	5.3	254	48.0	529
6039	12G4-2	6040	12G4-3	2.5	120	22.7	529
6040	12G4-3	6041	12G4-4	0.7	31	22.4	140
6042	12G8-1	6043	12G8-2	4.9	235	66.9	351
6043	12G8-2	6044	12G8-3	3.3	158	29.9	529
6045	12G1-1	6046	12G1-2	8.5	402	69.7	577
6046	12G1-2	6047	12G1-3	1.7	80	22.8	351
6046	12G1-2	6048	12G1-4	5.1	242	42.0	577
6048	12G1-4	6049	12G1-5	3.4	162	46.1	351
6049	12G1-5	6050	12G1-6	1.7	81	23.1	351

From Bus No.	From Bus Name	To Bus No.	To Bus Name	Branch Flow MVA	Branch Flow AMPS	% Rating	Rating AMPS
6051	12G5-1	6053	12G5-3	6.6	312	88.8	351
6051	12G5-1	6052	12G5-2	1.9	89	25.3	351
6054	12G10-1	6057	12G10-4	5.3	254	72.4	351
6054	12G10-1	6055	12G10-2	2.4	116	20.2	577
6055	12G10-2	6056	12G10-3	1.2	58	10.1	577
6057	12G10-4	6058	12G10-5	4.0	192	54.7	351
6058	12G10-5	6059	12G10-6	2.7	130	37.1	351
6059	12G10-6	6060	12G10-7	1.4	70	50.0	140
6500	12U	6508	12U7-1	5.7	270	46.7	577
6500	12U	6501	12U2-1	6.2	294	50.9	577
6501	12U2-1	6502	12U2-2	5.3	253	43.8	577
6502	12U2-2	6503	12U2-3	4.4	212	36.6	577
6503	12U2-3	6504	12U2-4	3.5	170	29.5	577
6504	12U2-4	6505	12U2-5	2.7	129	22.4	577
6505	12U2-5	6506	12U2-6	1.8	89	21.9	404
6506	12U2-6	6507	12U2-7	1.0	51	12.5	404
6508	12U7-1	6509	12U7-2	5.2	247	42.8	577
6509	12U7-2	6511	12U7-4	3.6	170	29.4	577
6509	12U7-2	6510	12U7-3	1.1	55	9.5	577
6511	12U7-4	6513	12U7-6	2.6	124	21.5	577
6511	12U7-4	6512	12U7-5	0.5	23	4.0	577
6513	12U7-6	6515	12U7-8	0.5	23	4.0	577
6513	12U7-6	6514	12U7-7	0.5	23	16.5	140
6513	12U7-6	6516	12U7-9	0.5	23	4.0	577
7000	12I	7001	12I4-1	12.0	567	98.2	577
7000	12I	7017	12I13-1	7.8	371	64.2	577
7000	12I	7012	12I9-1	12.0	570	98.7	577
7001	12I4-1	7002	12I4-2	10.9	517	89.6	577
7002	12I4-2	7003	12I4-3	9.6	467	80.9	577
7003	12I4-3	7004	12I4-4	8.5	417	72.2	577
7004	12I4-4	7005	12I4-5	7.5	368	69.5	529
7005	12I4-5	7006	12I4-6	6.5	319	55.2	577
7006	12I4-6	7007	12I4-7	5.5	271	51.2	529
7007	12I4-7	7008	12I4-8	4.6	225	39.0	577
7008	12I4-8	7010	12I4-10	2.2	108	20.5	529
7008	12I4-8	7009	12I4-9	1.2	59	10.1	577

From Bus No.	From Bus Name	To Bus No.	To Bus Name	Branch Flow MVA	Branch Flow AMPS	% Rating	Rating AMPS
7010	12I4-10	7011	12I4-11	1.1	54	10.2	529
7012	12I9-1	7014	12I9-3	7.0	345	59.7	577
7012	12I9-1	7013	12I9-2	2.3	113	19.5	577
7014	12I9-3	7015	12I9-4	2.3	113	63.7	178
7014	12I9-3	7016	12I9-5	2.4	118	20.5	577
7017	12I13-1	7018	12I13-2	6.8	321	55.6	577
7018	12I13-2	7019	12I13-3	2.3	110	19.0	577
7018	12I13-2	7021	12I13-5	3.4	161	27.9	577
7019	12I13-3	7020	12I13-4	1.0	50	8.7	577
7021	12I13-5	7022	12I13-6	2.3	111	19.3	577
7022	12I13-6	7023	12I13-7	1.3	61	34.2	178

Appendix B

Projected Peak Load Feeder Voltage Profiles

Table B-1: Projected 2003 Peak Load Mini-Grid Feeder Voltage Profiles

		Voltage
Bus No.	**Bus Name**	**PU**
3000	12A	1.0197
3001	12A9-1	1.0116
3002	12A9-2	1.0106
3003	12A9-3	1.0098
3004	12A6-1	1.0126
3005	12A6-2	1.0102
3006	12A6-3	1.0073
3007	12A6-4	1.0065
3008	12A6-5	1.0058
3009	12A6-6	1.0055
3010	12A6-7	1.0063
3011	12A6-8	1.0056
3012	12A10-1	1.0146
3013	12A10-2	1.0129
3014	12A10-3	1.0129
3015	12A7-1	1.0143
3016	12A7-2	1.0105
3017	12A7-3	1.0089
3018	12A7-4	1.0077
3019	12A7-5	1.0072
3020	12A7-6	0.9980
3021	12A7-7	0.9947
3022	12A7-8	0.9934
3023	12A7-9	0.9875
3024	12A7-10	0.9737
3025	12A7-11	0.9899
3026	12A7-12	0.9893
3027	12A7-13	0.9841
3028	12A7-14	0.9853

		Voltage
Bus No.	**Bus Name**	**PU**
3029	12A7-15	0.9849
3030	12A7-16	0.9849
3031	12A2-1	1.0163
3032	12A2-2	0.9979
3033	12A2-3	0.9969
3034	12A2-4	0.9953
3035	12A2-5	0.9918
3036	12A1-1	1.0143
3037	12A1-2	1.0127
3038	12A1-3	1.0102
3039	12A1-4	1.0113
3040	12A1-5	1.0105
3041	12A5-1	1.0111
3042	12A5-2	0.9999
3043	12A5-3	0.9969
3044	12A5-4	0.9941
3045	12A5-5	0.9843
3046	12A4-1	1.0089
3047	12A4-2	1.0022
3048	12A4-3	1.0010
3049	12A4-4	0.9976
3050	12A4-5	0.9979
3051	12A4-6	0.9966
3052	12A3-1	1.0119
3053	12A3-2	1.0076
3054	12A3-3	1.0018
3055	12A3-4	1.0002
3056	12A3-5	0.9999
3057	12A8-1	1.0112
3058	12A8-2	1.0041
3059	12A8-3	0.9973
3060	12A8-4	0.9944
3061	12A8-5	0.9929
3500	12B	1.0136
3501	12B12-1	1.0006
3502	12B12-2	0.9936

		Voltage
Bus No.	**Bus Name**	**PU**
3503	12B12-3	0.9886
3504	12B12-4	0.9919
3505	12B12-5	0.9886
3506	12B12-6	0.9984
3507	12B12-7	0.9920
3508	12B12-8	0.9973
3509	12B10-1	1.0077
3510	12B10-2	1.0061
3511	12B10-3	1.0047
3512	12B10-4	1.0037
3513	12B10-5	1.0032
3514	12B10-6	1.0016
3515	12B10-7	1.0010
3516	12B10-8	0.9976
3517	12B10-9	1.0008
3518	12B1-1	1.0060
3519	12B1-2	1.0017
3520	12B1-3	0.9978
3521	12B1-4	1.0003
3522	12B1-5	0.9964
3523	12B1-6	0.9997
3524	12B1-7	0.9993
3525	12B1-8	0.9987
3526	12B1-9	0.9994
3527	12B5-1	1.0058
3528	12B5-2	1.0050
3529	12B5-3	1.0025
3530	12B5-4	1.0017
3531	12B5-5	0.9969
3532	12B5-6	0.9962
3533	12B5-7	0.9946
3534	12B2-1	1.0094
3535	12B2-2	1.0084
3536	12B2-3	1.0081
3537	12B2-4	1.0079
3538	12B2-5	1.0078

		Voltage
Bus No.	**Bus Name**	**PU**
3539	12B2-6	1.0073
3540	12B4-1	1.0017
3541	12B4-2	0.9962
3542	12B4-3	0.9922
3543	12B4-4	0.9916
3544	12B4-5	0.9880
3545	12B7-1	0.9885
3546	12B7-2	0.9851
3547	12B7-3	0.9831
3548	12B7-4	0.9836
3549	12B7-5	0.9838
3550	12B7-6	0.9819
3551	12B7-7	0.9805
3552	12B11-1	1.0037
3553	12B11-2	1.0002
3554	12B11-3	0.9928
3555	12B11-4	0.9862
3556	12B11-5	0.9852
3558	12B11-7	0.9836
3559	12B11-8	0.9831
3560	12B11-9	0.9822
3561	12B11-10	0.9826
3562	12B6-1	1.0063
3563	12B6-2	1.0037
3564	12B6-3	1.0025
3565	12B6-4	0.9859
3566	12B6-5	0.9856
3567	12B6-6	0.9854
3568	12B6-7	0.9863
3569	12B6-8	0.9860
3570	12B6-9	0.9865
3571	12B8-1	1.0009
3572	12B8-2	0.9958
3573	12B8-3	0.9933

		Voltage
Bus No.	**Bus Name**	**PU**
3574	12B8-4	0.9956
3575	12B8-5	0.9942
3576	12B8-6	0.9932
3577	12B8-7	0.9924
3578	12B8-8	0.9925
3579	12B3-1	0.9985
3580	12B3-2	0.9967
3581	12B3-3	0.9959
3582	12B3-4	0.9902
3583	12B3-5	0.9884
3584	12B3-6	0.9829
3585	12B3-7	0.9871
3586	12B3-8	0.9837
3587	12B9-1	1.0032
3588	12B9-2	0.9892
3589	12B9-3	0.9849
3590	12B9-4	0.9838
3591	12B9-5	0.9826
3592	12B9-6	0.9817
3593	12B9-7	0.9804
3594	12B9-8	0.9802
3595	12B9-9	0.9802
3596	12B9-10	0.9805
4000	12C	1.0101
4001	12C3-1	1.0071
4002	12C3-2	1.0053
4003	12C3-3	1.0018
4004	12C3-4	0.9995
4005	12C3-5	0.9986
4006	12C3-6	0.9981
4007	12C4-1	1.0050
4008	12C4-2	1.0037
4009	12C4-3	1.0025
4010	12C4-4	1.0015
4011	12C4-5	1.0022
4012	12C4-6	1.0004

		Voltage
Bus No.	**Bus Name**	**PU**
4013	12C4-7	0.9998
4014	12C5-1	1.0035
4015	12C5-2	1.0021
4016	12C5-3	1.0012
4017	12C5-4	1.0008
4018	12C5-5	1.0000
4019	12C5-6	1.0005
4020	12C5-7	1.0014
4021	12C2-1	1.0092
4022	12C2-2	1.0064
4023	12C2-3	1.0049
4024	12C2-4	1.0044
4025	12C2-5	1.0041
4026	12C2-6	1.0042
4027	12C10-1	1.0074
4028	12C10-2	1.0058
4029	12C10-3	1.0039
4030	12C10-4	1.0003
4031	12C10-5	1.0000
4032	12C7-1	1.0084
4033	12C7-2	1.0062
4034	12C7-3	1.0049
4035	12C7-4	0.9951
4036	12C7-5	0.9908
4037	12C7-6	0.9891
4038	12C7-7	0.9887
4039	12C7-8	0.9866
4040	12C7-9	0.9835
4041	12C1-1	1.0086
4042	12C1-2	1.0057
4043	12C1-3	1.0037
4044	12C1-4	1.0019
4045	12C1-5	0.9951
4046	12C1-6	0.9897
4047	12C1-7	0.9869
4048	12C1-8	0.9855
4049	12C1-9	0.9836

		Voltage
Bus No.	**Bus Name**	**PU**
4050	12C1-10	0.9816
4051	12C1-11	0.9802
4052	12C9-1	0.9935
4053	12C9-2	0.9912
4054	12C9-3	0.9886
4055	12C9-4	0.9855
4056	12C9-5	0.9870
4057	12C9-6	0.9858
4058	12C6-1	1.0089
4059	12C6-2	1.0068
4060	12C6-3	1.0064
4061	12C6-4	1.0052
4062	12C6-5	1.0037
4063	12C6-6	1.0029
4064	12C8-1	1.0039
4065	12C8-2	1.0038
4500	12D	1.0225
4501	12D5-1	1.0076
4502	12D5-2	0.9991
4503	12D5-3	0.9968
4504	12D5-4	0.9976
4505	12D5-5	0.9980
4506	12D5-6	0.9906
4507	12D5-7	0.9838
4508	12D3-1	1.0054
4509	12D3-2	0.9991
4510	12D3-3	0.9978
4511	12D3-4	0.9875
4512	12D3-5	0.9851
4513	12D3-6	0.9825
4514	12D3-7	0.9831
4515	12D3-8	0.9857
4516	12D3-9	0.9830
4517	12D3-10	0.9805
4518	12D3-11	0.9835
4519	12D3-12	0.9788
4520	12D3-13	0.9844

		Voltage
Bus No.	**Bus Name**	**PU**
4521	12D3-14	0.9842
4522	12D3-15	0.9857
4523	12D3-16	0.9835
4524	12D3-17	0.9795
4525	12D3-18	0.9762
4526	12D7-1	1.0083
4527	12D7-2	1.0052
4528	12D7-3	1.0001
4529	12D7-4	0.9991
4530	12D7-5	0.9962
4531	12D7-6	0.9952
4532	12D7-7	0.9957
4533	12D6-1	1.0155
4534	12D6-2	1.0118
4535	12D6-3	1.0114
4536	12D6-4	1.0102
4537	12D2-1	1.0199
4538	12D2-2	1.0113
4539	12D2-3	1.0106
4540	12D2-4	1.0083
4541	12D2-5	1.0012
4542	12D2-6	1.0038
4543	12D2-7	1.0012
4544	12D2-8	1.0004
4545	12D2-9	1.0003
4546	12D1-1	1.0167
4547	12D1-2	1.0162
4548	12D1-3	1.0161
4549	12D1-4	1.0122
4550	12D1-5	1.0023
4551	12D1-6	0.9906
4552	12D1-7	0.9872
4553	12D4-1	1.0035
4554	12D4-2	1.0020
4555	12D4-3	1.0007
4556	12D4-4	1.0000

		Voltage
Bus No.	**Bus Name**	**PU**
4557	12D4-5	0.9957
4558	12D4-6	0.9937
4559	12D4-7	0.9904
4560	12D4-8	0.9857
4561	12D4-9	0.9898
4562	12D4-10	0.9872
4563	12D4-11	0.9869
4564	12D4-12	0.9842
4565	12D4-13	0.9836
4566	12D4-14	0.9803
4567	12D4-15	0.9829
5000	12E	1.0198
5001	12E1-1	1.0191
5002	12E1-2	0.9892
5003	12E1-3	0.9876
5004	12E1-4	0.9835
5005	12E1-5	0.9805
5006	12E1-6	0.9849
5007	12E1-7	0.9796
5008	12E1-8	0.9787
5009	12E1-9	0.9764
5010	12E2-1	1.0099
5011	12E2-2	1.0082
5012	12E2-3	1.0075
5013	12E2-4	1.0071
5014	12E2-5	1.0069
5015	12E2-6	1.0052
5016	12E2-7	1.0021
5017	12E2-8	0.9865
5018	12E2-9	0.9812
5019	12E2-10	0.9786
5020	12E3-1	1.0062
5021	12E3-2	1.0057
5022	12E3-3	1.0056
5023	12E3-4	0.9952
5024	12E3-5	0.9915
5025	12E3-6	0.9853

		Voltage
Bus No.	**Bus Name**	**PU**
5026	12E4-1	1.0067
5027	12E4-2	1.0006
5028	12E4-3	0.9991
5029	12E4-4	0.9991
5030	12E4-5	0.9876
5031	12E4-6	0.9837
5032	12E4-7	0.9986
5033	12E4-8	0.9984
5034	12E4-9	0.9975
5035	12E4-10	0.9971
5036	12E4-11	0.9975
5037	12E4-12	0.9971
5500	12F	1.0244
5501	12F3-1	1.0160
5502	12F3-2	1.0015
5503	12F3-3	0.9850
5504	12F3-4	0.9776
5505	12F2-1	1.0198
5506	12F2-2	1.0170
5507	12F2-3	1.0162
5508	12F2-4	1.0151
5509	12F11-1	1.0170
5510	12F11-2	1.0154
5511	12F11-3	1.0132
5512	12F11-4	1.0128
5513	12F11-5	1.0124
5514	12F11-6	1.0134
5515	12F11-7	1.0119
5516	12F11-8	1.0110
5517	12F11-9	1.0125
5518	12F11-10	1.0133
5519	12F13-1	1.0117
5520	12F13-2	1.0104
5521	12F13-3	1.0081
5522	12F13-4	1.0038
5523	12F5-1	1.0078
5524	12F5-2	0.9985

		Voltage
Bus No.	**Bus Name**	**PU**
5525	12F5-3	0.9931
5526	12F5-4	0.9912
5527	12F5-5	0.9908
5528	12F8-1	1.0221
5529	12F8-2	1.0142
5530	12F8-3	1.0130
5531	12F8-4	1.0127
5532	12F8-5	1.0112
5533	12F8-6	1.0104
5534	12F8-7	1.0100
5535	12F9-1	1.0097
5536	12F9-2	1.0093
5537	12F9-3	1.0068
5538	12F9-4	1.0049
5539	12F9-5	1.0034
5540	12F9-6	1.0019
5541	12F9-7	1.0009
5542	12F9-8	1.0006
5543	12F4-1	1.0174
5544	12F4-2	1.0157
5545	12F4-3	1.0150
5546	12F14-1	1.0136
5547	12F14-2	1.0108
5548	12F14-3	1.0082
5549	12F14-4	1.0073
5550	12F6-1	1.0120
5551	12F6-2	1.0093
5552	12F6-3	1.0076
5553	12F6-4	1.0067
5554	12F6-5	1.0114
5555	12F6-6	1.0106
5556	12F6-7	1.0100
5557	12F7-1	1.0221
5558	12F7-2	1.0206
5559	12F7-3	1.0197
5560	12F7-4	1.0195

		Voltage
Bus No.	**Bus Name**	**PU**
5561	12F7-5	1.0196
5562	12F7-6	1.0196
5563	12F10-1	1.0209
5564	12F10-2	1.0137
5565	12F10-3	1.0069
5566	12F10-4	1.0045
5567	12F10-5	1.0031
5568	12F12-1	1.0197
5569	12F12-2	1.0190
5570	12F12-3	1.0175
5571	12F12-4	1.0158
5572	12F12-5	1.0153
5573	12F12-6	1.0152
5574	12F12-7	1.0149
5575	12F1-1	1.0163
5576	12F1-2	1.0159
5577	12F1-3	1.0149
5578	12F1-4	1.0139
5579	12F1-5	1.0131
5580	12F1-6	1.0156
6000	12G	1.0155
6001	12G3-1	1.0145
6002	12G3-2	1.0130
6003	12G3-3	1.0115
6004	12G3-4	1.0108
6005	12G7-1	1.0127
6006	12G7-2	1.0103
6007	12G7-3	1.0095
6008	12G7-4	1.0099
6009	12G7-5	1.0085
6010	12G7-6	1.0059
6011	12G6-1	1.0085
6012	12G6-2	1.0039
6013	12G6-3	1.0020
6014	12G6-4	1.0004
6015	12G6-5	0.9997

		Voltage
Bus No.	**Bus Name**	**PU**
6016	12G6-6	0.9993
6017	12G6-7	0.9996
6018	12G2-1	1.0108
6019	12G2-2	1.0065
6020	12G2-3	1.0029
6021	12G2-4	1.0025
6022	12G2-5	1.0001
6023	12G2-6	0.9994
6024	12G2-7	0.9991
6025	12G9-1	1.0113
6026	12G9-2	1.0083
6027	12G9-3	1.0050
6028	12G9-4	1.0023
6029	12G9-5	1.0010
6030	12G9-6	1.0004
6031	12G9-7	0.9997
6032	12G9-8	0.9991
6033	12G9-9	1.0050
6034	12G9-10	1.0042
6035	12G9-11	1.0036
6036	12G9-12	1.0022
6037	12G9-13	1.0014
6038	12G4-1	1.0119
6039	12G4-2	1.0098
6040	12G4-3	1.0093
6041	12G4-4	1.0071
6042	12G8-1	1.0040
6043	12G8-2	0.9976
6044	12G8-3	0.9936
6045	12G1-1	1.0132
6046	12G1-2	1.0112
6047	12G1-3	1.0101
6048	12G1-4	1.0061
6049	12G1-5	1.0010
6050	12G1-6	0.9985
6051	12G5-1	1.0123
6052	12G5-2	1.0111

		Voltage
Bus No.	**Bus Name**	**PU**
6053	12G5-3	1.0081
6054	12G10-1	1.0061
6055	12G10-2	1.0048
6056	12G10-3	1.0036
6057	12G10-4	1.0029
6058	12G10-5	1.0006
6059	12G10-6	0.9977
6060	12G10-7	0.9871
6500	12U	1.0161
6501	12U2-1	1.0035
6502	12U2-2	0.9979
6503	12U2-3	0.9936
6504	12U2-4	0.9906
6505	12U2-5	0.9889
6506	12U2-6	0.9872
6507	12U2-7	0.9877
6508	12U7-1	1.0114
6509	12U7-2	1.0094
6510	12U7-3	1.0077
6511	12U7-4	1.0051
6512	12U7-5	1.0036
6513	12U7-6	1.0029
6514	12U7-7	0.9967
6515	12U7-8	1.0023
6516	12U7-9	1.0012
7000	12I	1.0153
7001	12I4-1	1.0112
7002	12I4-2	0.9874
7003	12I4-3	0.9862
7004	12I4-4	0.9862
7005	12I4-5	0.9839
7006	12I4-6	0.9831
7007	12I4-7	0.9805
7008	12I4-8	0.9823
7009	12I4-9	0.9827
7010	12I4-10	0.9821
7011	12I4-11	0.9820

		Voltage
Bus No.	**Bus Name**	**PU**
7012	12I9-1	0.9845
7013	12I9-2	0.9810
7014	12I9-3	0.9800
7015	12I9-4	0.9767
7016	12I9-5	0.9797
7017	12I13-1	1.0134
7018	12I13-2	1.0095
7019	12I13-3	1.0072
7020	12I13-4	1.0062
7021	12I13-5	1.0037
7022	12I13-6	0.9993
7023	12I13-7	0.9930

Appendix C

Shunt Capacitors Added to Maintain Minimum Voltage

Table C-1: Shunt Capacitors Added to Maintain Minimum 97% Voltage – 2003 Peak Loads

			100 MVA
		Shunt	Base
Bus No.	Bus Name	ID	B PU
3024	12A7-10	b1	0.006
3569	12B6-8	b1	0.006
3570	12B6-9	b1	0.006
3584	12B3-6	b1	0.006
3586	12B3-8	b1	0.006
3595	12B9-9	b1	0.006
3596	12B9-10	b1	0.006
4504	12D5-4	b1	0.006
4505	12D5-5	b1	0.006
4506	12D5-6	b1	0.006
4507	12D5-7	b1	0.012
4521	12D3-14	b1	0.006
4523	12D3-16	b1	0.006
5007	12E1-7	b1	0.006
5008	12E1-8	b1	0.006
5009	12E1-9	b1	0.006
5504	12F3-4	b1	0.012
6060	12G10-7	b1	0.006
6507	12U2-7	b1	0.006
7008	12I4-8	b1	0.006
7009	12I4-9	b1	0.006
7010	12I4-10	b1	0.006
7011	12I4-11	b1	0.006