Southern Alberta Transmission Reinforcement

Need Identification Results

September 5, 2008

EXECUTIVE SUMMARY

This document presents the results of the need analysis for transmission reinforcement in southern Alberta to address the integration of approximately 2,700 MW of wind power interest in this region.

The AESO has now received over 11,000 MW of wind interest of which approximately 7,500 MW is located in southern Alberta. However, the AESO has also determined that up to 3,400 MW of wind interest could realistically materialize in Alberta in the next 10 years, in addition to the approximately 500 MW currently in operation. In southern Alberta, approximately 2,700 MW of additional wind interest is anticipated in the next 10 years. The wind interest is spread throughout the southern Alberta region and is not concentrated in any one area.

The AESO submitted a Need Application for the southeast Alberta transmission development in November 2007. This Need Application, among other things, focused on load supply adequacy. A Need Application for southwest Alberta, which was approved in 2005 made recommendations regarding the supply and load situation in the southwest Alberta. Besides the Southwest and the Southeast, the southern region considered in this study also includes High River and Strathmore/Blackie areas which were not included in the previous two applications. Therefore, a need analysis was performed on these areas as well.

The results of the existing southern Alberta transmission system analysis are summarized as follows:

- Most of the southern Alberta transmission system was originally designed to supply rural loads and does not have the capacity to deliver large amounts of generation output on a firm basis to AESO load.
- Given the large numbers of system constraints, the southern Alberta transmission system will require substantial system improvements to accommodate the proposed wind generation regardless of the generation location.
- The AESO transmission system responds differently with system overloading depending upon the location of generation interconnections.
- There are load supply issues in High River, Strathmore as well as Glenwood areas.

To address the identified transmission system needs within the southern Alberta region the AESO will proceed to the next phase of the process to assess potential alternatives to relieve the identified constraints. These potential alternatives will be screened to select a set of viable alternatives to conduct detailed analysis from which the recommended transmission development for the region will be determined and the appropriate Need Identification Documents will be filed with the Alberta Utilities Commission (AUC).

During each stage of the process, participant involvement program (PIP) will be carried out to provide an open and transparent environment leading to the Need Application for southern Alberta transmission reinforcement.

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1.0 INTRODUCTION

The southern Alberta region is comprised of ten individual transmission planning areas of High River, Strathmore/Blackie, Brooks, Empress, Stavely, Vauxhall, Fort McLeod, Medicine Hat, Lethbridge, and Glenwood. It borders Sheerness and Hanna to the north, Saskatchewan to the east, Montana to the south and British Columbia to the west. The total distance from Calgary to the Montana border is approximately 300 km and the distance from Crowsnest pass to Medicine Hat is approximately 350 km.

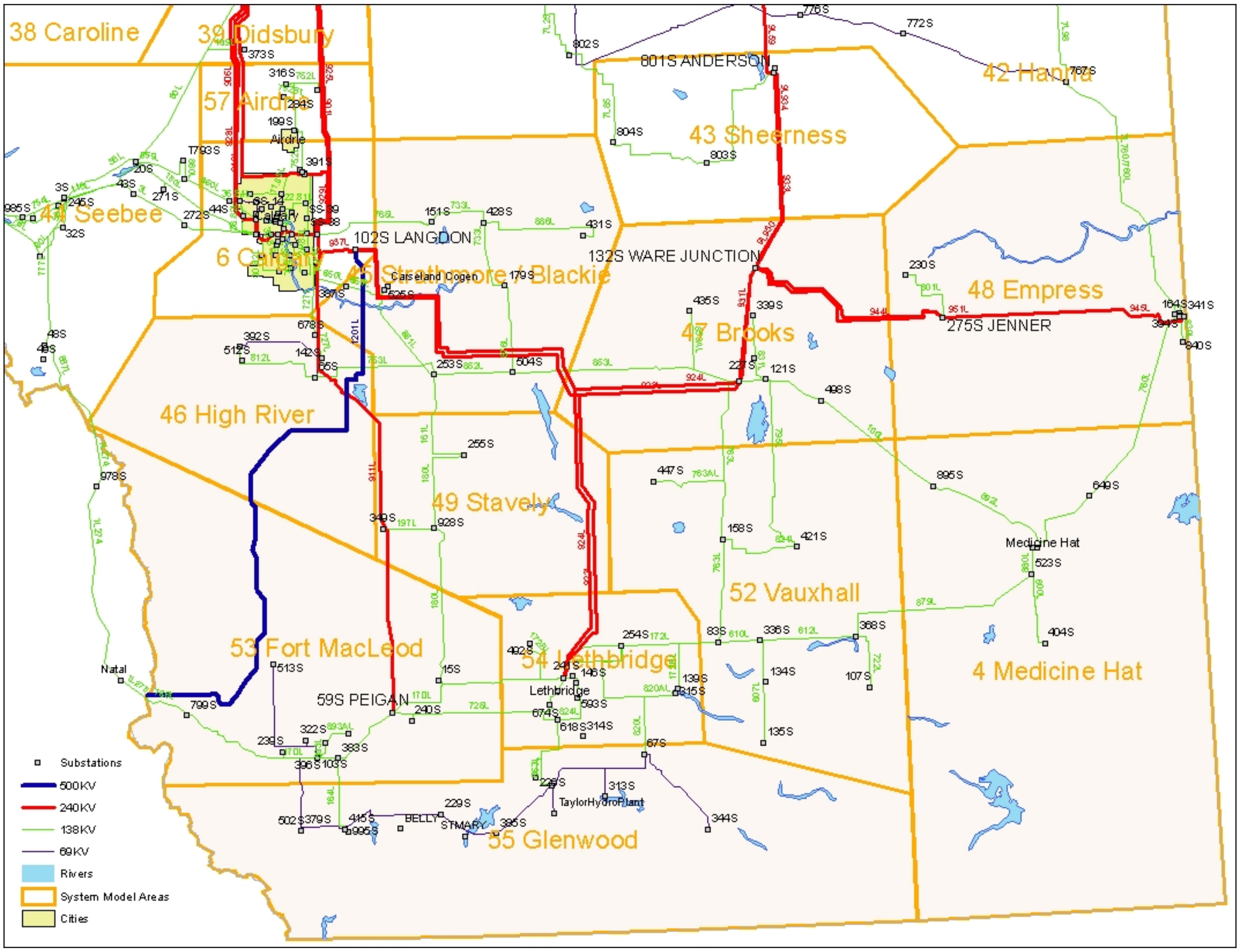
The southern Alberta region consists of three major cities; Lethbridge, Brooks and Medicine Hat. Most of the area is farm land with irrigation systems. The Empress area to the east is the major industrial area and has the highest peak demand of the ten areas followed by Medicine Hat and Lethbridge. The region is mostly served by a 138 kV network with 240 kV transmission supply lines. The 500 kV Alberta – British Columbia tie line also traverses through the southern Alberta region but is not connected to the network in the region.

The purpose of the document is to set out the need for potential transmission reinforcement in the southern Alberta region. It also provides an explanation of the criteria and assumptions the AESO has used to identify the need for potential transmission reinforcement in the region and to present the preliminary need identification results.

2.0 THE EXISTING SOUTHERN ALBERTA TRANSMISSION SYSTEM

Existing southern Alberta transmission system is shown as the shaded region in Figure 2-1. The southern Alberta transmission system at present consists mostly of 138 kV network with several 240 kV lines. There are some 69 kV transmission lines as well. The 911L 240 kV line connects Janet 74S to Peigan 59S substations in the southwest. A 240 kV double circuit 923L and 924L from Langdon substation connects to North Lethbridge 370S through the Milo Junction. Another double circuit 240 kV line is tapped off the Milo Junction to West Brooks 28S and onwards to Anderson 801S and Empress 163S substations. There is a HVDC back-to-back intertie between Alberta and Saskatchewan at Empress which is rated at 150 MW. The present export capability of this tie is reduced to 60 MW due to low voltage concerns during high power transfer conditions. The AESO has submitted a Southeast Alberta Transmission Development Needs Identification Document that, among other items, addresses this issue.

Figure 2-1 Existing Southern Alberta Region Transmission System



Of the ten planning areas included in the southern Alberta region, the Empress area, located on the border with Saskatchewan, has the largest load with a summer peak of nearly 300 MW. The Lethbridge area includes the City of Lethbridge and the peak load is close to 200 MW. The City of Medicine Hat has its own generation and load and has supply transmission service (STS) and demand transmission service (DTS) contracts of 90 MW and 26 MW respectively. The southern Alberta region is a summer peaking region compared to the Alberta Interconnected Electric System (AIES) which is winter peaking. The coincidental summer peak for the southern Alberta is forecast to be 1,162 MW for 2008.

At present the southern Alberta region has approximately 500 MW of wind generation connected to the grid. These plants are mostly located in or near the Pincher Creek area. In addition to the wind generation, there is a small amount of hydro generation installed in the southwest region. In the past few months, the AESO has received generation interconnection applications for a large number of wind power projects. This wind interest is spread throughout the southern Alberta region and is not concentrated in any one area. The total wind interest for the province of Alberta currently stands at over 11,000 MW. Figure A-1 in Appendix A exhibits the wind interest in southern Alberta. For better management of the application queue, the wind interest was divided into zones as shown. The generation interconnection queue is tabulated in Table A-1.

3.0 CONSTRAINTS AND NEED IDENTIFICATION

The AESO performs technical studies to assess transmission supply and reliability needs in Alberta. The technical needs that the AESO tests for include capacity, security, performance, operability and maintenance management. To identify the need to reinforce transmission in the southern region, the AESO will test the existing transmission system by applying the AESO's Reliability Criteria, establishing cut-planes and applying forecast load and generation assumptions.

3.1 RELIABILITY CRITERIA

The AESO Reliability Criteria has been applied in the southern region need identification studies. The southern region transmission system has been tested to achieve acceptable performance following Category A (i.e. all elements in service) and B (i.e. one element out of service) contingencies. Studies will be undertaken to assess Category C and D contingencies as part of the assessment of the recommended alternative.

In addition, the transmission system will be assessed for the capability of meeting Category B requirements while accommodating planned outages at demand levels for which planned outages are performed. This will be applied only on the bulk system as defined in the AESO Reliability Criteria and not in the local area assessments.

3.2 INPUT ASSUMPTIONS

3.2.1 Load Forecast

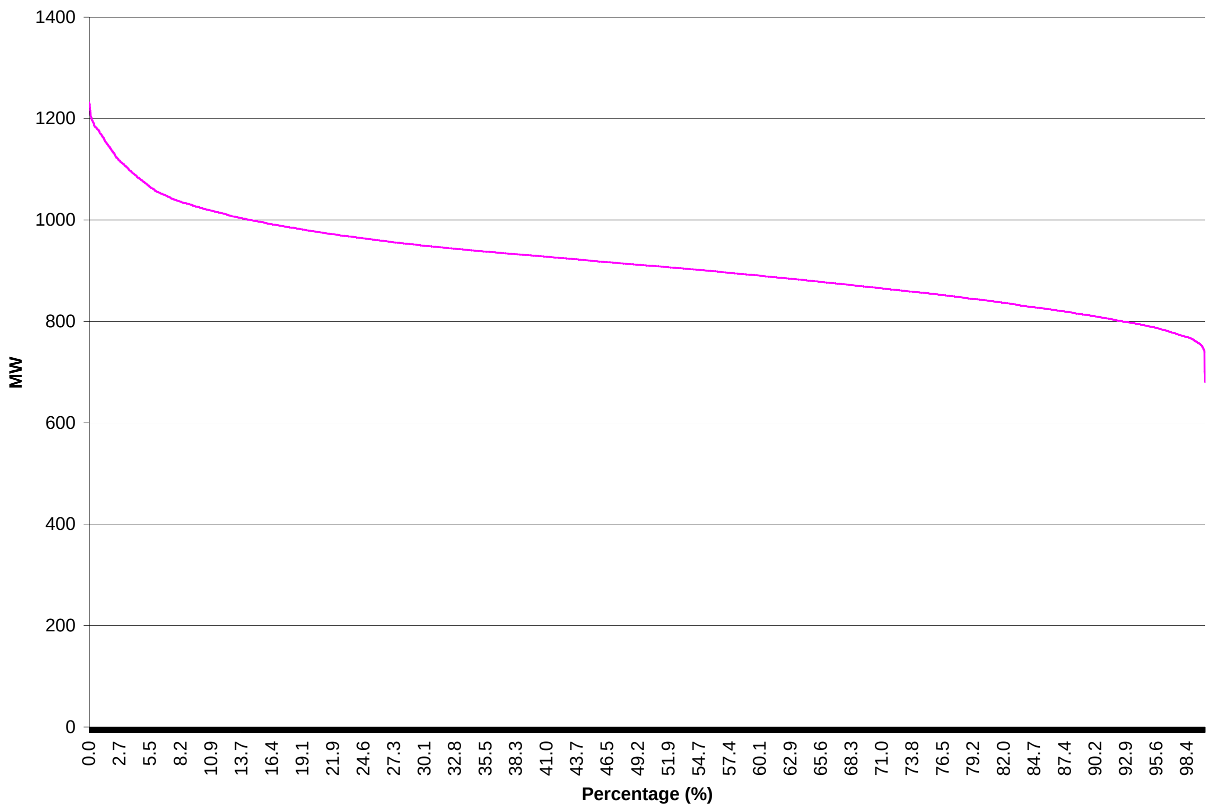
Table 3-1 provides the historical and forecast coincident area peak load for the southern Alberta region. The table shows that southern Alberta is a summer peaking region and the rate of load growth is of the order of 2% for the period of 2007 – 2017 and is based on the FC2007 AESO forecast.

Table 3-1 Southern Alberta Seasonal Historic and Forecast Coincident Peak Load

Southern Alberta	Historical Load (MW)					Forecast Load (MW)									
Season	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
SUMMER	1064	1090	1114	1131	1232	1162	1189	1213	1229	1252	1274	1295	1322	1349	1376
WINTER	1006	1092	1123	1097	1123	1146	1179	1198	1222	1245	1269	1296	1321	1348	1372

Figure 3-1 provides the load duration curve for the southern Alberta region for 2007. It presents the variation of the southern region load over a one year period. The peak load is over 1,200 MW and the minimum load is of the order of 700 MW. For most of the time, the load varies between 800 MW and 1,000 MW.

Figure 3-1 Southern Alberta 2007 Load Duration Curve



3.2.2 Generation Assumptions

The total installed generation capacity in the southern Alberta region is 775 MW as shown in Table 3-2. This table includes the existing wind capacity in southern Alberta. Besides the wind interest, there are applications for gas turbine/combined cycle power plants in the southern region. The City of Medicine Hat has its own generation and load and has STS and DTS contracts of 90 MW and 26 MW respectively.

Table 3-2 Southern Alberta Generation Summary

#	Generating Plants	Fuel	MCR (MW)	Type
1	Castle River	Wind	40	Wind
2	Cowley Ridge	Wind	41	Wind
3	McBride Lake	Wind	75	Wind
4	Summerview	Wind	68	Wind
5	Magrath	Wind	30	Wind
6	Taylor Wind	Wind	3	Wind
7	Soderglen	Wind	71	Wind
8	Chin Chute	Wind	30	Wind
9	Kettles Hills	Wind	63	Wind
10	ENMAX Taber wind	Wind	80	Wind
11	Carseland 1	Gas	40	Cogen
12	Carseland 1	Gas	40	Cogen
13	Cavalier 1	Gas	40.8	Cogen
14	Cavalier 2	Gas	40.8	Cogen
15	Cavalier 3	Gas	25.5	Cogen
16	Old man river	Hydro	32	Hydro
17	Chin Chute	Hydro	11	Hydro

#	Generating Plants	Fuel	MCR (MW)	Type
18	Irrican	Hydro	7	Hydro
19	Taylor	Hydro	12.6	Hydro
20	Drywood	Hydro	6	Hydro
21	Raymond Reservoir	Hydro	18.5	Hydro
Total			**775.2**	

MCR - Machine Continuous Rating
GT - Gas Turbine

Due to the nature of Alberta's electricity market being a non-regulated, competitive business whereby investment decisions are driven by market conditions, the AESO creates generation development scenarios against which the transmission system can be tested to reveal where future reinforcement is required.

The AESO has developed several generation scenarios based on existing and future generation technologies, generation development plans and future expectations. The generation scenarios provide insight into where new generation will be located, when and how much will be developed in order to ensure that the transmission system is planned to provide reliable power to Albertans and facilitate the competitive electricity market.

The AESO's analysis indicates that existing generation technologies will continue to be developed over the next 10 years. Technology advancement will provide additional generation options later in the ten year planning horizon, however the significant generation additions are expected to be Cogeneration, Combined Cycle, Simple Cycle, Supercritical Pulverized Coal Plants (SCPC), and Wind.

Based on expected increases in provincial electricity demand, the AESO expects Alberta's generation capacity to increase by 5,000 MW by 2017 and by 11,500 MW by 2027. A number of generation expansion scenarios developed by the AESO for these timeframes are shown in Appendix A. For southern Alberta planning study, scenario 5 was considered as the base scenario. This scenario has the highest increase in southern generation and foresees 3,400 MW of wind additions in the province between 2008 and 2017. Under this scenario, the total installed wind capacity, including the existing capacity, will reach 3,900 MW in Alberta by 2017. The majority of these additions, 2,700 MW, are assumed to be located in southern Alberta. The full ENMAX Shepard Energy Center combined cycle plant currently planned in the Calgary area is also included in Scenario 5.

Table 3-3   10-Year Generation Scenarios (MW)

Generation Additions Common to All Scenarios		Scenario 5	Scenario 1
	Keephills	450	450
	Coal Upgrades	150	150
	Simple Cycle	200	200
	Hydro	100	100
	Other Small Additions	100	100
Generation Additions			
	Wind	3400	1600
	Keephills 4	450	450
	Calgary area gas	1200	
	Genesee 4		450
	HR Milner Expansion		450
	Cogeneration	1760	1760
	Simple Cycle		600
Total 10-Year Additions		**7810**	**5310**
	Effective Capacity Adjustments for Wind and Hydro	2770	1330
Total Effective Additions		**5040**	**4980**

The planning study also considers the ultimate development of the system using the 20-year generation scenarios. The two 20-year scenarios apply an additional 6500 MW of generation additions to the 10-year scenarios to reach the required 11500 MW in total effective generation additions by 2027. The scenarios include the addition of hydro, nuclear, wind, gas and clean coal generation driven by technology improvements and an increased cost for greenhouse gases. The main scenario investigated in the Southern Alberta Planning Study is Scenario B5 as it has more Southern generation than Scenario A1. Scenario B5 includes an additional 4000 MW of wind. When paired with Scenario 5 for the first ten years, implies a total wind capacity of nearly 8,000 MW by 2027.

Table 3-4 20-Year Generation Scenarios (MW)

Generation Additions Common to All Scenarios		**Scenario B5**	**Scenario A1**
	Battle River 6	400	400
	Bow City	1000	
	IGCC		600
	Combined Cycle	500	500
	Simple Cycle	300	300
	Wind	4000	2000
	Hydro	1400	1400
	Nuclear	2200	2200
	Cogeneration	600	1400
Total 10 to 20-Year Additions		10400	8800
	Effective Capacity Adjustments for Wind and Hydro	3900	2300
Total Effective Additions		6500	6500

3.2.3 Production Simulation Analysis

Hourly simulation studies were also carried out for the southern Alberta region under Generation Scenario 5. This study was undertaken to observe the impact of the high wind generation scenario on the transmission system in southern Alberta. The following input parameters were used in the studies:

- AESO 2007 Future Demand and Energy Outlook
- Hourly wind output was estimated randomly from a historic hourly wind capacity profile, daily and seasonal patterns were maintained
- Imports and exports limited to 1000 MW import/800 MW export with BC, 150 MW with Saskatchewan
- Planned maintenance automatically scheduled for low load hours

Flows across the south cut plane, which comprises 911L Peigan – Janet 240 kV, 936L & 937L Langdon – Janet 240 kV D/C and 9L59 Anderson – Battle River 240 kV transmission lines, were tracked. Simulations were carried out for 2012 and 2017 and for each of the two years 20 randomized runs were simulated in order to capture the effects of the variability of wind on the flows on the south cutplane. Duration curves of the flows on the south cutplane in 2012 and 2017 under Scenario 5 are shown in Figure 3-2 and Figure 3-3.

Figure 3-2 2012 South Path Flow Duration Curve

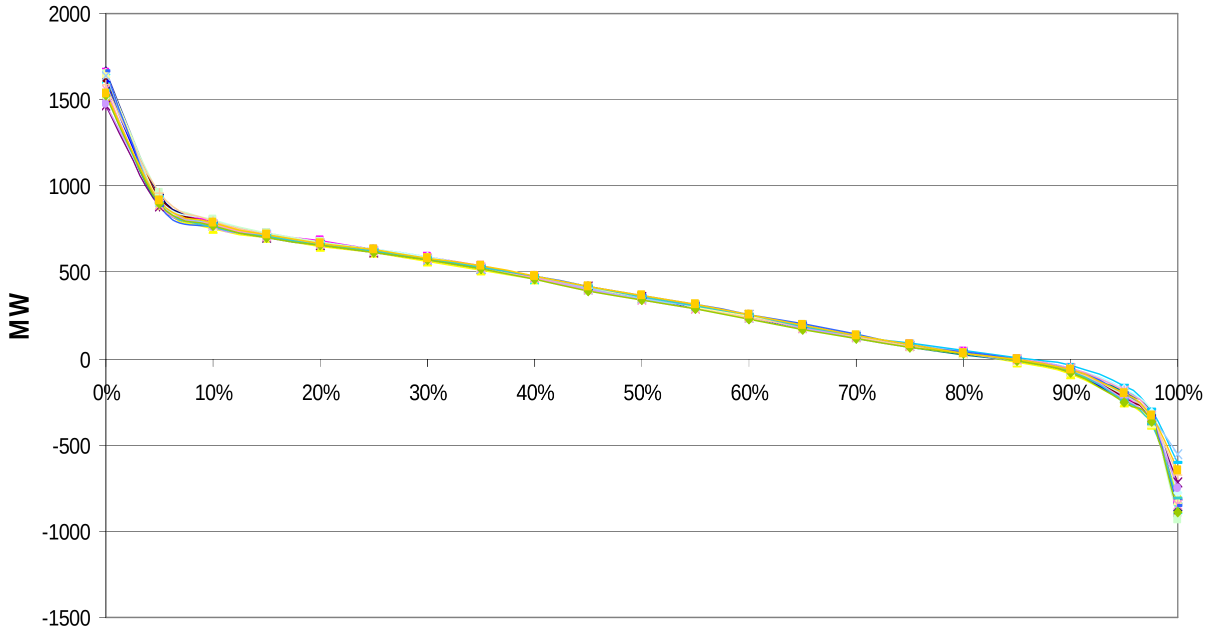
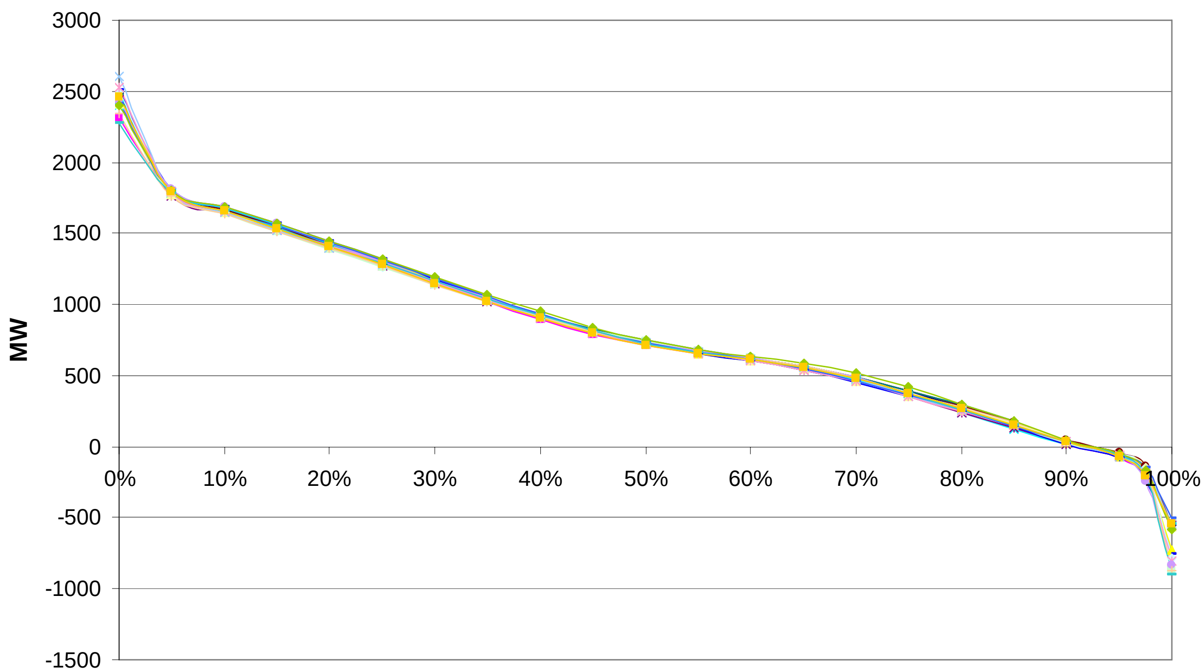


Figure 3-3 2017 South Path Flow Duration Curve



3.3 TRANSMISSION SYSTEM ANALYSIS

3.3.1 General

The AESO has carried out the analysis on the existing system as well as future scenarios to ascertain the transmission system capacity to absorb wind. The load serving capability of the system was also tested for the High River and Strathmore/Blackie areas as these two individual areas were not part of the Southeast Transmission Need Application. In addition, Glenwood area 69 kV system was also tested for load carrying capability. The results of the analysis are discussed in the following sections.

3.3.2 Generation Interconnection

For evaluating the system capability to accommodate wind generation, first contingency incremental transfer capability (FCITC) analysis was carried out on the 2010 system.

A first contingency incremental transfer capability (FCITC) analysis was performed to determine the regional transfer capability of southern Alberta transmission system to deliver the wind generation to regional load centers. The overall purpose of the transfer capability analysis was to identify the levels of wind generation capacity within a cluster area that creates or worsens thermal overload conditions and also how those thermal loading impacts are similar or unique between different wind farm cluster areas. The results of this approach provide an understanding of the transmission systems ability to deliver the proposed wind generation and how different interconnection locations influence the need for improvements in the AESO network. The SIEMENS MUST Version 8.3.2 software was used for the FCITC analysis. The MUST software is most commonly used to perform FCITC analysis in large interconnected networks due to its simulation automation techniques.

The FCITC analysis was based on the following assumptions:

a) The 2010 summer light and peak cases were analyzed.

b) The source subsystem was sixteen independent generation collection points.

c) The sink subsystem was generation in the Wabamun area.

d) The monitored facilities included the entire AESO system.

e) Single contingencies for the entire AESO system were examined.

Sixteen different collection substations were identified based on the interconnection requestors' geographic proximity to the existing AESO transmission system. The collection substations are shown in the Figure B-1. The collection substations served the function of interconnecting a group of wind farms to the existing AESO transmission network. In connecting the cluster area generation to the AESO system, it was assumed that the nearest existing transmission facilities were utilized for the interconnection. Therefore, the collection substation for the cluster area was placed on the nearest existing 69 kV or higher transmission line. This approach was consistent with purpose of the FCITC analysis to identify the existing transmission system's ability to deliver wind generation based on the requested locations.

The FCITC analysis studied the transfer of wind generation energy from a single wind farm cluster area (collection substation) to AESO load from zero MW injected (Base Case) up to 1000 MW of wind generation capacity for that cluster area. The maximum transfer level of 1000 MW provided sufficient generation injection to identify transfer levels which impacted the AESO system. The 1000 MW transfer simulation was repeated for each of the sixteen wind farm cluster areas independently.

A distribution factor criteria of 3 percent was used for identifying impacts to existing AESO system constraints. Impacts to existing network constraints were considered negligible if the distribution factor was less than 3 percent. The transfer distribution factor (TDF) is calculated based on the MW flow on the limiting element during an outage of the critical facility per the following equation:

TDF(%) = 100 x [Branch MW flow with Transfer – Branch MW flow w/o Transfer] / Transfer Amount

The distribution factor calculation is a very common method of associating individual branch loading constraints to various transfers of generation to load within a large interconnected network. In doing so, the relative responsibility of overloading system elements can be determined for different generator locations.

The result of the FCITC analysis for the summer peak and summer light cases are summarized in Appendix B respectively. All results shown are for the worst case single contingency conditions. In the result tables, there are positive and negative values as well as the notation "NC". The positive values indicate that the limiting element shown became an overloaded system constraint at that level of MW transfer from the respective collection point (CP) substation. For example, in Table B-1, the positive value of 37 shown in the CP #1 column indicates that the Peigan 240/138 kV transformer T1 becomes overloaded when 37 MW of generation is injected at the collection substation CP #1.

A negative value in the FCITC analysis results indicates that the limiting element shown is already overloaded under single contingency conditions and has zero incremental transfer capability. This means that zero wind generation can be injected at that collection substation without overloading the limiting element during a single contingency condition. The negative value shown also indicates that a transfer of that amount in the opposite direction would be required to eliminate the existing system constraint.

The notation "NC" in the results indicates that the worst case single contingency did not converge for the identified limiting element. There is a high likelihood that a transfer limitation exists for the identified limiting element, but the transfer MW value is not known from this result. However, if the same limiting element consistently has reported values for other collection point substation columns, then the transfer MW value can be inferred from the results from similar collection point substations.

Some important factors about the FCITC results in Tables B-1 and B-2 can be observed. As shown by the rows in the result tables with some blank cells and some non-blank cells, a transmission line or transformer which is a limiting element for one collection substation is not necessarily a limiting element for all collection substations. For example, the Peigan 240/138 kV transformer T1, shown in Table B-1, is a transfer limiting element for collection substations 1, 2, 3, 6, and 7, while not a limiting element for the remaining collection substations. This clearly illustrates that the southern transmission system responds differently depending upon the generation interconnection location. What might be a limiting element for a generation interconnection at one location will not necessarily be a limiting element for another location.

Also shown by the results are that some limiting elements are persistent across all or most collection substations. For example, the Peigan to Janet 240 kV line is a limiting element in the summer light FCITC results for all but four of the collection substation locations. Therefore, some lines and transformers are consistently overloading regardless of the generation interconnection location.

Most importantly, the results show that all collection point substations have a negative value or very small positive value for multiple limiting elements. For most of the collection point substations there are numerous MW transfer limitations which are very small or less than zero. As well, there are 138 different limiting elements reported across all collection point substations in the summer peak case alone. This result demonstrates that the existing transmission system in southern Alberta does not have any incremental transfer capability regardless of the location of proposed generation interconnection and that the impacts are widespread across the network.

Based on the FCITC analysis results, the following conclusions are made:

1. There is no incremental capability in the southern Alberta transmission system to deliver additional generation output on a firm basis to AESO load.

2. Given the large numbers of system constraints, the southern Alberta transmission system will require substantial system improvements to integrate the proposed generation regardless of the generation location.

3. The AESO transmission system responds differently with system overloading depending upon the location of generation interconnections.

3.3.3 Load Adequacy Study for High River, Strathmore/Blackie and Glenwood Areas

The AESO submitted a Need Application for the southeast Alberta transmission development in November, 2007. This Need Application, among other things, focused on load supply adequacy. The southwest Need Application, which was approved in 2005 made recommendations regarding the supply and load situation in the south west Alberta. Besides the SW and the SE, the southern region now also includes High River and Strathmore/Blackie areas which were not included in the previous two applications. Therefore, a power flow analysis was performed on these areas and the observations are discussed in the following sections. In addition problems were also observed in the 69 kV system in Glenwood area. Therefore this area was also included in the analysis. Summer peak case was used for the load adequacy analysis as southern Alberta peaks in summer and summer line ratings are lower than in winter.

3.3.3.1 Existing System Analysis

Power flow analysis was carried out for peak load summer 2008 to assess the existing system capability in High River and Blackie/Strathmore area. The results are shown in Table 3-5 and the power flow plots are provided in Appendix C.

Table 3-5 Existing problems in High River and Strathmore/Blackie Area

Contingency	Overloaded element	Voltage violation
727L Janet 74S to Okotoks 678S	• 158L High River 65S to Black Diamond 392S	• Low voltage in High River area
753L High River 65S to Blackie 253S		• Voltage drops more than 5% on the High River 65S and Black Diamond 392S 25kV, 69 kV & 138 kV buses and Hartell 512S 138 kV bus

3.3.3.2 2012 System Analysis

Analysis was also carried out for peak load summer 2012 scenario. The results of the analysis are provided in Table 3-6 and the power flow plots are attached as Appendix C.

Table 3-6 Problems in High River and Strathmore/Blackie Area by 2012

Contingency	Overloaded element	Voltage violation
727L Janet 74S to Okotoks 678S	• 158L High River 65S to Black Diamond 392S 69kV • 753L High River 65S to Blackie 253S 138 kV	• Voltage collapse in High River area
850L Janet 74S to Shepard 387S		• Voltage drops more than 5% on the Shepard 387S, Carseland 525S and Wyndham 269S 138 kV buses
753L High River 65S to Blackie 253S		• Voltage drops more than 5% on the High River 65S 69 kV & 138kV buses, Black Diamond 392S 25 kV, 69kV & 138kV buses and Hartell 512S 138kV bus

3.3.3.3 2017 System Analysis

The results of the 2017 peak load summer conditions are provided in Table 3-7 and the power flow plots are attached as Appendix C.

Table 3-7 Problems in High River and Strathmore/Blackie Area by 2017

Contingency	Overloaded element	Voltage violation
727L Janet 74S to Okotoks 678S	• 158L High River 65S to Black Diamond 392S • 753L High River 65S to Blackie 253S • 850L Janet 74S to Carseland 525S	• Voltage collapse in High River area

765L Janet 74S to Strathmore 151S	• 876L Gleichen 179S to Queenstown 504S	• Voltage drops more than 5% on Cavalier, Strathmore 151S, Hussar431S and Namaka 428S 138kV buses and Strathmore 151S and Namaka 428S 25kV buses
850L Janet 74S to Shepard 387S		• Voltage drops more than 5% on the Shepard 387S, Carseland 525S and Wyndham 269S 138kV buses
753L High River 65S to Blackie 253S	• 727L Janet 74S to Okotoks 678S	• Low voltage on the Black Diamond 392S 25kV buses • Voltage drops more than 5% on the High River 65S 69kV & 25kV buses, Hartell 512S 138kV bus and Black Diamond 138kV, 69kV & 25kV buses

3.3.4 Load Adequacy Study for Glenwood Area

In addition to High River and Strathmore/Blackie Area study, Glenwood Area 69kV transmission issues also need to be addressed. Summer peak case was used for the load adequacy analysis.

3.3.4.1 Existing System Analysis

Power flow analysis was carried out for peak load summer 2008 to assess the existing system capability in Glenwood Area. The results are shown in Table 3-8 and the power flow plots are provided in Appendix D.

Table 3-8 Existing problems in Glenwood Area

Contingency	Overloaded element	Voltage violation
Pincher Creek 396S 138/69kV transformer T1		• Voltage drops more than 5% on the Pincher Creek 396S 69kV bus
185L Drywood 415S to Waterton 379S		• Voltage drops more than 5% on the Waterton 379S 69kV bus and Shell Waterton 502S 69kV & 25kV buses
164L Goose Lake 103S to Drywood 415S		• Voltage drops more than 5% on the Drywood 415S 138kV &25kV buses, Waterton 379S, Shell Waterton 502S, Yarrow 995S

		and Glenwood 229S 69 kV buses and Shell Waterton 502S 25kV bus
Drywood 415S 138/69kV transformer T1		• Voltage drops more than 5% on the Drywood 415S , Waterton 379S, Yarrow 995S, Glenwood 229S and Shell Waterton 502S 69kV buses and Shell Waterton 502S 25kV bus
820L Stirling to Coaldale		• Low Voltage on the Stirling 67S 138 kV bus

3.3.4.2 2012 System Analysis

Analysis was also carried out for peak load summer 2012 scenario. The results of the analysis are provided in Table 3-9 and the power flow plots are attached as Appendix D.

Table 3-9 Problems in Glenwood Area by 2012

Contingency	Overloaded element	Voltage violation
Pincher Creek 396S 138/69kV transformer T1		• Voltage drops more than 5% on the Pincher Creek 396S 69kV bus
185L Drywood to Waterton		• Voltage drops more than 5% on the Shell Waterton 502S 25kV bus
164L Goose Lake 103S to Drywood 415S		• Low voltage on the Drywood 415S 138kV bus • Voltage drops more than 5% on the Drywood 415S 69kV and 138kV buses, Yarrow 995S 69kV bus and Shell Waterton 502S 25kV bus
Drywood 415S 138/69kV transformer T1		• Voltage drops more than 5% on the Drywood 415S and Yarrow 995S 69kV buses
225L Spring Coulee 385S to Magrath 225S		• Voltage drops more than 5% on the Glenwood 229S and Spring Coulee 385S 69kV buses

820L Stirling 67S to Coaldale 254S		• Low voltage on the Stirling 67S 138kV and 25kV buses • Voltage drops more than 5% on the Irrican 25kV buses
Stirling 67S 138/69kV transformer T1		• Voltage drops more than 5% at Irrican and Stirling 67S 25kV bus

3.3.4.3 2017 System Analysis

The results of the 2017 peak load summer conditions are provided in Table 3-10 and the power flow plots are attached as Appendix D.

Table 3-10 Problems in Glenwood Area by 2017

Contingency	Overloaded element	Voltage violation
Base Case	• Stirling 67S 69/25kV transformer T3	
Pincher Creek 396S 138/69kV transformer T1		• Voltage drops more than 5% on the Pincher Creek 396S 69kV bus
185L Pincher Creek 396S to Waterton 379S		• Voltage drops more than 5% on the Shell Waterton 502S 69kV bus
185L Drywood 415S to Waterton 379S		• Voltage drops more than 5% on the Waterton 379S 69kV bus and Shell Waterton 502S 69kV & 25kV buses
164L Goose Lake 103S to Drywood 415S		• Low voltage on Drywood 415S 138kV bus and Stirling 67S 25kV bus, • Voltage drops more than 5% on the Drywood 415S 138kV bus, Drywood 415S, Yarrow 995S, Waterton 379S, Shell Waterton 502S and Glenwood 229S 69kV buses and Shell Waterton 502S, Belly River IPP, St. Mary IPP,

		Glenwood 229S and Spring Coulee 385S 25kV buses
Drywood 415S 138/69kV transformer T1		• Low voltage on Stirling 67S 25kV bus, • Voltage drops more than 5% on the Drywood 415S,Yarrow 995S, Waterton 379S, Shell Waterton 502S and Glenwood 229S 69kV buses and Shell Waterton 502S, Belly River IPP, St. Mary IPP, Glenwood 229S and Spring Coulee 385S 25kV buses
146L Drywood 415S to Glenwood 229S		• Low voltage on Stirling 67S 25kV bus • Voltage drops more t than 5% on the Glenwood 229S 69kV bus and Belly River IPP and Glenwood 229S 25kV buses
225L Spring Coulee to Magrath		• Voltage drops more than 5% on the Spring Coulee 229S 69kV & 25kV buses and St. Mary IPP 25kV bus
820L Stirling 67S to Coaldale 254S		• Voltage collapse
225L Taylor to Magrath 225S	• 207L N.Lethbridge 370S to Coal Banks 111S	
Stirling 67S 138/69kV transformer T3		• Voltage collapse
863L Magrath 225S to Riverbend 618S	• 207L N.Lethbridge 370S to Coal Banks 111S	• High voltage on Magrath 225S 138kV bus • Voltage rises more than 5% on the Taylor and Magrath 225S 69kV buses and Magrath 225S 138kV bus

4.0 SUMMARY OF RESULTS

The analysis of the existing transmission system carried out for the South region indicates a large number of system performance concerns related to impact of generation additions and load supply adequacy. Table 4-1 below provides a summary of the study results for southern Alberta. Unless otherwise noted the issues listed in the table occur under Category B conditions. The issues that exist in previous year are not listed.

Table 4-1 Summary of Results

Generation Interconnection Analysis		
FCITC results show that the existing transmission system in southern Alberta does not have any incremental transfer capability regardless of the location of proposed generation interconnection and that the impacts are widespread across the network.		
Load Adequacy Analysis		
Year	Area	Issue
At present	High River & Strathmore	Overloading of 158L High River 65S to Black Diamond 392S and Voltage criteria violation in High River area
At present	Glenwood	Overloading of Drywood 415S 138/69kV transformer and Voltage criteria violation on Glenwood 69 kV system
2012	High River & Strathmore	Overloading of 753L High River 65S to Blackie 253S 850L Janet 74S to Carseland 525S Voltage collapse in High River area
2012	Glenwood	Voltage criteria violation on Glenwood 69 kV system (Overloading of Drywood 415S 138/69kV transformer will be removed after SW development)
2017	High River & Strathmore	Overloading of 876L Gleichen 179S to Queenstown 504S, 850L Janet 74S to Carseland 525S and 727L Janet 74S to Okotoks 678S
2017	Glenwood	Stirling 67S 69/25kV transformer and 207L overload and Voltage collapse in Glenwood area

5.0 CONCLUSIONS

The analysis of the existing transmission system within Southern Alberta revealed that:

- There is no incremental capability in the southern Alberta transmission system to deliver additional generation output on a firm basis to AESO load.
- Given the large numbers of system constraints, the southern Alberta transmission system will require substantial system improvements to accommodate the proposed wind generation regardless of the generation location.
- The AESO transmission system responds differently with system overloading depending upon the location of generation interconnections.
- In High River area, there is insufficient load serving capability of the transmission system and voltage support under Category B conditions.
- In Strathmore area thermal overload will start to manifest by 2017.
- In Glenwood area, thermal overload and voltage issues are present under Category B conditions.

To address the identified transmission system needs within Southern Alberta the AESO will proceed to the next phase of the process to assess potential alternatives to relieve the identified constraints. These potential alternatives will be screened to select a set of viable alternatives to conduct detailed technical and economic analysis. The social impacts of these final alternatives will also be assessed in determining the final recommendation. A Need Identification Document will then be prepared and filed with the Alberta Utilities Commission for review and approval.

APPENDIX A

Southern Alberta Wind Generation Queue

Wind Farm Planning Map

Updated: 2007-10-16

South_Alberta_Future_Windfarms.mxd

Queue by Zone

Zone 1
519
509
524
510
462
580
691
742

Zone 2
393
502
515
750

Zone 3
376
469
581
614

Zone 4
751
758

Zone 5
681

Zone 6
392
505
622
690

Zone 7
679
695

Zone 8
514
740
756

Zone 9
728

Zone 10
534
689
729

Zone 11
513
389

Zone 12
715
754

Zone 13
590

Zone 14
617
752

Zone 15
680
760

Zone 16
761

Zone 17
716

Zone 18
635
718

Zone 19
634
678
753
759

Zone 20
743

Zone 21
757

Zone 22
731

Zone 23
518

Zone 24
723

*Includes only those applied for prior to December 4, 2007. The list will be updated in the January 2008.

Table A-1
Southern Alberta Wind Interest Queue
September 2, 2008

Position	Project #	Facility Name	(MW)
1	502	Kettles Hill Wind Farm- Expansion	77
2	518	Confidential Wind Project	75
3	519	Old Man River Wind Farm	47
4	393	VisionQuest Summerview Ph. 2 Wind Farm	63
5	376	VisionQuest Bluetrail Wind Farm	66
6	513	Confidential Wind Project	116
7	509	Yagos Wind Farm	100
8	524	River View Wind Power Plant	115
9	510	HWY 785 Wind Plant	235
10	462	Castle Rock Ridge Wind Power	112
11	392	VisionQuest - Waterton Wind Farm	300
12	389	VisionQuest Seven Persons Wind Farm	120
14	469	Confidential Wind Project	99
15	515	Confidential Wind Project	350
16	505	Confidential Wind Project	110
17	479	Wild Rose Wind Project Phase 1	200
21	514	Confidential Wind Project	80
22	534	Confidential Wind Project	75
24	581	Confidential Wind Project	49.5
25	580	Confidential Wind Project	61.2
26	590	Confidential Wind Project	99
28	614	Confidential Wind Project	100
29	617	Confidential Wind Project	100
30	622	Confidential Wind Project	120
31	634	Confidential Wind Project	99
32	635	Confidential Wind Project	79.5
34	678	Confidential Wind Project	80
37	679	Confidential Wind Project	99
38	680	Confidential Wind Project	70.5
39	681	Confidential Wind Project	99
40	689	Confidential Wind Project	15
41	690	Confidential Wind Project	60
42	691	Confidential Wind Project	30
44	693	Confidential Wind Project	200
45	695	Greengate Stirling Wind Project	100
48	718	Greengate Wintering Hills Wind Project	150
49	715	Confidential Wind Project	79.5
50	716	Confidential Wind Project	79.5
52	723	Greengate Halkirk Wind Project	150
54	728	Greengate Blackspring Ridge Wind Project	300
56	729	Confidential Wind Project	700
57	731	Greengate Ponoka Wind Project	150
60	740	Confidential Wind Project	150
62	742	Confidential Wind Project	120
63	743	Greengate Radar Hill Wind Farm	100
68	750	Confidential Wind Project	25
69	751	Confidential Wind Project	100
70	752	Confidential Wind Project	100
71	753	Confidential Wind Project	130
72	754	Confidential Wind Project	300
73	756	Confidential Wind Project	40
74	757	Greengate Chigwell Wind Project	150
75	758	Confidential Wind Project	102
76	759	Confidential Wind Project	102
77	760	Confidential Wind Project	102
78	761	Confidential Wind Project	102
79	762	Confidential Wind Project	200
80	763	Confidential Wind Project	200
81	764	Confidential Wind Project	150
82	765	Confidential Wind Project	150
83	766	Confidential Wind Project	100
84	767	Confidential Wind Project	300
85	770	Greengate Blackspring Ridge Phase II	300
86	773	Confidential Wind Project	210
90	790	Confidential Wind Project	400
92	789	Confidential Wind Project	130
93	796	Confidential Wind Project	2
95	798	Confidential Wind project	2
96	800	Confidential Wind Project	200
97	802	Confidential Wind Project	240

Table A-1
Southern Alberta Wind Interest Queue
September 2, 2008

98	799	Confidential Wind Project	299
100	805	Greengate Power Halkirk II Wind Project	150
102	818	Confidential Wind Project	250
103	819	Confidential Wind Project	500
109	845	Confidential Wind Project	102
112	847	Confidential Wind Project	60

Table A-2 10-Year Generation Scenarios (MW)

Generation Additions Common to All Scenarios		**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Scenario 5**
	Keephills	450	450	450	450	450
	Coal Upgrades	150	150	150	150	150
	Simple Cycle	200	200	200	200	200
	Hydro	100	100	100	100	100
	Other Small Additions	100	100	100	100	100
Generation Additions						
	Wind	1,600	1,600	1,600	1,600	3,400
	Keephills 4	450	450	450		450
	Shepard Energy Center			600	1,200	1,200
	Genesee 4	450	450	450	450	
	HR Milner Expansion	450				
	Cogeneration	1,760	2,260	1,760	1,760	1,760
	Simple Cycle	600	600	400	300	
Total 10-Year Additions		**6,310**	**6,360**	**6,260**	**6,310**	**7,810**
	Effective Capacity Adjustments for Wind and Hydro	1,330	1,330	1,330	1,330	2,770
Total Effective Additions		**4,980**	**5,030**	**4,930**	**4,980**	**5,040**

Table A-3 20-Year Generation Scenarios (MW)

Generation Additions Common to All Scenarios		Scenario B	Scenario A
	Battle River 6	400	400
	Bow City	1,000	
	IGCC		600
	Combined Cycle	500	500
	Simple Cycle	300	300
	Wind	4,000	2,000
	Hydro	1,400	1,400
	Nuclear	2,200	2,200
	Cogeneration	600	1,400
Total 10 to 20-Year Additions		10,400	8,800
	Effective Capacity Adjustments for Wind and Hydro	3,900	2,300
Total Effective Additions		6,500	6,500

APPENDIX B

FCITC Analysis Results

Table B-1

FCITC ANALYSIS RESULTS
2010 Summer Peak Model

Limiting Element	CP #1	CP #2	CP #3	CP #4	CP #5	CP #6	CP #7	CP #8	CP #9	CP #10	CP #11	CP #12	CP #13	CP #14	CP #15	CP #16
1382[BUFALOTP] - 1383[VERMILO7] 138 kV line 50														NC		
1382[BUFALOTP] - 1490[JAROW TP] 138 kV line 50		NC	NC		NC				NC					NC		NC
1471[MONITOR7] - 89993[KYSTP3T3] 138 kV line 98													1451	1018		
1474[OYEN 7] - 89993[KYSTP3T3] 138 kV line 98													699	900		
1474[OYEN 7] - 89994[KYSTP4T4] 138 kV line 60													636	788		
159[LANGDON4] - 160[JANET 4] 240 kV line 36		803	824		785				787					809		697
159[LANGDON4] - 160[JANET 4] 240 kV line 37		803	824		785				787					809		697
159[LANGDON4] - 281[MILO 2] 240 kV line 27									923							
160[JANET 4] - 162[E CALGAR] 240 kV line 17	377	762	762	856	839	531	754	790	784	830	857			929		800
160[JANET 4] - 165[PEIGAN 4] 240 kV line 11	301	664	635			492	701		808							
165[PEIGAN 4] - 166[PEIGAN 7] 240/138 kV transformer T1	37	31	26			54	429									
165[PEIGAN 4] - 346[GOOSEL4] 240 kV line 75		847														
165[PEIGAN 4] - 346[GOOSEL4] 240 kV line 76		847														
166[PEIGAN 7] - 77703[TAP BUS] 138 kV line 70	62	49	43			88	705									
167[N LETHB4] - 692[N LETHB7] 240/138 kV transformer T3				520	470		727	747								467
167[N LETHB4] - 692[N LETHB7] 240/138 kV transformer T5				489	444		739	677								443
167[N LETHB4] - 943[MILO 1] 240 kV line 24									903							
167[N LETHB4] - 9990[MATL120S] 240 kV line 1		794	698						299							
171[SEEBE 7] - 329[POCATER7] 138 kV line 77	213	439	504													
207[JANET 7] - 212[SHEPARD7] 138 kV line 50				359	331			980	790	786				825	89	680
207[JANET 7] - 239[OKOTOKS7] 138 kV line 27															378	
207[JANET 7] - 259[STRATHM7] 138 kV line 65														771	85	
207[JANET 7] - 577[ENMX23S7] 138 kV line 80	-194	-527	-524	-331	-325	-128	-364	-351	-420	-398	-388	-374	-428	-493	-138	-407
207[JANET 7] - 590[ENMX24S7] 138 kV line 83	-193	-637	-633	-950	-1058	-123	-375	-400	-544	-475	-483	-406	-490	-619	-490	-474
208[ENMX2S 7] - 577[ENMX23S7] 138 kV line 80		925	905	675	655				840	867				923	263	837
212[SHEPARD7] - 252[CARSELA7] 138 kV line 50				405	379			1000	882	966				932	99	771
223[PINCHER8] - 227[SHELL WA] 69 kV line 85	18					158										
223[PINCHER8] - 876[514BL TP] 69 kV line 14	2															
224[PINCHER7] - 223[PINCHER8] 138/69 kV transformer T1	10	808	828			66	311	194								
224[PINCHER7] - 229[170AL-TA] 138 kV line 70	206	313	358			398										
224[PINCHER7] - 296[GOOSEL7] 138 kV line 1	58	346	395			301										
225[WARE JCT] - 260[JENNER 4] 240 kV line 44														978		
225[WARE JCT] - 260[JENNER 4] 240 kV line 51														792		
225[WARE JCT] - 430[W BROOK4] 240 kV line 31														288		
226[DRYWOOD8] - 227[SHELL WA] 69 kV line 85	32					131	303									
226[DRYWOOD8] - 245[GLENWOO8] 69 kV line 46	82	301	370			19	61	90								615
229[170AL-TA] - 232[COLEMAN7] 138 kV line 70	117	160	187		1000	267	605	759	611							991
232[COLEMAN7] - 1501[NATAL 7] 138 kV line 86	87	107	126	682	620	250	609	763	444	1000						1000
233[DRYWOOD7] - 226[DRYWOOD8] 138/69 kV transformer T1	38	790	846			41	269	235								
233[DRYWOOD7] - 54827[164AL TA] 138 kV line 64	1					97	347									
237[FORT MA7] - 279[STAVELEY] 138 kV line 80	345	666	629	166	132	209	620	566	590	817					623	515
237[FORT MA7] - 77705[TAP BUS] 138 kV line 72				85	87			1000	994						499	962
237[FORT MA7] - 823[725BL] 138 kV line 25		989	936	13	218	226	284	224	759							631
239[OKOTOKS7] - 886[MAG TAP7] 138 kV line 27															330	
242[HIGH RI7] - 253[BLACKIE7] 138 kV line 53				780	713										168	
242[HIGH RI7] - 886[MAG TAP7] 138 kV line 27															291	
244[VULCAN 7] - 253[BLACKIE7] 138 kV line 61		948	894	226	174	480	695	811	803						534	809
244[VULCAN 7] - 279[STAVELEY] 138 kV line 80		828	782	200	156	516	708	842	711						576	669

Table B-1 - continued

FCITC ANALYSIS RESULTS
2010 Summer Peak Model

Limiting Element	CP #1	CP #2	CP #3	CP #4	CP #5	CP #6	CP #7	CP #8	CP #9	CP #10	CP #11	CP #12	CP #13	CP #14	CP #15	CP #16
245[GLENWOO8] - 246[SPRING 8] 69 kV line 25	116	273	339		947	21	1	4								922
246[SPRING 8] - 693[MAGRATH8] 69 kV line 25	122	274	340		963	20	1	5								
252[CARSELA7] - 253[BLACKIE7] 138 kV line 51				788	720										170	
253[BLACKIE7] - 77715[TAP BUS] 138 kV line 52														762	55	1000
254[GLEICHE7] - 333[QUENSTWN] 138 kV line 76															151	
254[GLEICHE7] - 340[NAMAKA 7] 138 kV line 33															267	
256[BROOKS 7] - 10111[] 138 kV line 1										632	345	290	315			
256[BROOKS 7] - 401[HAYS 7] 138 kV line 95										569						528
259[STRATHM7] - 340[NAMAKA 7] 138 kV line 33					968									734	82	
260[JENNER 4] - 677[CYPRESS1] 240 kV line 45														723		
260[JENNER 4] - 77714[TAP BUS] 240 kV line 51														346		
262[DOME EM4] - 267[DOME EM7] 240/138 kV transformer T5													287	NC		
262[DOME EM4] - 677[CYPRESS1] 240 kV line 45														723		
266[EMPRESA7] - 267[DOME EM7] 138 kV line 60										877	690	705	153	351		
266[EMPRESA7] - 77713[TAP BUS] 138 kV line 60							-38	-31		-16	-10	-7	-4	526		-24
267[DOME EM7] - 911[EMPLIQTP] 138 kV line 60												1000	NC	744		
269[BURDETT7] - 77711[TAP BUS] 138 kV line 72					575			1000		54	86	116	265			202
270[SUFFIEL7] - 275[TILLEY 7] 138 kV line 00										231	182	166	179			1022
270[SUFFIEL7] - 675[REDCLIFF] 138 kV line 00										146	121	112	125			
271[BULLS H7] - 54839[600AL TA] 138 kV line 00												117				
271[BULLS H7] - 680[MEDICIN7] 138 kV line 80										162	134	125	211			771
271[BULLS H7] - 93003[STEERTAP] 138 kV line 72								1000		68	60	103	217			311
272[TABER 7] - 274[VAUXHAL7] 138 kV line 63							664	900		191	251	531				176
272[TABER 7] - 834[CHIN_CHT] 138 kV line 72				433	418	233	655	235	869	210	254	382	739			92
274[VAUXHAL7] - 401[HAYS 7] 138 kV line 21										359						331
274[VAUXHAL7] - 928[ENCH TAP] 138 kV line 63										387						360
275[TILLEY 7] - 10111[] 138 kV line 00										612	342	288	313			
276[W BROOK7] - 877[BASNTAP] 138 kV line 53												1000	847	559	248	
276[W BROOK7] - 928[ENCH TAP] 138 kV line 63										404						375
280[STIRLIN8] - 863[RAYRS TP] 69 kV line 25	-190					-48	-28	13								
281[MILO 2] - 9990[MATL120S] 240 kV line 23									348							
284[BUTTE7] - 54839[600AL TA] 138 kV line 00												117				
293[STIRLIN7] - 280[STIRLIN8] 138/69 kV transformer T3	119					13	7	35								
293[STIRLIN7] - 869[TEPST TP] 138 kV line 20						416	318	100								
296[GOOSEL7] - 409[KETTLES] 138 kV line 70	1	127	-11			212										
296[GOOSEL7] - 54543[OLDMAN1] 138 kV line 24		163														
296[GOOSEL7] - 54827[164AL TA] 138 kV line 64	1					100	351									
31[FINCAST7] - 269[BURDETT7] 138 kV line 12				-243	-242	-118	-194	-139		-49	118	156	389			-91
31[FINCAST7] - 272[TABER 7] 138 kV line 10				717	698		729	363		27	59	85	177			212
31[FINCAST7] - 828[PURPLETP] 138 kV line 88										10						
320[CHAPPIC7] - 680[MEDICIN7] 138 kV line 60							-374	-398		-375	-259	-209	99	808		-544
320[CHAPPIC7] - 77713[TAP BUS] 138 kV line 60							-362	-397		-275	-181	-169	93	754		-418
329[POCATER7] - 819[BRITT TP] 138 kV line 87	151	302	341		481	162			764							397
333[QUENSTWN] - 77715[TAP BUS] 138 kV line 52										530			408	354	116	736
333[QUENSTWN] - 877[BASNTAP] 138 kV line 53												1000	861	566	246	
346[GOOSEL4] - 296[GOOSEL7] 240/138 kV transformer T1	374	263	272			238										
389[CHIN-CH8] - 834[CHIN_CHT] 138 kV line 72																85
409[KETTLES] - 77703[TAP BUS] 138 kV line 70	40	36	53			61	504									

Table B-1 - continued

FCITC ANALYSIS RESULTS
2010 Summer Peak Model

Limiting Element	CP #1	CP #2	CP #3	CP #4	CP #5	CP #6	CP #7	CP #8	CP #9	CP #10	CP #11	CP #12	CP #13	CP #14	CP #15	CP #16
430[W BROOK4] - 1484[ANDERSO4] 240 kV line 33														427		
430[W BROOK4] - 276[W BROOK7] 240/138 kV transformer T1														-334		861
430[W BROOK4] - 276[W BROOK7] 240/138 kV transformer T2														-334		861
550[ENMX22S7] - 572[ENMX39S7] 138 kV line 81		576	569	536	532				551	568				632	304	559
567[ENMX1S 7] - 568[ENMX5S 7] 138 kV line 82				-1054	-974			-400	-1238	-388					-884	-383
567[ENMX1S 7] - 568[ENMX5S 7] 138 kV line 84				-1054	-974			-400	-1238	-388					-884	-383
579[ENMX31S7] - 585[ENMX9S 7] 138 kV line 80															920	
579[ENMX31S7] - 590[ENMX24S7] 138 kV line 81															630	
583[ENMX32S7] - 589[ENMX26S7] 138 kV line 81															903	
589[ENMX26S7] - 590[ENMX24S7] 138 kV line 82															356	
65[BARDO 7] - 68[N HOLDE7] 138 kV line 74														726		
670[TAYLOR 8] - 693[MAGRATH8] 69 kV line 25							14									
675[REDCLIFF] - 680[MEDICIN7] 138 kV line 00										145	121	112	125			
679[LETH111S] - 692[N LETHB7] 138 kV line 07				122	295	264	192	232								
679[LETH111S] - 939[RVBD TAP] 138 kV line 25				81	222	199	129	200								
68[N HOLDE7] - 76[IPPL ST7] 138 kV line 01													822	593		
690[COALDAL7] - 692[N LETHB7] 138 kV line 70								259		377	494					252
690[COALDAL7] - 692[N LETHB7] 138 kV line 72					970			235		344	448	1074				204
690[COALDAL7] - 834[CHIN_CHT] 138 kV line 72				582	573	457	690	280		182	229	325	674			93
690[COALDAL7] - 869[TEPST TP] 138 kV line 20						431	291	92								
691[LETH241S] - 692[N LETHB7] 138 kV line 34				320	782	514	185	232								
691[LETH241S] - 696[LETH146S] 138 kV line 13				289	727	266	169	234								
692[N LETHB7] - 916[MONAR TP] 138 kV line 72		667	656	117	96			311	576	451					717	315
693[MAGRATH8] - 863[RAYRS TP] 69 kV line 25	-191					-43	-24	6		337						253
694[MAGRATH7] - 693[MAGRATH8] 138/69 kV transformer T1	132					47	19	25								
694[MAGRATH7] - 794[MAGRATH9] 138 kV line 63	128					207	76	183								
696[LETH146S] - 697[LETH593S] 138 kV line 23				276	722	266	165	222								
697[LETH593S] - 699[RIVERBN7] 138 kV line 24				228	615	220	137	198								
698[LETH674S] - 823[725BL] 138 kV line 25				12	103										640	
698[LETH674S] - 939[RVBD TAP] 138 kV line 25				45	155											
699[RIVERBN7] - 794[MAGRATH9] 138 kV line 63	133					106	38	65								
699[RIVERBN7] - 939[RVBD TAP] 138 kV line 25				227	572	231	80	208								
74[METIS647] - 814[KILRY TP] 138 kV line 49														881		
76[IPPL ST7] - 1491[BAT. RV7] 138 kV line 01									960	966			779	569		989
77711[TAP BUS] - 93003[STEERTAP] 138 kV line 72								1000		67	60	104	220			308
816[LINE TP] - 1501[NATAL 7] 138 kV line 87	212	573	628													
816[LINE TP] - 817[ELKFRD T] 138 kV line 87	217	604	666													
817[ELKFRD T] - 818[GR HL TP] 138 kV line 87		636	702													
818[GR HL TP] - 819[BRITT TP] 138 kV line 87		666														
823[725BL] - 901[MCBRIDE1] 138 kV line B1				105												
911[EMPLIQTP] - 89994[KYSTP4T4] 138 kV line 60												1000	NC	676		
916[MONAR TP] - 77705[TAP BUS] 138 kV line 72		749	723	107	89			342	672						643	392

Table B-2

FCITC ANALYSIS RESULTS
2010 Summer Light Model

Limiting Element	CP #1	CP #2	CP #3	CP #4	CP #5	CP #6	CP #7	CP #8	CP #9	CP #10	CP #11	CP #12	CP #13	CP #14	CP #15	CP #16
1382[BUFALOTP] - 1383[VERMILO7] 138 kV line 50														923		
1382[BUFALOTP] - 1490[JAROW TP] 138 kV line 50														831		
1474[OYEN 7] - 89993[KYSTP3T3] 138 kV line 98														1043		
1474[OYEN 7] - 89994[KYSTP4T4] 138 kV line 60													612	930		
159[LANGDON4] - 160[JANET 4] 240 kV line 36	268	424	439	394	408	413	320	328	376	334	345	333	350	405		351
159[LANGDON4] - 281[MILO 2] 240 kV line 27																
160[JANET 4] - 165[PEIGAN 4] 240 kV line 11	366	426	417	551	552	468	715	1000	491	583				720		555
165[PEIGAN 4] - 166[PEIGAN 7] 240/138 kV transformer T1	11	9	8			17	113									
165[PEIGAN 4] - 346[GOOSEL4] 240 kV line 75		841														
165[PEIGAN 4] - 346[GOOSEL4] 240 kV line 76		841														
166[PEIGAN 7] - 77703[TAP BUS] 138 kV line 70	34	29	25			48	339									
167[N LETHB4] - 692[N LETHB7] 240/138 kV transformer T3				474	441		767	777								505
167[N LETHB4] - 692[N LETHB7] 240/138 kV transformer T5				425	407		766	448								455
167[N LETHB4] - 943[MILO 1] 240 kV line 24			929						775							
167[N LETHB4] - 9990[MATL120S] 240 kV line 1		807	700						270							
171[SEEBE 7] - 329[POCATER7] 138 kV line 77	225	523	580						829							756
207[JANET 7] - 212[SHEPARD7] 138 kV line 50		666	668	550	512				860	783				888	129	759
207[JANET 7] - 239[OKOTOKS7] 138 kV line 27															364	
207[JANET 7] - 259[STRATHM7] 138 kV line 65															264	
207[JANET 7] - 577[ENMX23S7] 138 kV line 80															681	
207[JANET 7] - 590[ENMX24S7] 138 kV line 83															786	
212[SHEPARD7] - 252[CARSELA7] 138 kV line 50		743	806	615	571				662					972	141	822
223[PINCHER8] - 227[SHELL WA] 69 kV line 85	18					151										
223[PINCHER8] - 876[514BL TP] 69 kV line 14	0															
224[PINCHER7] - 223[PINCHER8] 138/69 kV transformer T1	7	683	703			48	346	141								
224[PINCHER7] - 229[170AL-TA] 138 kV line 70	201	321	367			435										
224[PINCHER7] - 296[GOOSEL7] 138 kV line 1	59	372	424													
225[WARE JCT] - 260[JENNER 4] 240 kV line 44														872		
225[WARE JCT] - 260[JENNER 4] 240 kV line 51														687		
225[WARE JCT] - 430[W BROOK4] 240 kV line 31														728		
226[DRYWOOD8] - 227[SHELL WA] 69 kV line 85	29					132	409									
226[DRYWOOD8] - 245[GLENWOO8] 69 kV line 46	87	297	365		656	17	49	193								632
229[170AL-TA] - 232[COLEMAN7] 138 kV line 70	113	166	194		1000	457	636		655							1000
232[COLEMAN7] - 1501[NATAL 7] 138 kV line 86	81	103	122	752	654	349	614	773	454							1000
233[DRYWOOD7] - 226[DRYWOOD8] 138/69 kV transformer T1	34	893	957			41	240	210								
233[DRYWOOD7] - 54827[164AL TA] 138 kV line 64	73					88	352									
237[FORT MA7] - 279[STAVELEY] 138 kV line 80	358	519	516	152	120	412	312	327	429	424				694	603	352
237[FORT MA7] - 77705[TAP BUS] 138 kV line 72				86	87				982						514	919
237[FORT MA7] - 823[725BL] 138 kV line 25		995	945	12	219	467	248	209	776							651
239[OKOTOKS7] - 886[MAG TAP7] 138 kV line 27															331	
242[HIGH RI7] - 253[BLACKIE7] 138 kV line 53					1000										239	
242[HIGH RI7] - 886[MAG TAP7] 138 kV line 27															330	
244[VULCAN 7] - 253[BLACKIE7] 138 kV line 61		677	621	202	155	454	705	470	586	580					536	492
244[VULCAN 7] - 279[STAVELEY] 138 kV line 80	357	621	617	180	140	481	689	397	521	520				816	567	431

Table B-2 - continued

FCITC ANALYSIS RESULTS
2010 Summer Light Model

Limiting Element	CP #1	CP #2	CP #3	CP #4	CP #5	CP #6	CP #7	CP #8	CP #9	CP #10	CP #11	CP #12	CP #13	CP #14	CP #15	CP #16
245[GLENWOO8] - 246[SPRING 8] 69 kV line 25	133	263	328		938	19	1	3								1000
246[SPRING 8] - 693[MAGRATH8] 69 kV line 25	135	261	324		953	19	1	5								
252[CARSELA7] - 253[BLACKIE7] 138 kV line 51					933										223	
253[BLACKIE7] - 77715[TAP BUS] 138 kV line 52					459										116	
254[GLEICHE7] - 333[QUENSTWN] 138 kV line 76		786	806	693	683				823	721				767	118	724
254[GLEICHE7] - 340[NAMAKA 7] 138 kV line 33															227	
256[BROOKS 7] - 10111[] 138 kV line 1										648	264	272	289			
256[BROOKS 7] - 401[HAYS 7] 138 kV line 95										511						476
259[STRATHM7] - 340[NAMAKA 7] 138 kV line 33															275	
260[JENNER 4] - 677[CYPRESS1] 240 kV line 45														650		
260[JENNER 4] - 77714[TAP BUS] 240 kV line 51														345		
262[DOME EM4] - 267[DOME EM7] 240/138 kV transformer T5													241	377		
262[DOME EM4] - 677[CYPRESS1] 240 kV line 45														650		
262[DOME EM4] - 77714[TAP BUS] 240 kV line 51														343		
266[EMPRESA7] - 267[DOME EM7] 138 kV line 60										827	625	681	144	559		
266[EMPRESA7] - 77713[TAP BUS] 138 kV line 60					992					302	184	117	62	653		558
267[DOME EM7] - 911[EMPLIQTP] 138 kV line 60													563	824		
269[BURDETT7] - 77711[TAP BUS] 138 kV line 72				817	291			395		31	88	112	327			109
270[SUFFIEL7] - 275[TILLEY 7] 138 kV line 00										233	180	160	170			986
270[SUFFIEL7] - 675[REDCLIFF] 138 kV line 00										167	136	122	132			991
271[BULLS H7] - 54839[600AL TA] 138 kV line 00												119				
271[BULLS H7] - 680[MEDICIN7] 138 kV line 80										130	108	100	269			583
271[BULLS H7] - 93003[STEERTAP] 138 kV line 72					972			872		51	44	97	255			252
272[TABER 7] - 274[VAUXHAL7] 138 kV line 63				789	758		722	477		160	207	290				147
272[TABER 7] - 834[CHIN_CHT] 138 kV line 72	309		936	404	386	452	509	217	796	194	243	344	746			92
274[VAUXHAL7] - 401[HAYS 7] 138 kV line 21										322	440					295
274[VAUXHAL7] - 928[ENCH TAP] 138 kV line 63										344	450					318
275[TILLEY 7] - 10111[] 138 kV line 00										637	263	270	287			
276[W BROOK7] - 877[BASNTAP] 138 kV line 53		586	592						542	417	397	1000	388	398	273	472
276[W BROOK7] - 928[ENCH TAP] 138 kV line 63										353	465					326
280[STIRLIN8] - 863[RAYRS TP] 69 kV line 25	-195					-47	-27	11								
281[MILO 2] - 9990[MATL120S] 240 kV line 23			995						347							
284[BUTTE7] - 54839[600AL TA] 138 kV line 00												119				
293[STIRLIN7] - 280[STIRLIN8] 138/69 kV transformer T3	236					19	10	33								
293[STIRLIN7] - 869[TEPST TP] 138 kV line 20						430	302	94								
296[GOOSEL7] - 409[KETTLES] 138 kV line 70	1	116	-10			199										
296[GOOSEL7] - 54543[OLDMAN1] 138 kV line 24		164														
296[GOOSEL7] - 54827[164AL TA] 138 kV line 64	75					90	355									
31[FINCAST7] - 269[BURDETT7] 138 kV line 12		995	967	-17	-17	431	-15	-11	868	-4	105	133	400			-7
31[FINCAST7] - 272[TABER 7] 138 kV line 10				703	685		689	358		21	43	60	175			209
31[FINCAST7] - 828[PURPLETP] 138 kV line 88										11						
320[CHAPPIC7] - 680[MEDICIN7] 138 kV line 60					211					74	39	27	97	911		116
320[CHAPPIC7] - 77713[TAP BUS] 138 kV line 60					371					133	68	47	93	872		206
329[POCATER7] - 819[BRITT TP] 138 kV line 87	211	412	459		613				636					763		595

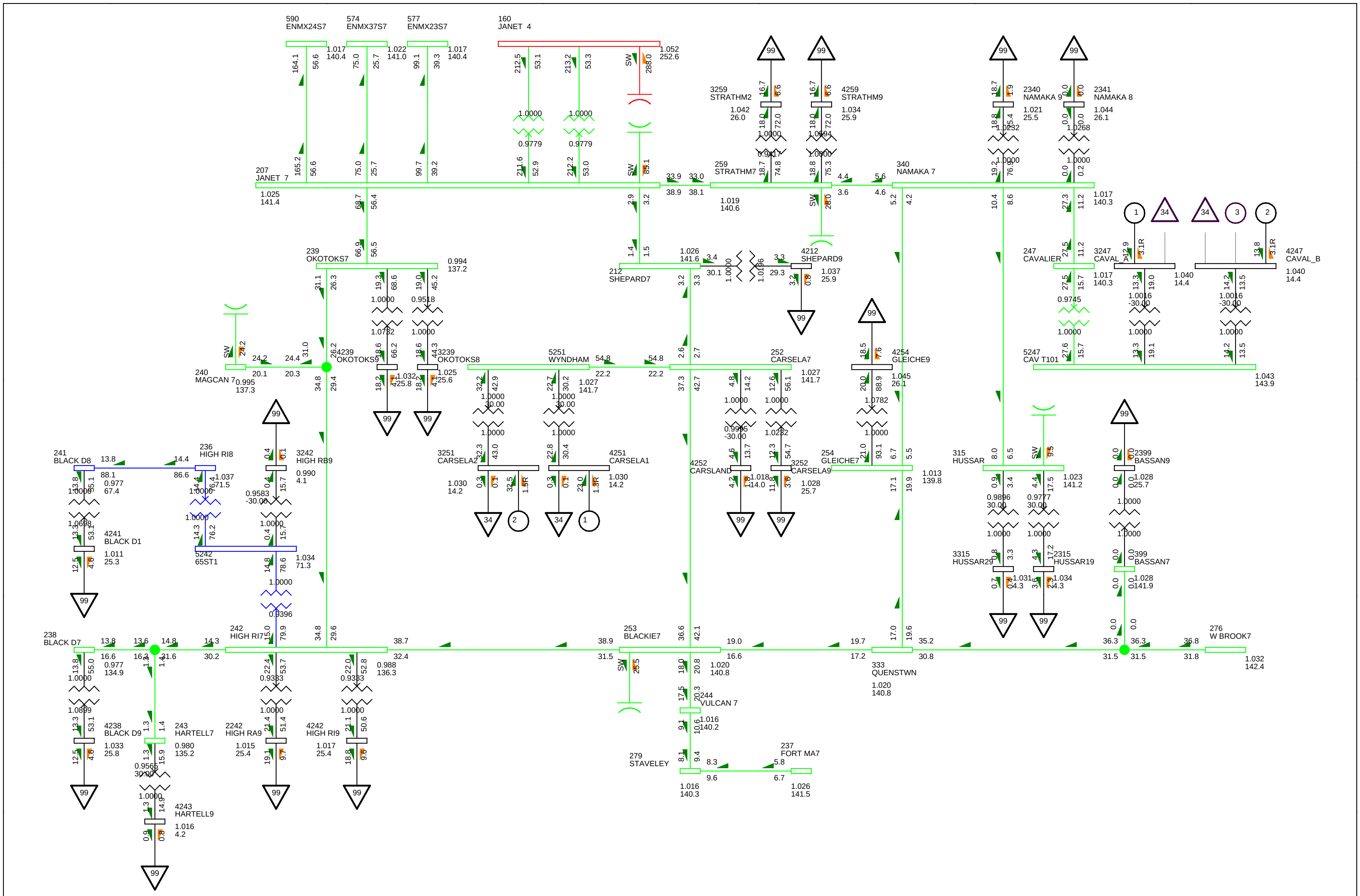
Table B-2 - continued

FCITC ANALYSIS RESULTS
2010 Summer Light Model

Limiting Element	CP #1	CP #2	CP #3	CP #4	CP #5	CP #6	CP #7	CP #8	CP #9	CP #10	CP #11	CP #12	CP #13	CP #14	CP #15	CP #16
333[QUENSTWN] - 77715[TAP BUS] 138 kV line 52					1000										115	
333[QUENSTWN] - 877[BASNTAP] 138 kV line 53		590	605						547	421	401	1000	392	401	270	476
346[GOOSEL4] - 296[GOOSEL7] 240/138 kV transformer T1	377	238	246			510										
389[CHIN-CH8] - 834[CHIN_CHT] 138 kV line 72																87
409[KETTLES] - 77703[TAP BUS] 138 kV line 70	25	24	55			38	264									
430[W BROOK4] - 276[W BROOK7] 240/138 kV transformer T1																845
430[W BROOK4] - 276[W BROOK7] 240/138 kV transformer T2																845
65[BARDO 7] - 68[N HOLDE7] 138 kV line 74														825		
670[TAYLOR 8] - 693[MAGRATH8] 69 kV line 25							13									
675[REDCLIFF] - 680[MEDICIN7] 138 kV line 00										168	135	122	132			987
679[LETH111S] - 692[N LETHB7] 138 kV line 07				92	241	260	145	215								
679[LETH111S] - 939[RVBD TAP] 138 kV line 25				65	194	222	106	213								
68[N HOLDE7] - 76[IPPL ST7] 138 kV line 01														693		
690[COALDAL7] - 692[N LETHB7] 138 kV line 70								252		366	475					241
690[COALDAL7] - 692[N LETHB7] 138 kV line 72								227		329	423	1000				194
690[COALDAL7] - 834[CHIN_CHT] 138 kV line 72				569	546	484	658	268	961	168	214	306	715			93
690[COALDAL7] - 869[TEPST TP] 138 kV line 20						400	274	87								
691[LETH241S] - 692[N LETHB7] 138 kV line 34				258	699		157	224								
691[LETH241S] - 696[LETH146S] 138 kV line 13				235	640	538	146	201								
692[N LETHB7] - 916[MONAR TP] 138 kV line 72		616	590	112	92			348	526						677	322
693[MAGRATH8] - 863[RAYRS TP] 69 kV line 25	-178					-36	-20	2		444						687
694[MAGRATH7] - 693[MAGRATH8] 138/69 kV transformer T1	127					38	16	21								
694[MAGRATH7] - 794[MAGRATH9] 138 kV line 63	126					203	71	185								
696[LETH146S] - 697[LETH593S] 138 kV line 23				240	652	460	151	203								
697[LETH593S] - 699[RIVERBN7] 138 kV line 24				206	558	399	131	193								
698[LETH674S] - 823[725BL] 138 kV line 25				13	102										631	
698[LETH674S] - 939[RVBD TAP] 138 kV line 25				35	141										904	
699[RIVERBN7] - 794[MAGRATH9] 138 kV line 63	129					88	33	52								
699[RIVERBN7] - 939[RVBD TAP] 138 kV line 25				214	550	218	75	195								
76[IPPL ST7] - 1491[BAT. RV7] 138 kV line 01														672		
77711[TAP BUS] - 93003[STEERTAP] 138 kV line 72					953		677	852		50	44	98	257			250
816[LINE TP] - 1501[NATAL 7] 138 kV line 87	230	628	693													
816[LINE TP] - 817[ELKFRD T] 138 kV line 87	218	659														
823[725BL] - 901[MCBRIDE1] 138 kV line B1				105												
911[EMPLIQTP] - 89994[KYSTP4T4] 138 kV line 60												1000	518	723		
916[MONAR TP] - 77705[TAP BUS] 138 kV line 72		668	643	105	86				584						626	423

APPENDIX C

Power Flow Plots: Highriver and Strathmore/Blackie Area

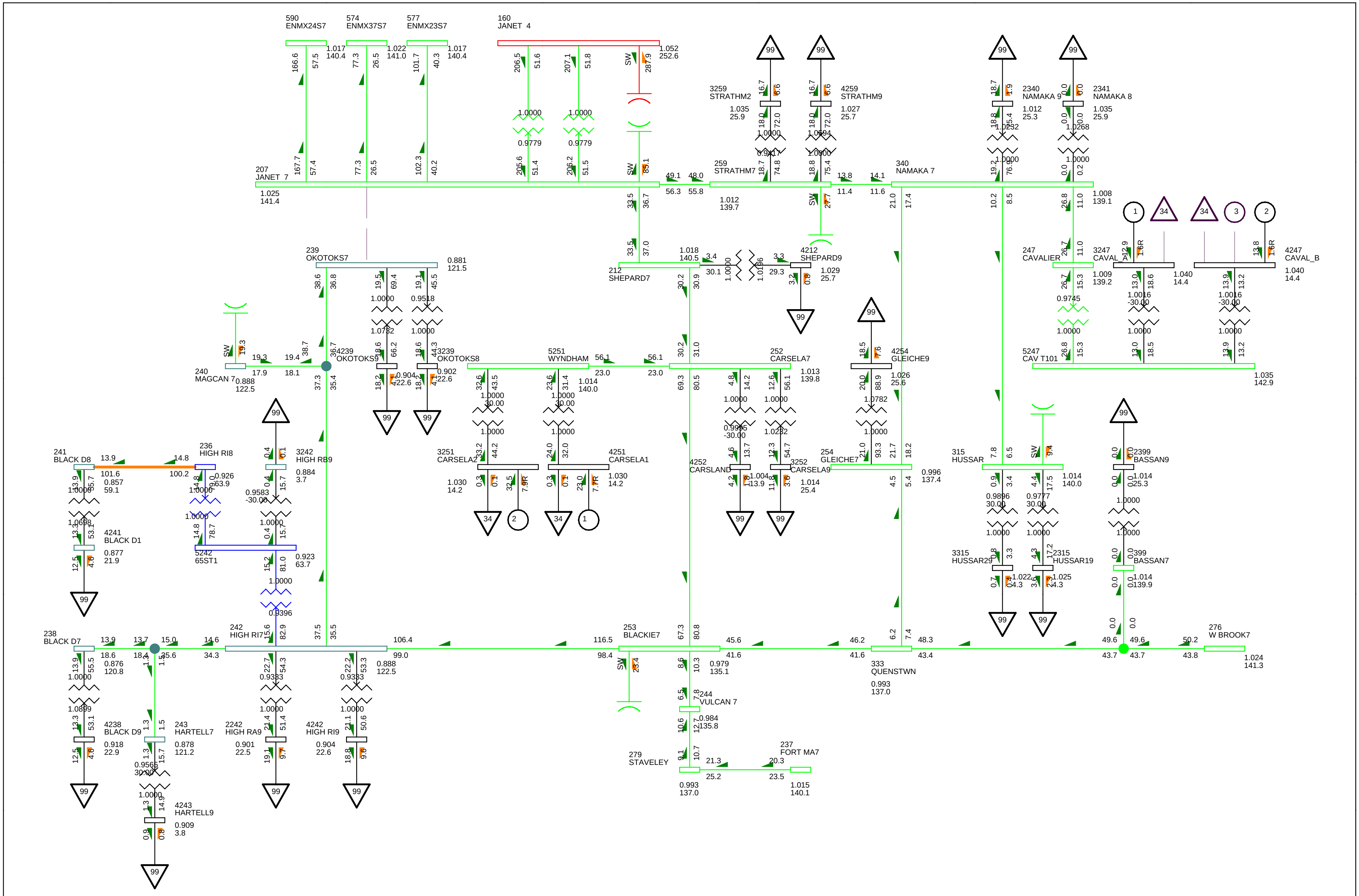


SOUTH PLANNING STUDY
2007 SUMMER PEAK CASE
FRI, MAY 23 2008 17:44

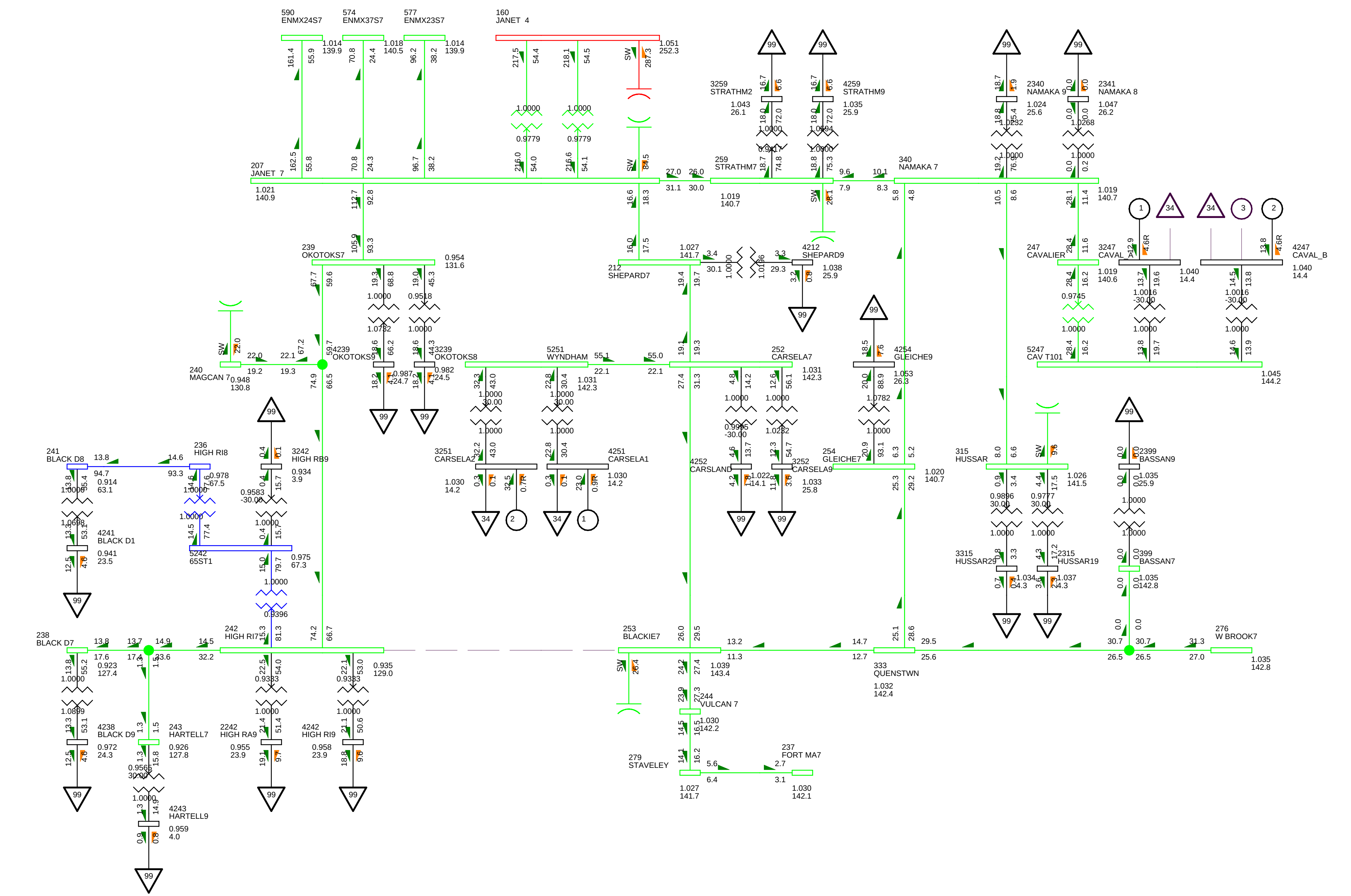
Figure C-1 2007 N-0 Condition

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR

100.0%RATEA
1.100OV0.900UV
KV: <=34.500 <=69.000 <=138.000 <=240.000 >240.000



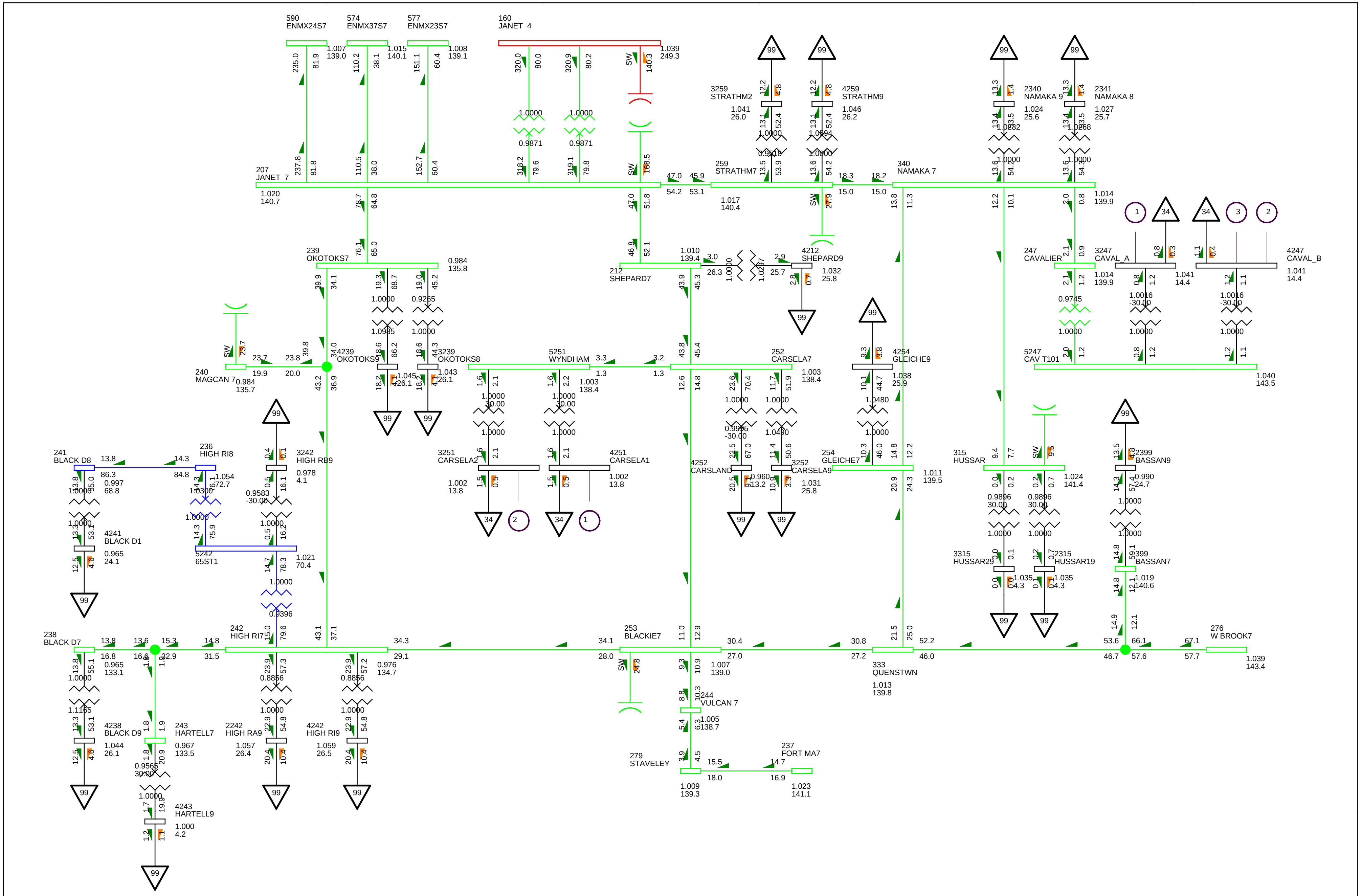
SOUTH PLANNING STUDY 2007 SUMMER PEAK CASE FRI, MAY 23 2008 17:45	Figure C-2 2007 N-1 Condition -- Contingency 727L	Bus - VOLTAGE (KV/PU) Branch - MVA/% OF RATE A Equipment - MW/MVAR 100.0%RATEA 1.100OV0.900UV KV: <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2007 SUMMER PEAK CASE
FRI, MAY 23 2008 17:42

Figure C-3 2007 N-1 Condition -- Contingency 753L

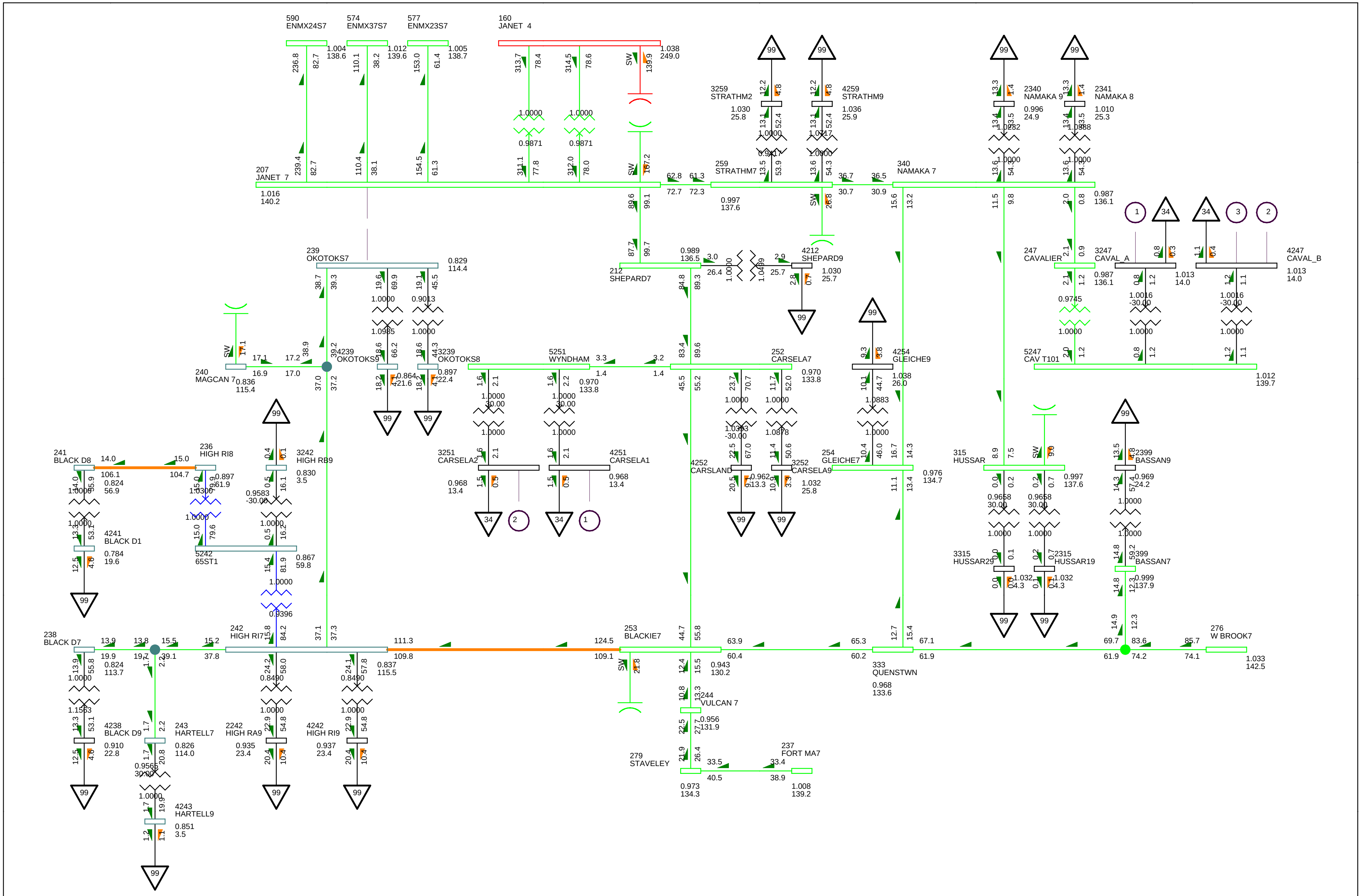
Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV0.900UV
KV: <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2012 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 17:46

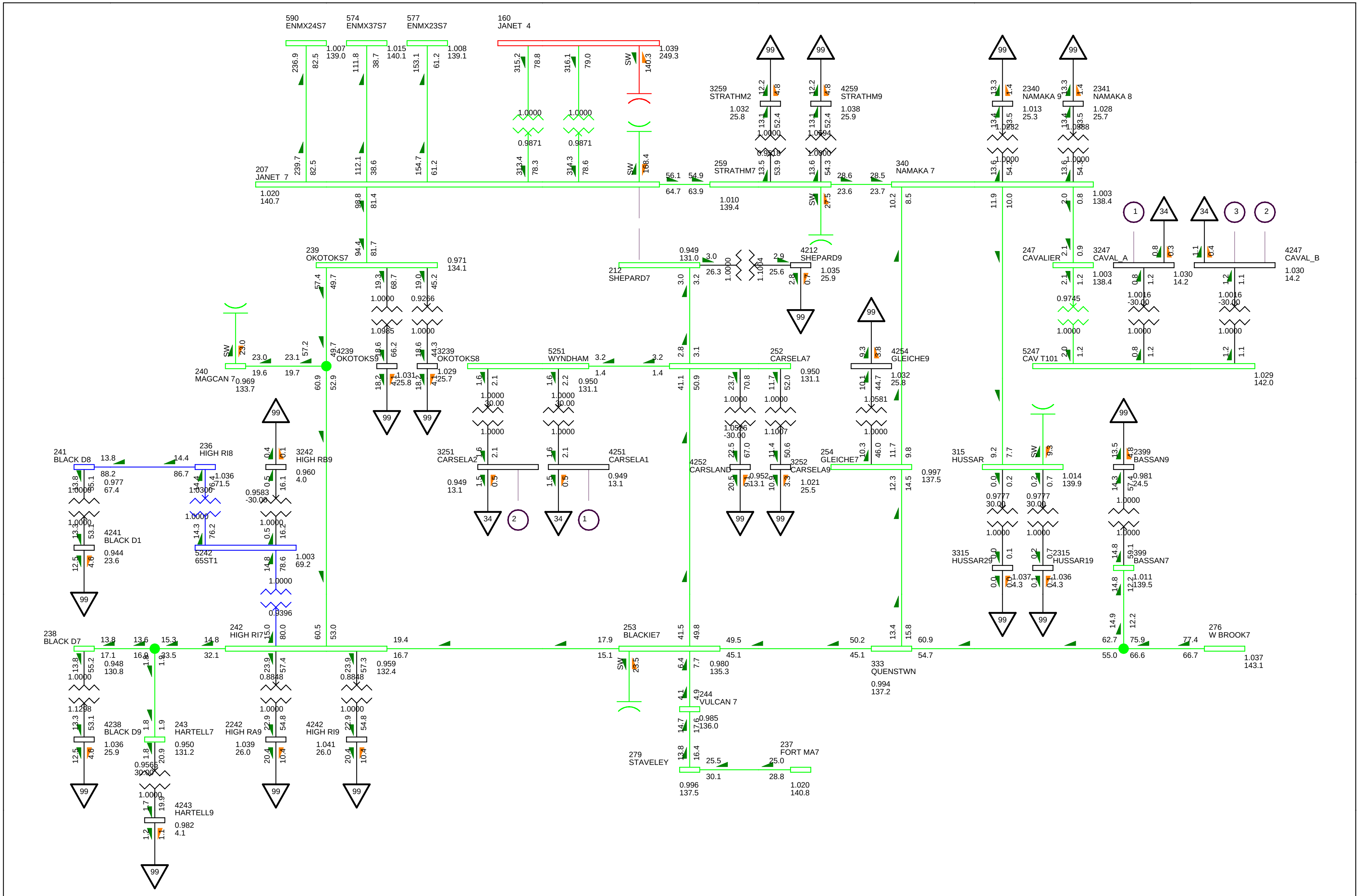
Figure C-4 2012 N-0 Condition

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV0.900UV
KV: <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2012 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 17:48

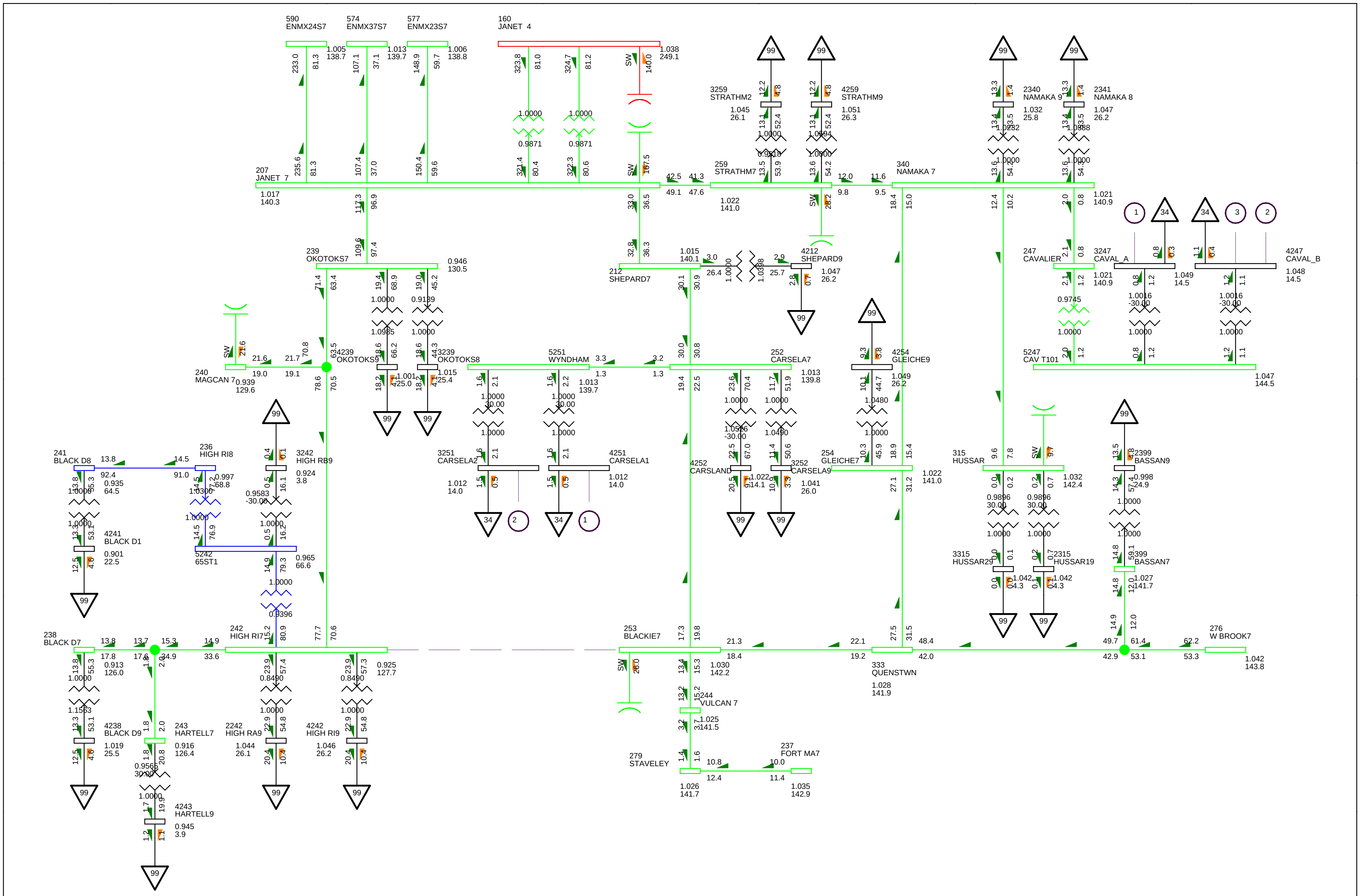
Figure C-5 2012 N-1 Condition -- Contingency 727L



SOUTH PLANNING STUDY
2012 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 17:49

Figure C-6 2012 N-1 Condition -- Contingency 850L

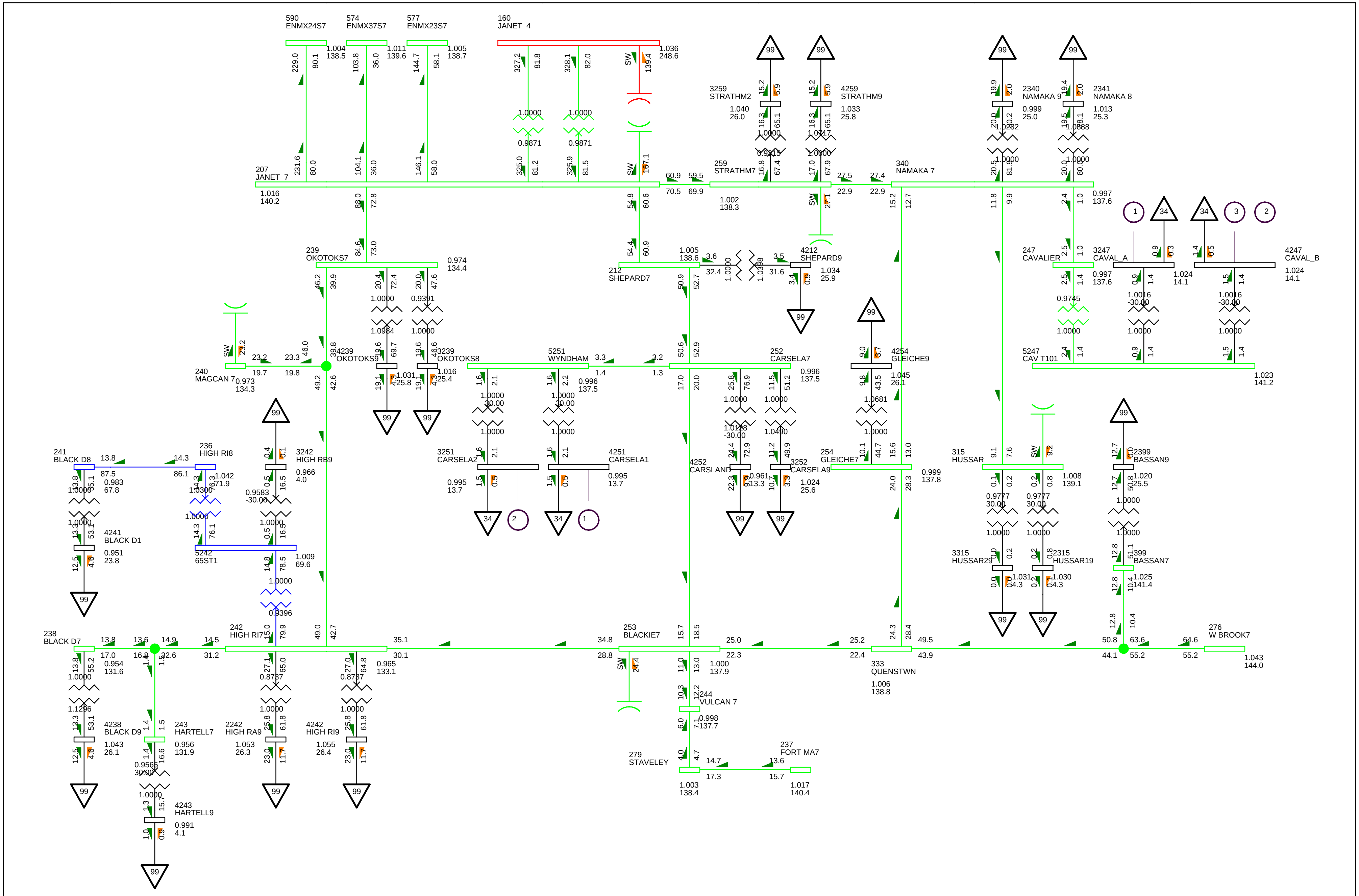
Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV0.900UV
KV: <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2012 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 17:50

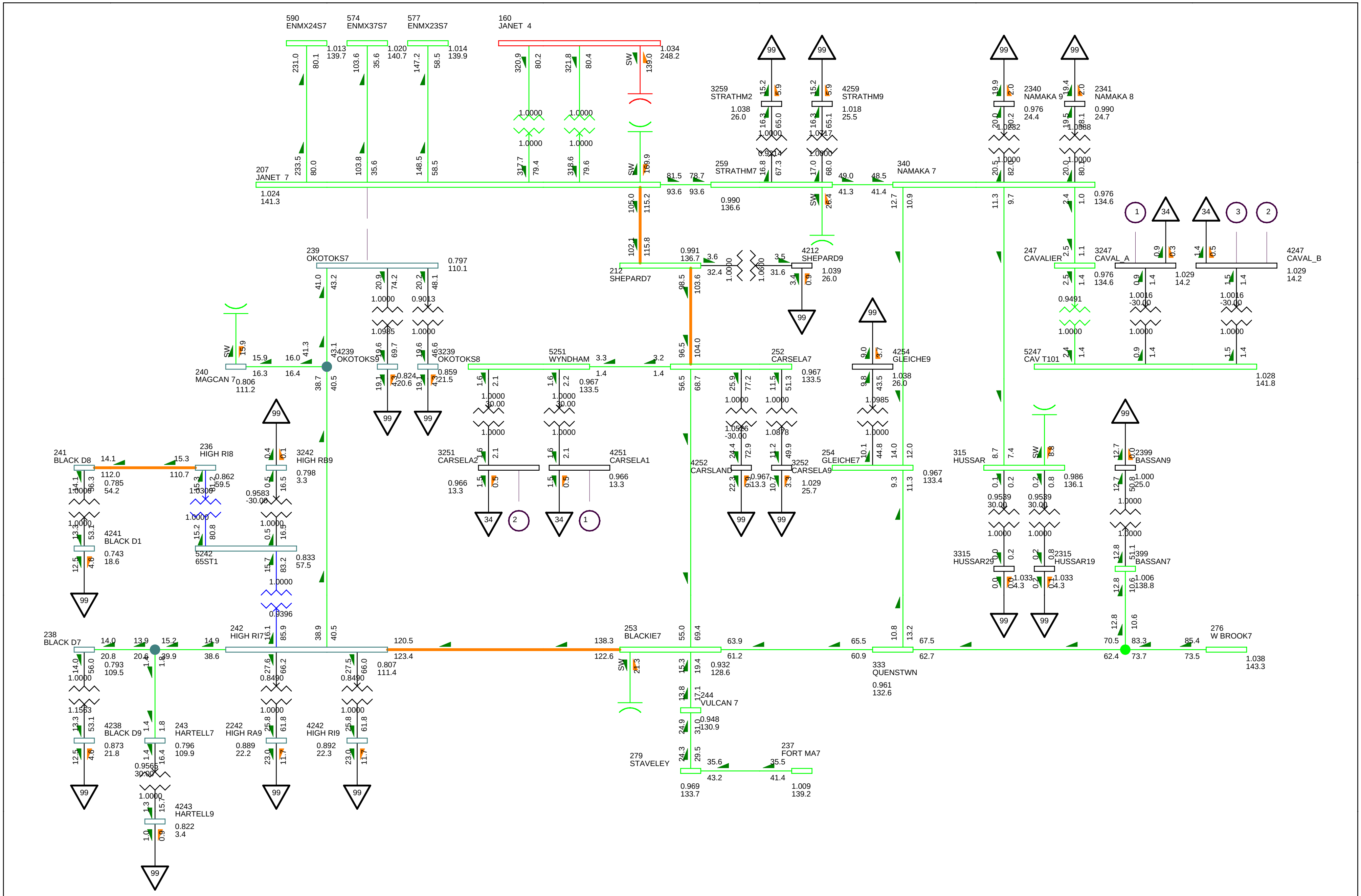
Figure C-7 2012 N-1 Condition -- Contingency 753L

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV0.900UV
KV: <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2017 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 17:52

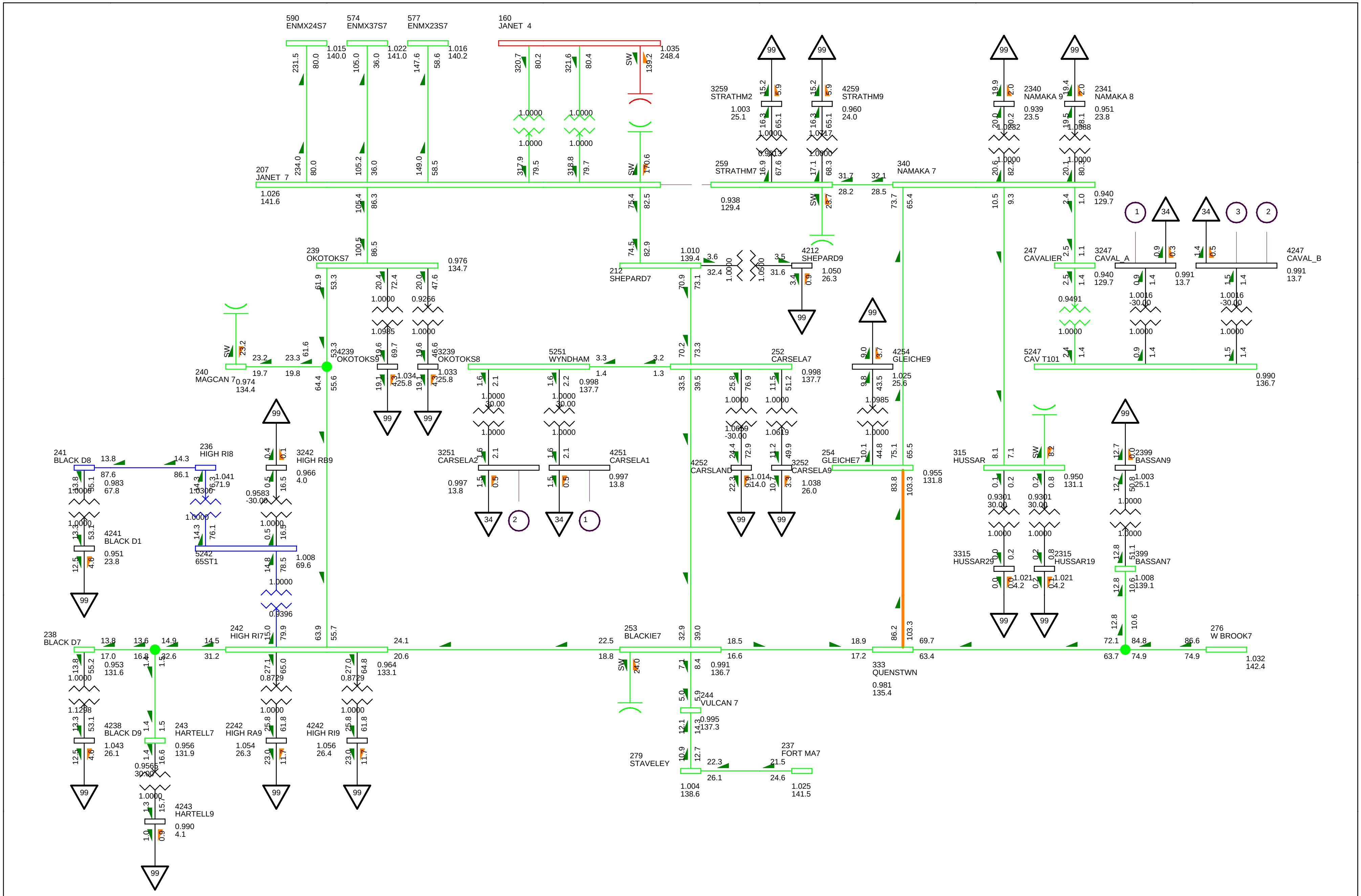
Figure C-8 2017 N-0 Condition



SOUTH PLANNING STUDY
2017 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 17:54

Figure C-9 2017 N-1 Condition -- Contingency 727L

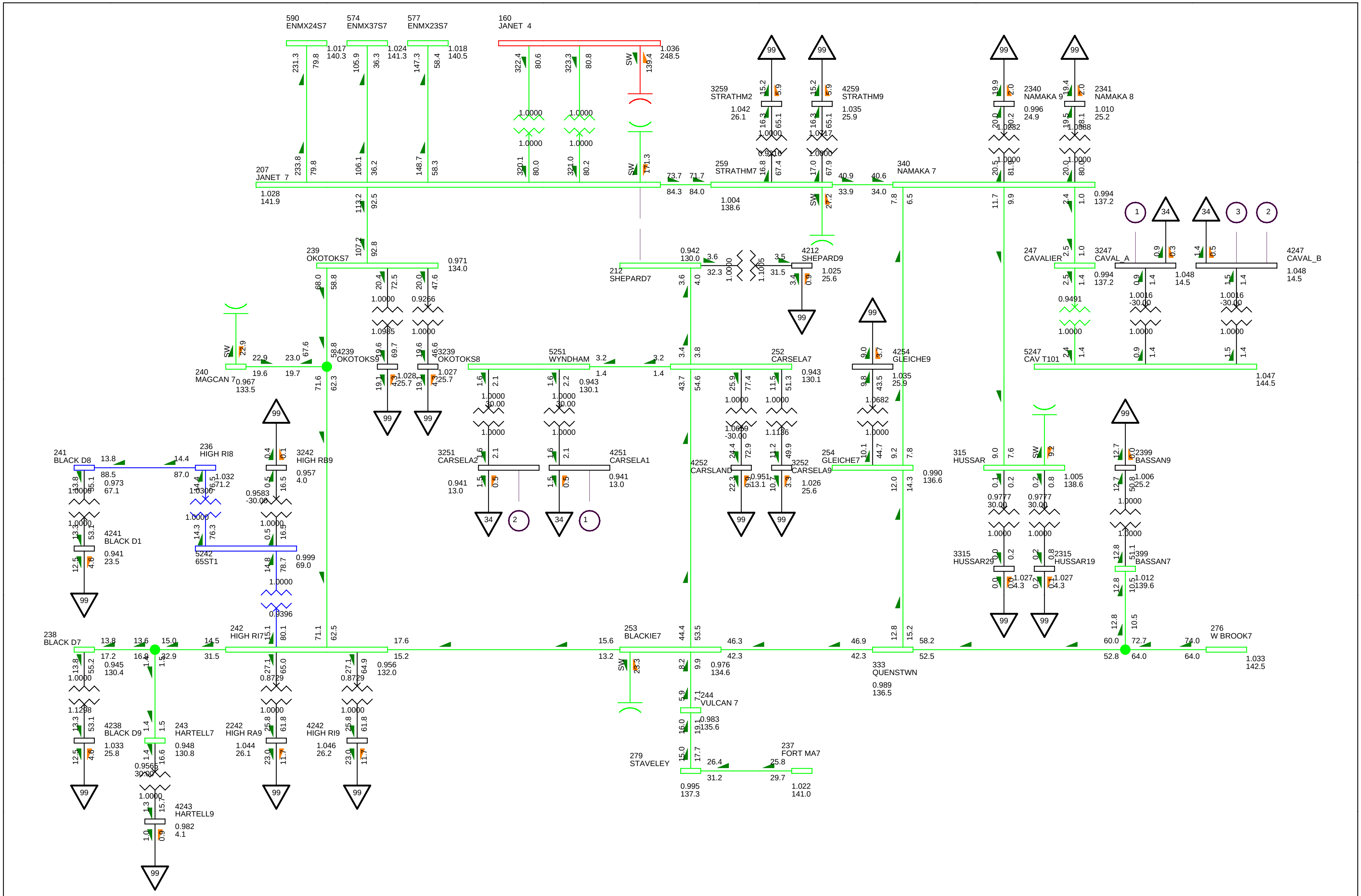
Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV0.900UV
KV: <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2017 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 17:57

Figure C-10 2017 N-1 Condition -- Contingency 765L

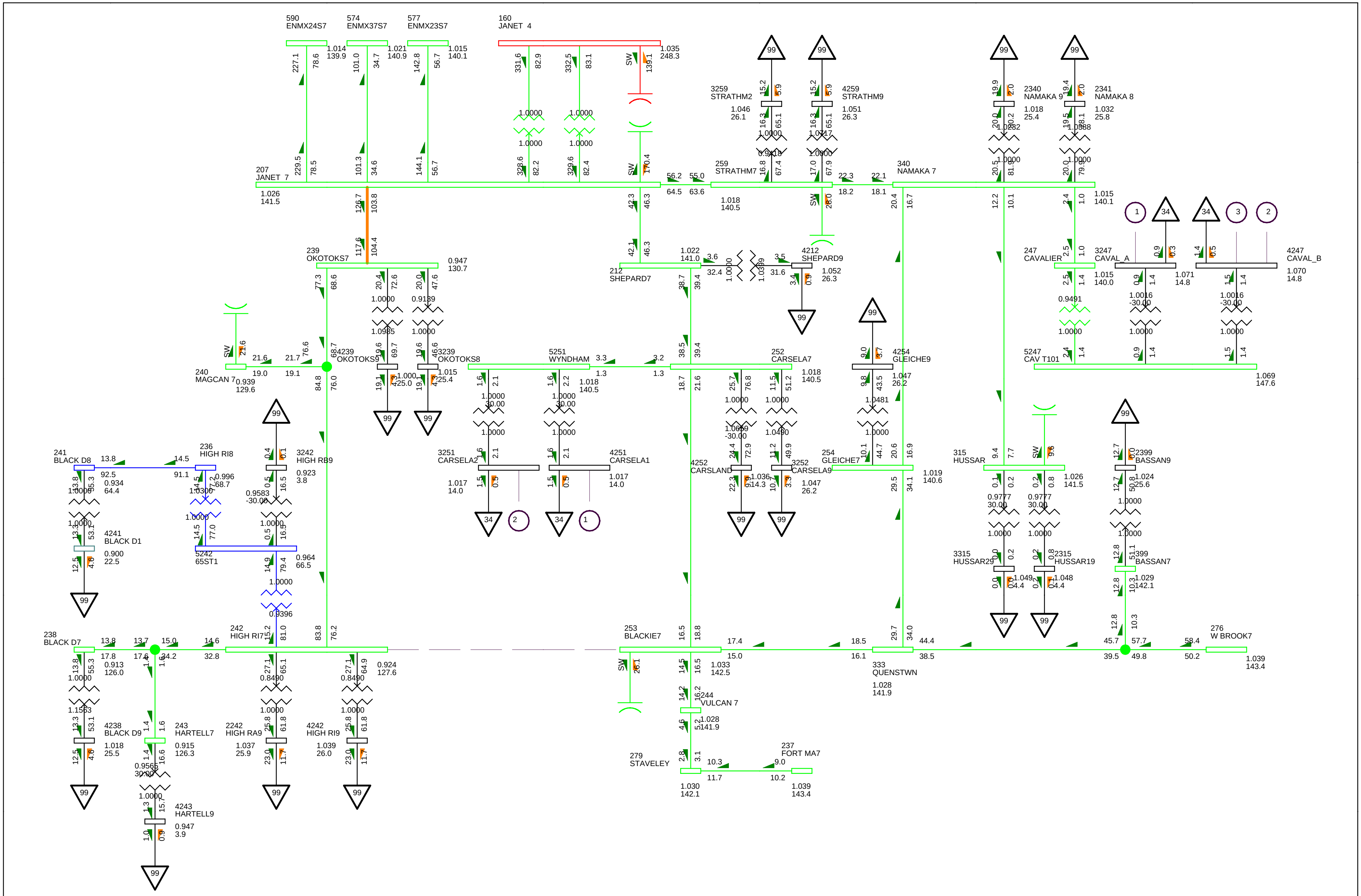
Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV0.900UV
KV: <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2017 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 17:58

Figure C-11 2017 N-1 Condition -- Contingency 850L

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV0.900UV
KV: <=34.500 <=69.000 <=138.000 <=240.000 >240.000



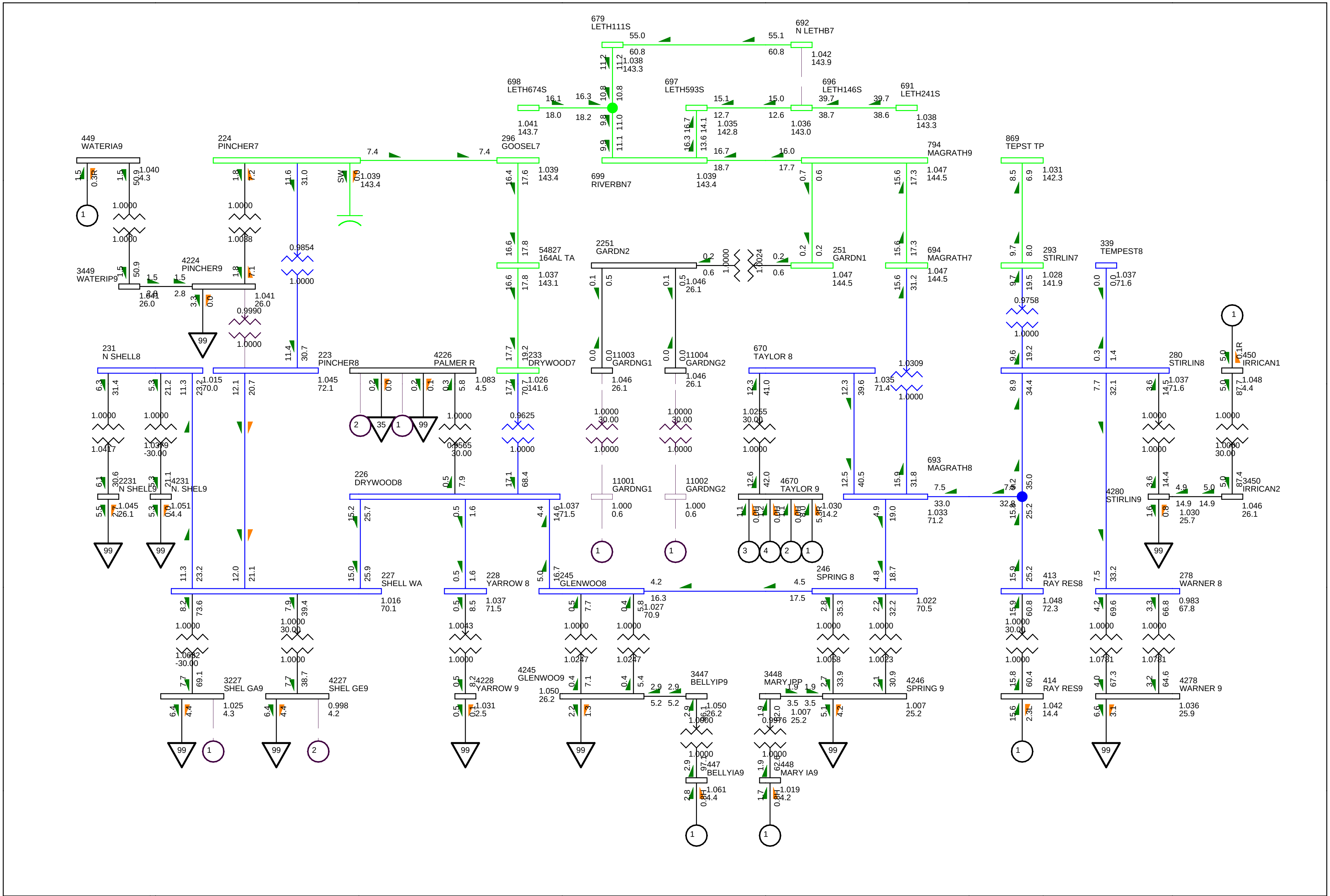
SOUTH PLANNING STUDY
2017 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 18:00

Figure C-12 2017 N-1 Condition -- Contingency 753L

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV0.900UV
KV: <=34.500 <=69.000 <=138.000 <=240.000 >240.000

APPENDIX D

Power Flow Plots: Glenwood Area

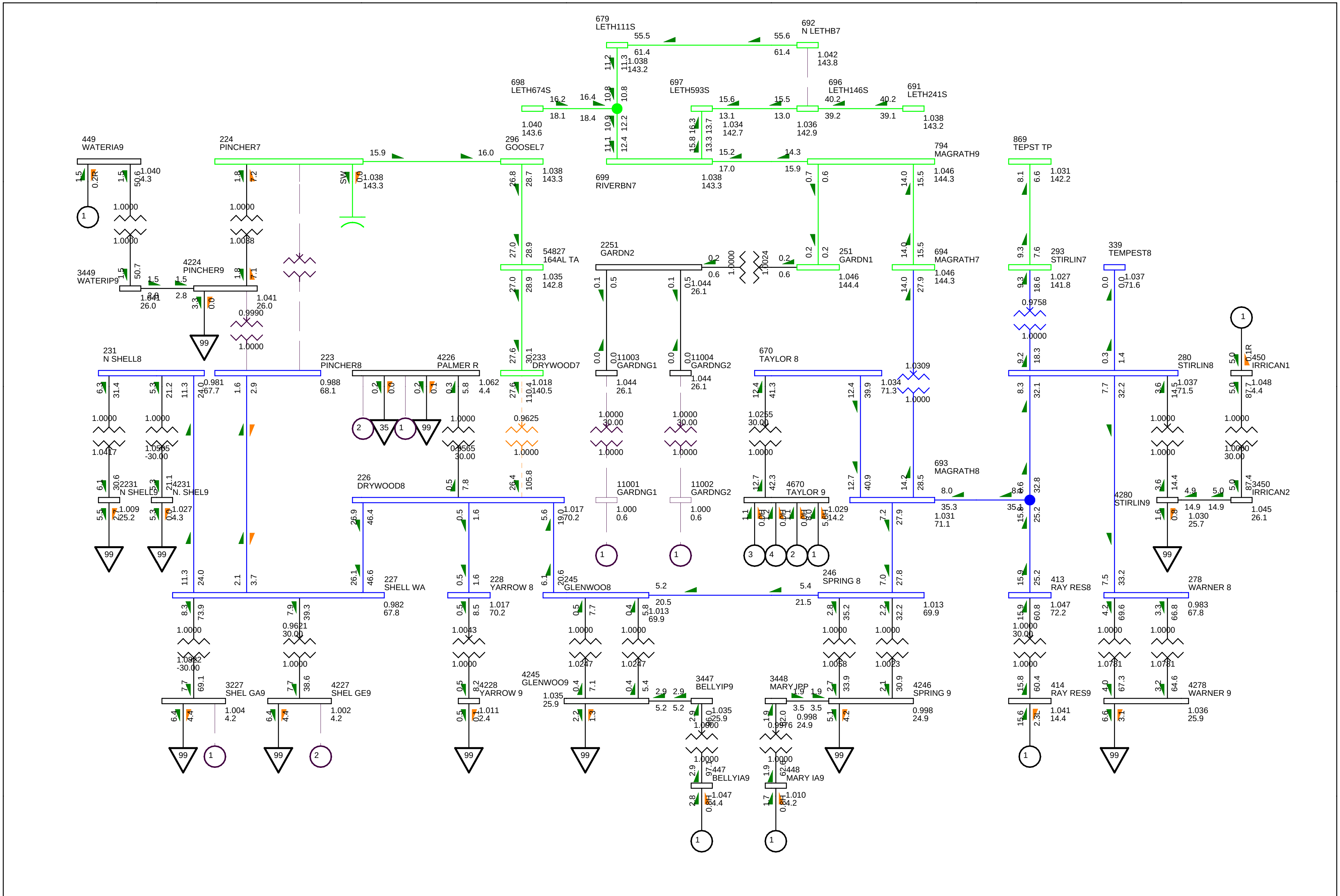


SOUTH PLANNING STUDY
2007 SUMMER PEAK CASE
FRI, MAY 23 2008 18:15

Fig D-1

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR

100.0%RATEA
1.100OV0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000

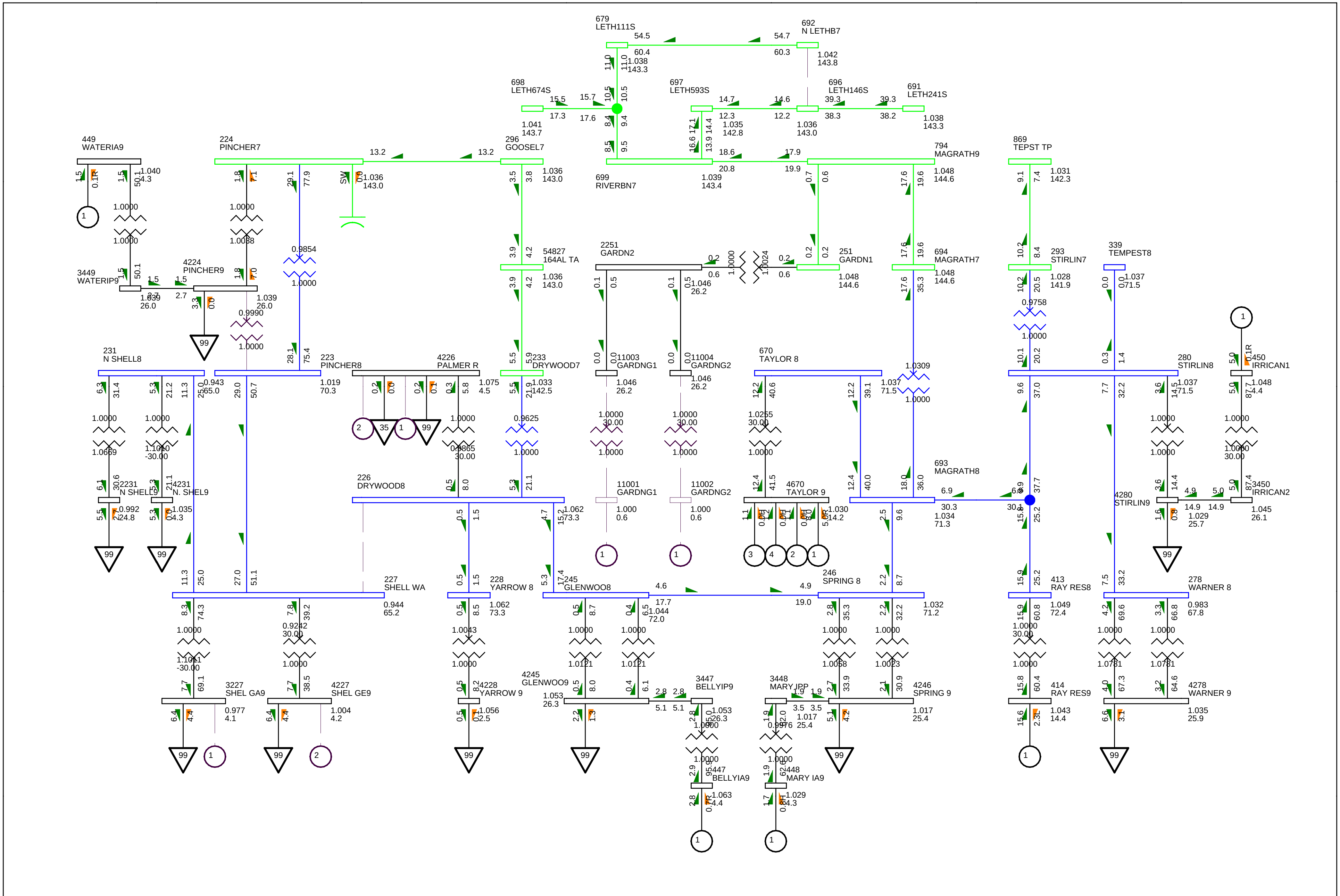


SOUTH PLANNING STUDY
2007 SUMMER PEAK CASE
FRI, MAY 23 2008 18:16

Fig D-2

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR

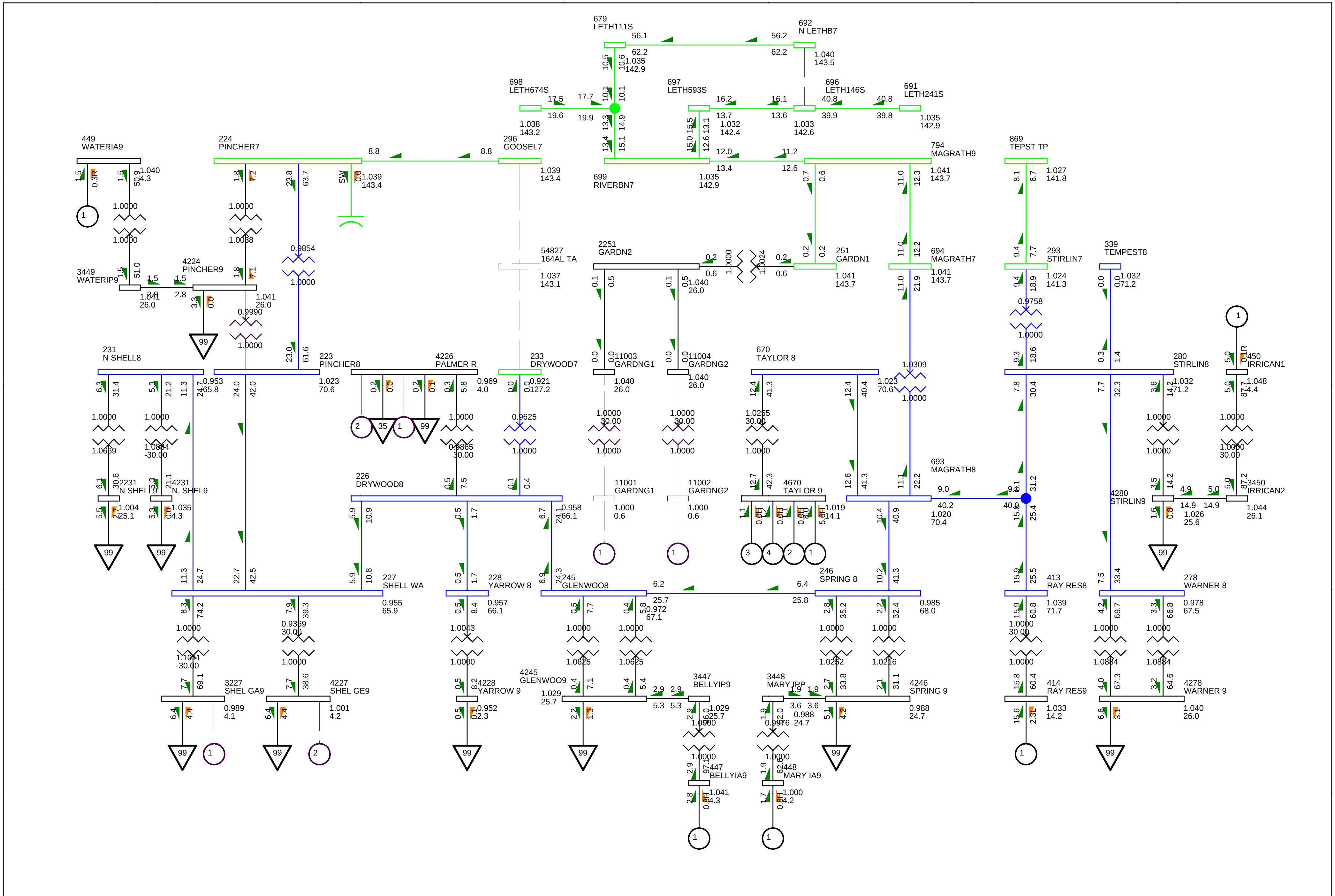
100.0%RATEA
1.100OV0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2007 SUMMER PEAK CASE
FRI, MAY 23 2008 18:34

Fig D-3

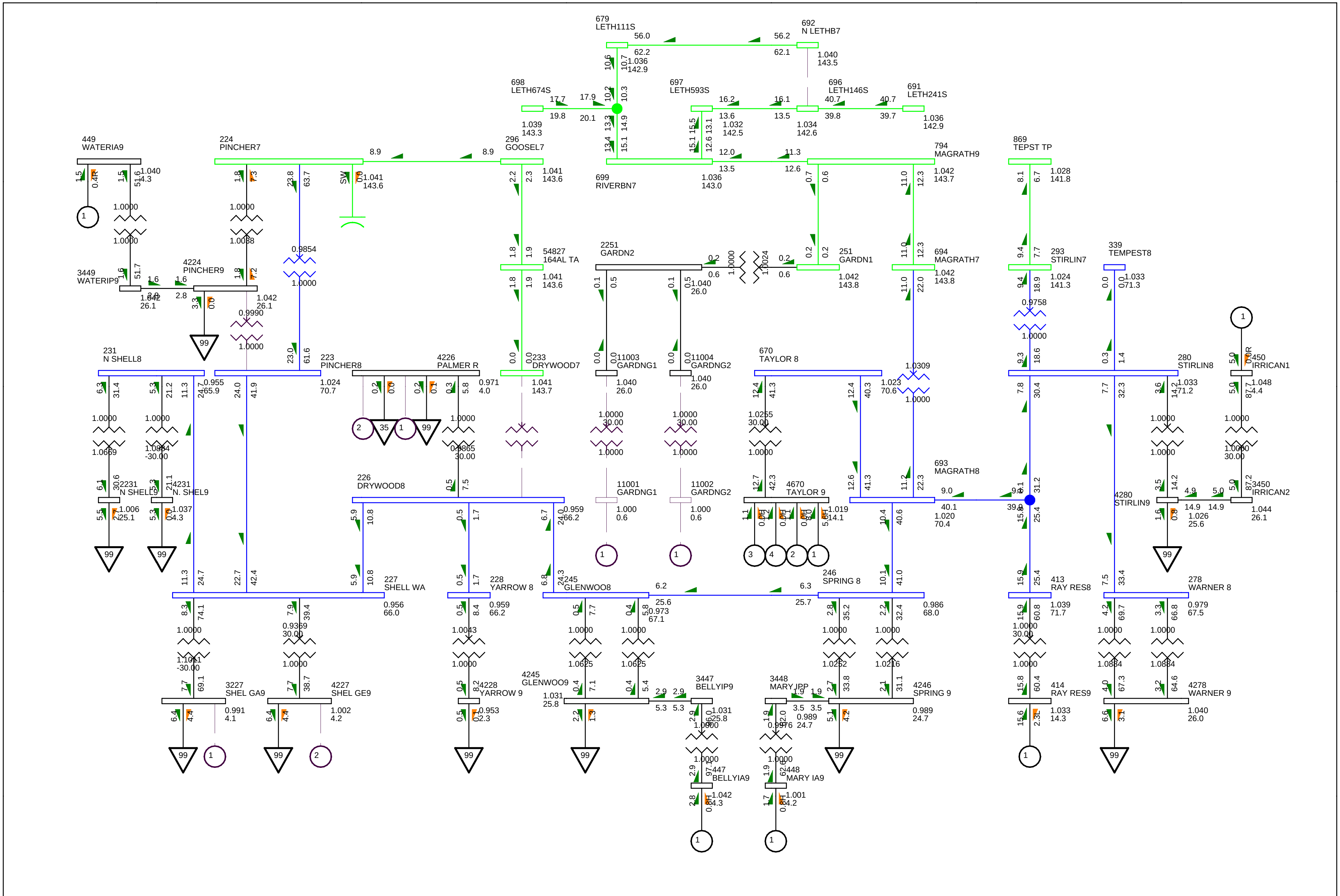
Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2007 SUMMER PEAK CASE
FRI, MAY 23 2008 18:36

Fig D-4

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000

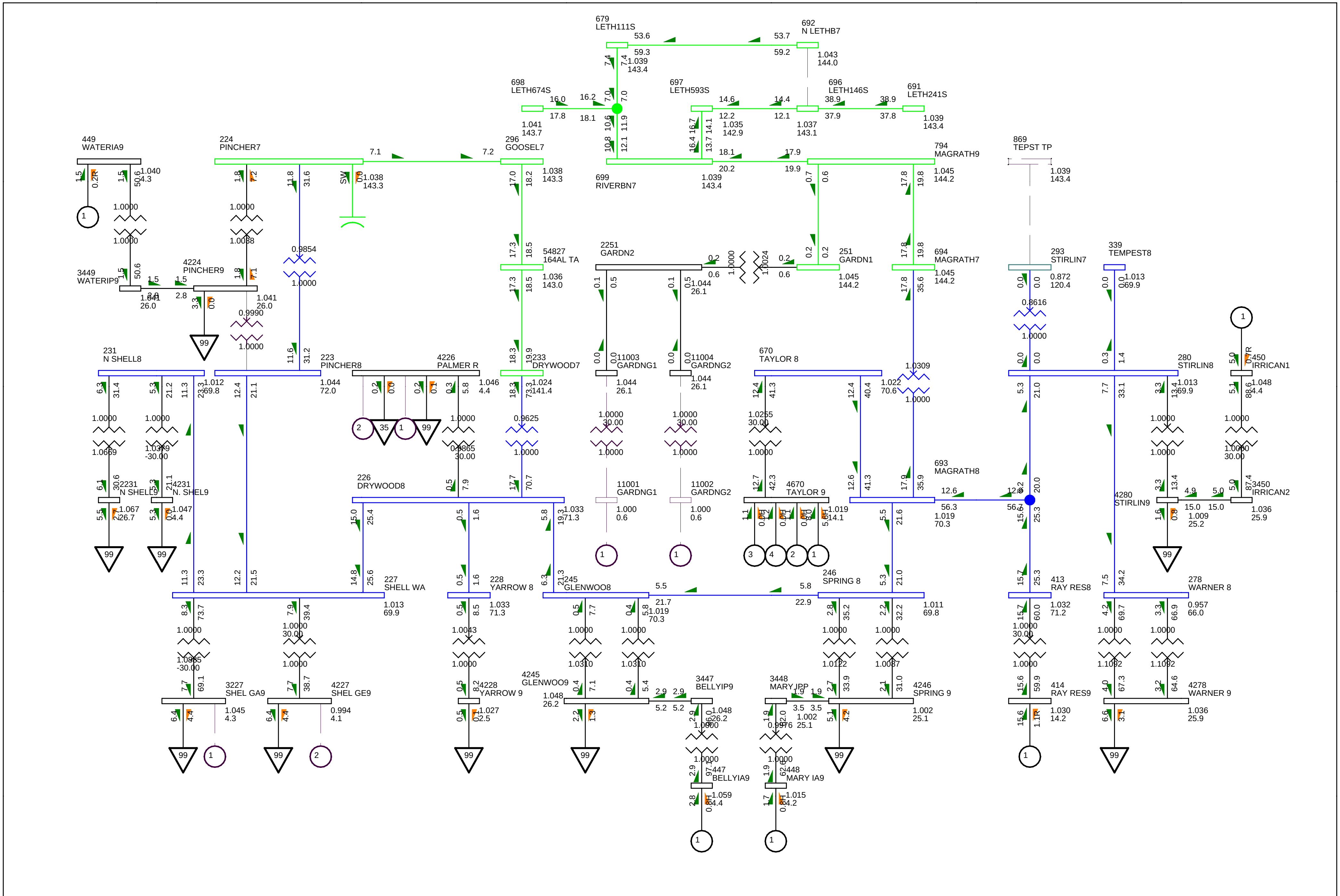


SOUTH PLANNING STUDY
2007 SUMMER PEAK CASE
FRI, MAY 23 2008 18:37

Fig D-5

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR

100.0%RATEA
1.100OV0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000

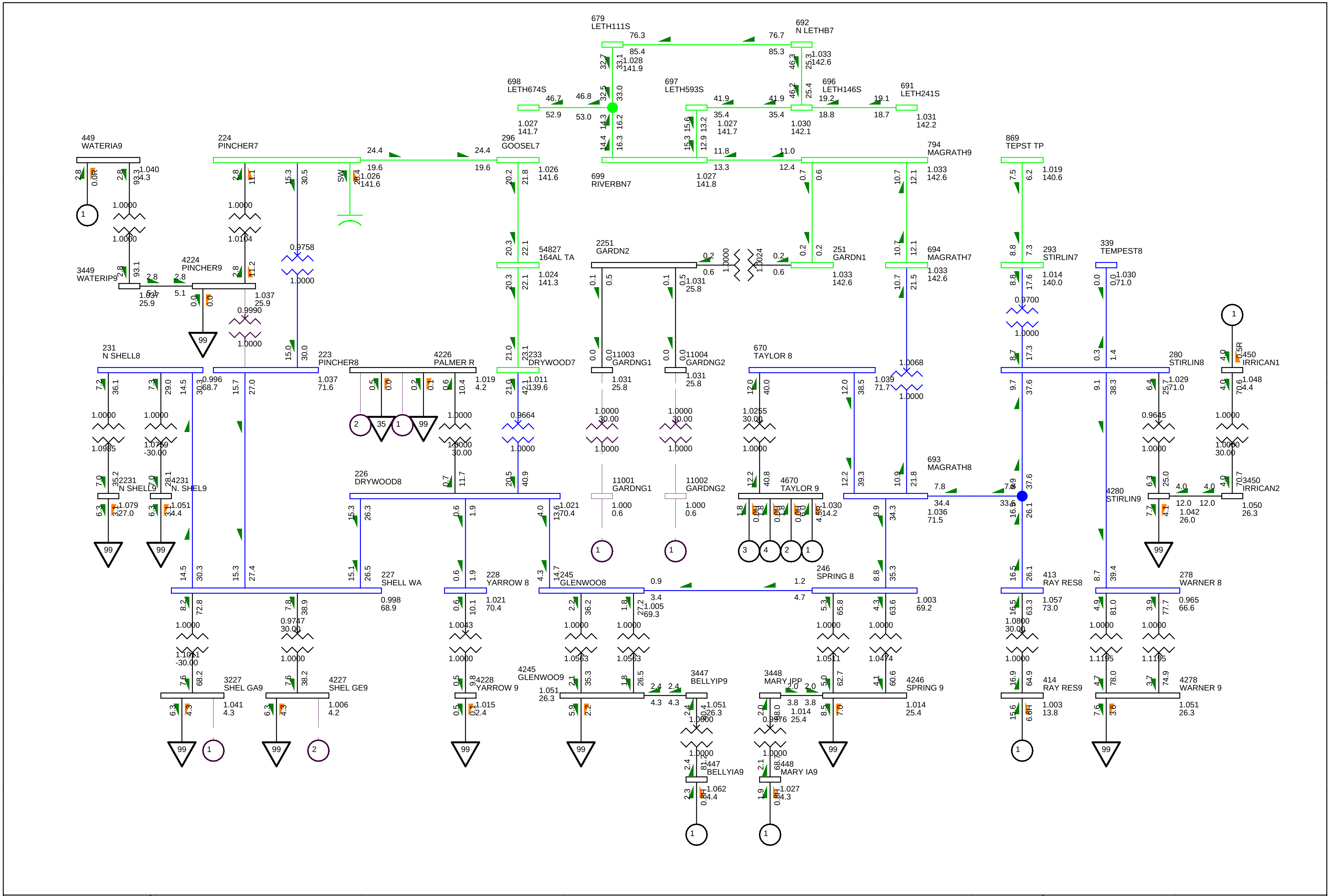


SOUTH PLANNING STUDY
2007 SUMMER PEAK CASE
FRI, MAY 23 2008 18:41

Fig D-6

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR

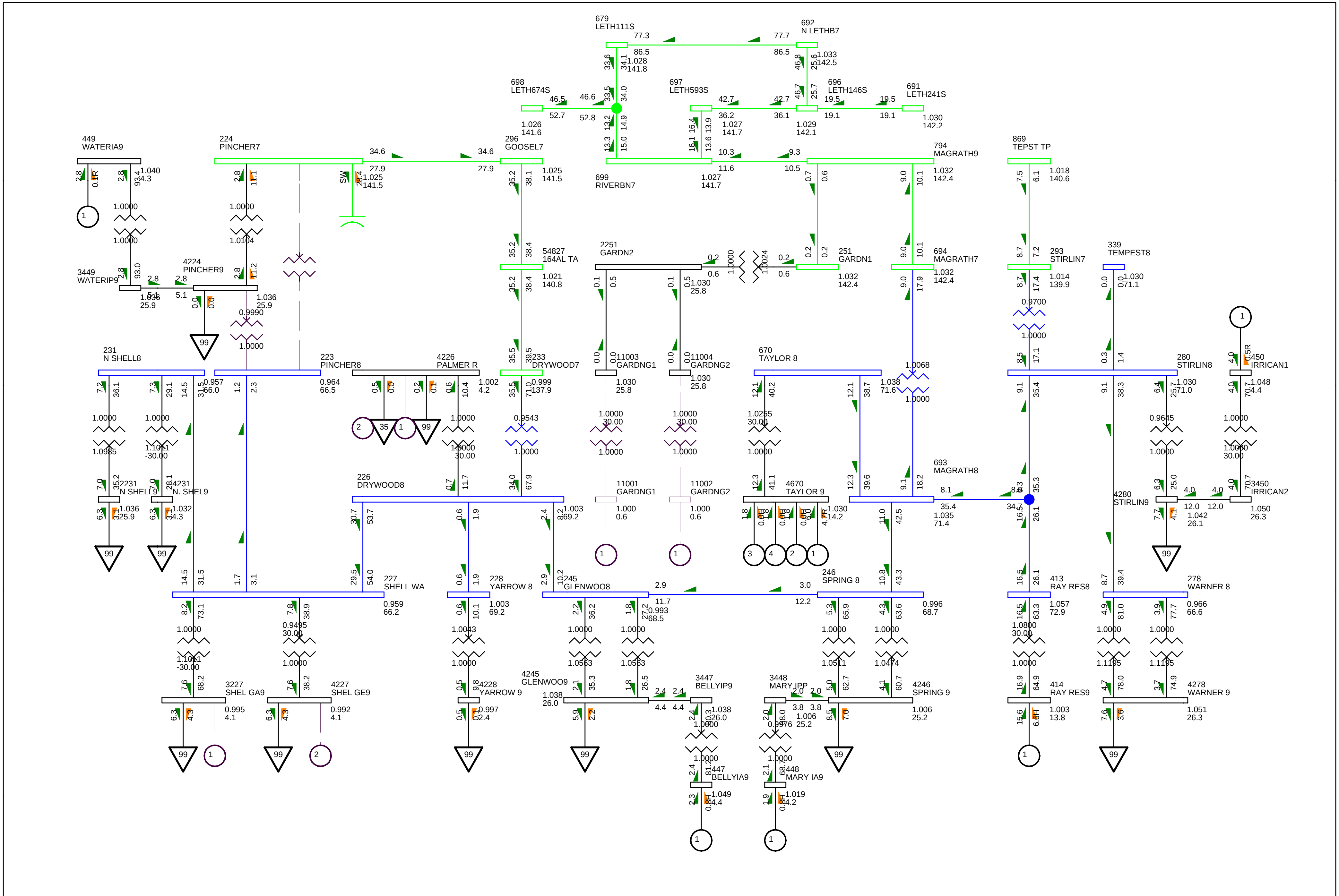
100.0%RATEA
1.100OV0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2012 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 18:43

Fig D-7

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV 0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2012 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 18:44

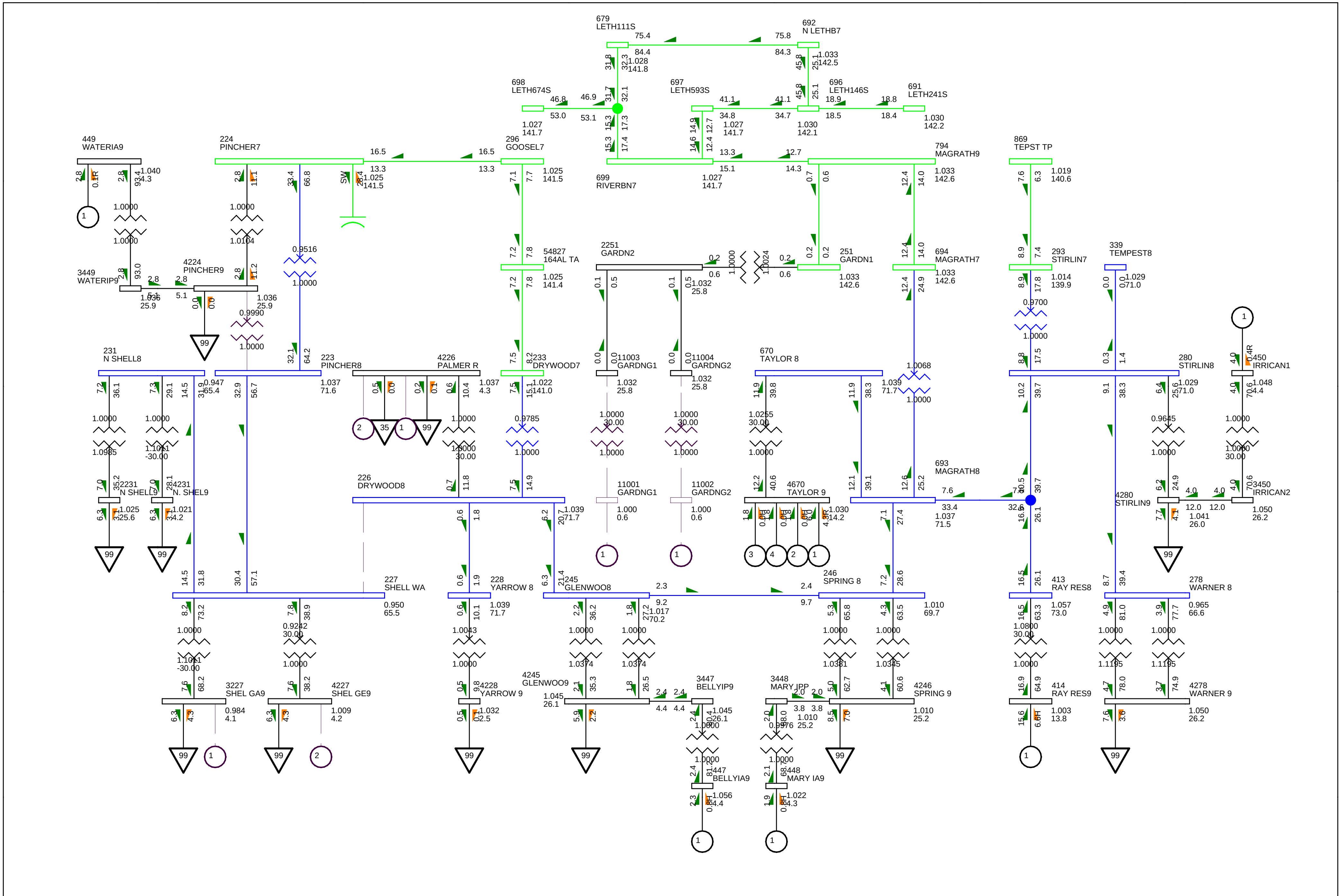
Fig D-8

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR

100.0%RATEA

1.100OV 0.900UV

KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2012 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 18:47

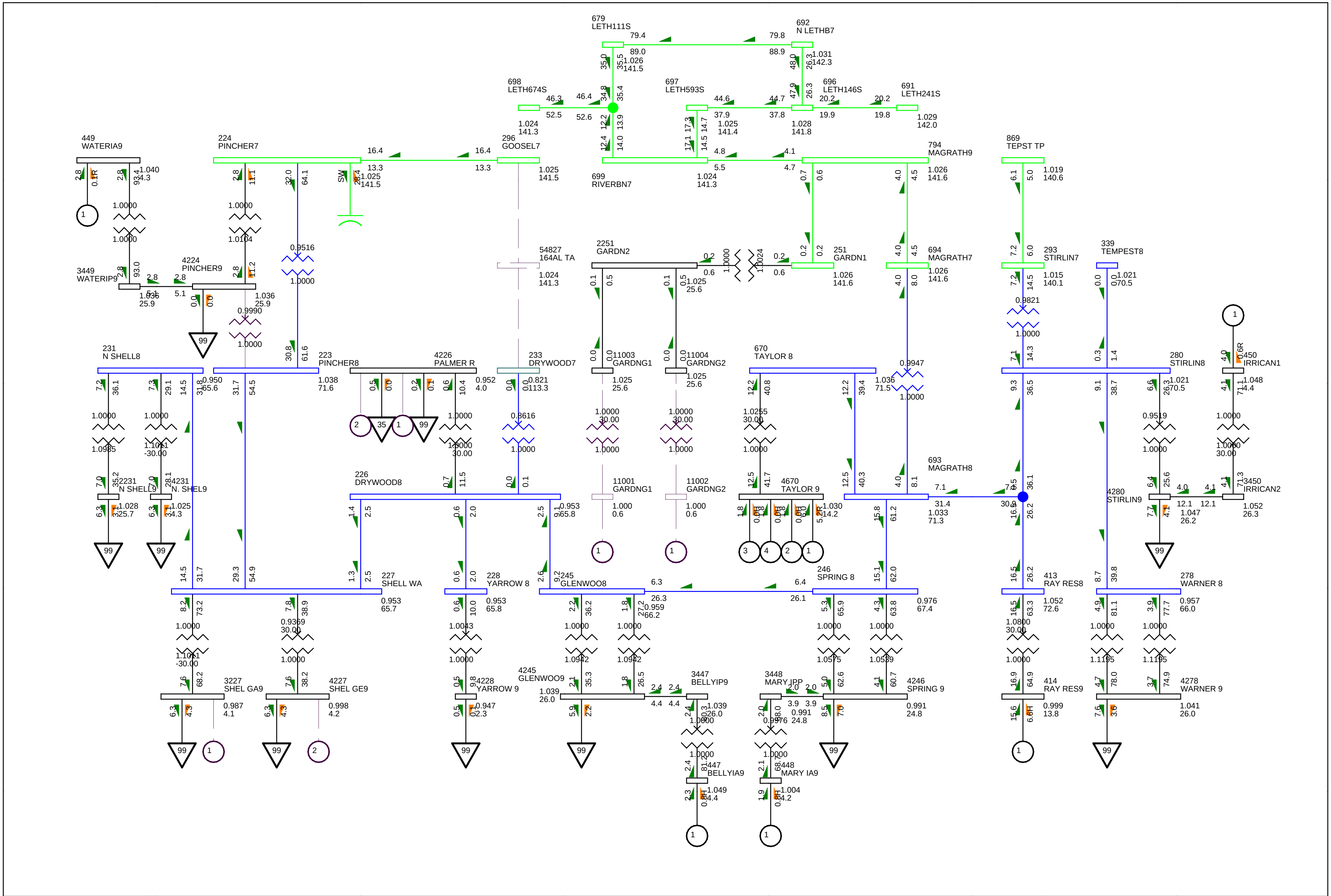
Fig D-9

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR

100.0%RATEA

1.100OV 0.900UV

KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000

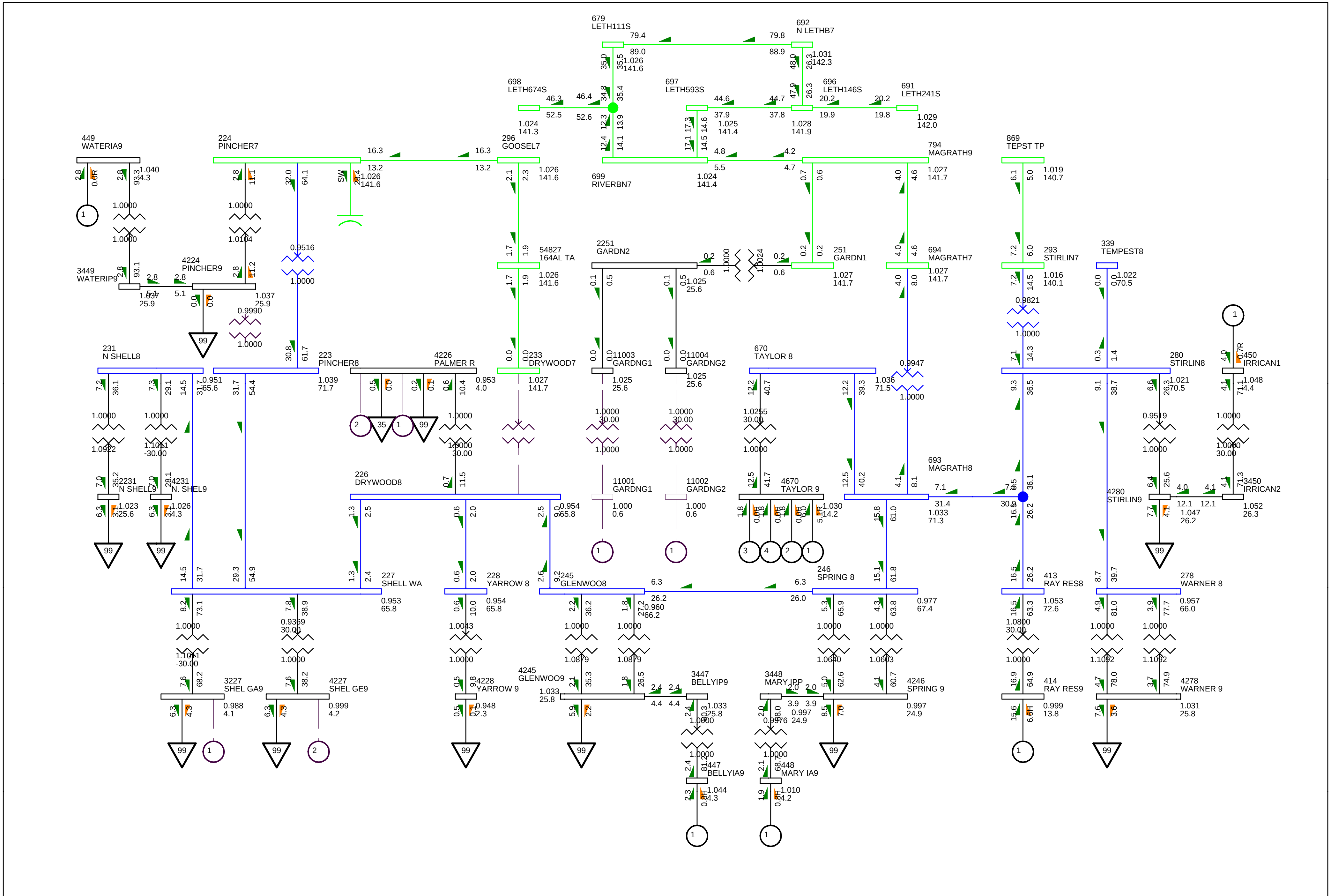


SOUTH PLANNING STUDY
2012 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 18:48

Fig D-10

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR

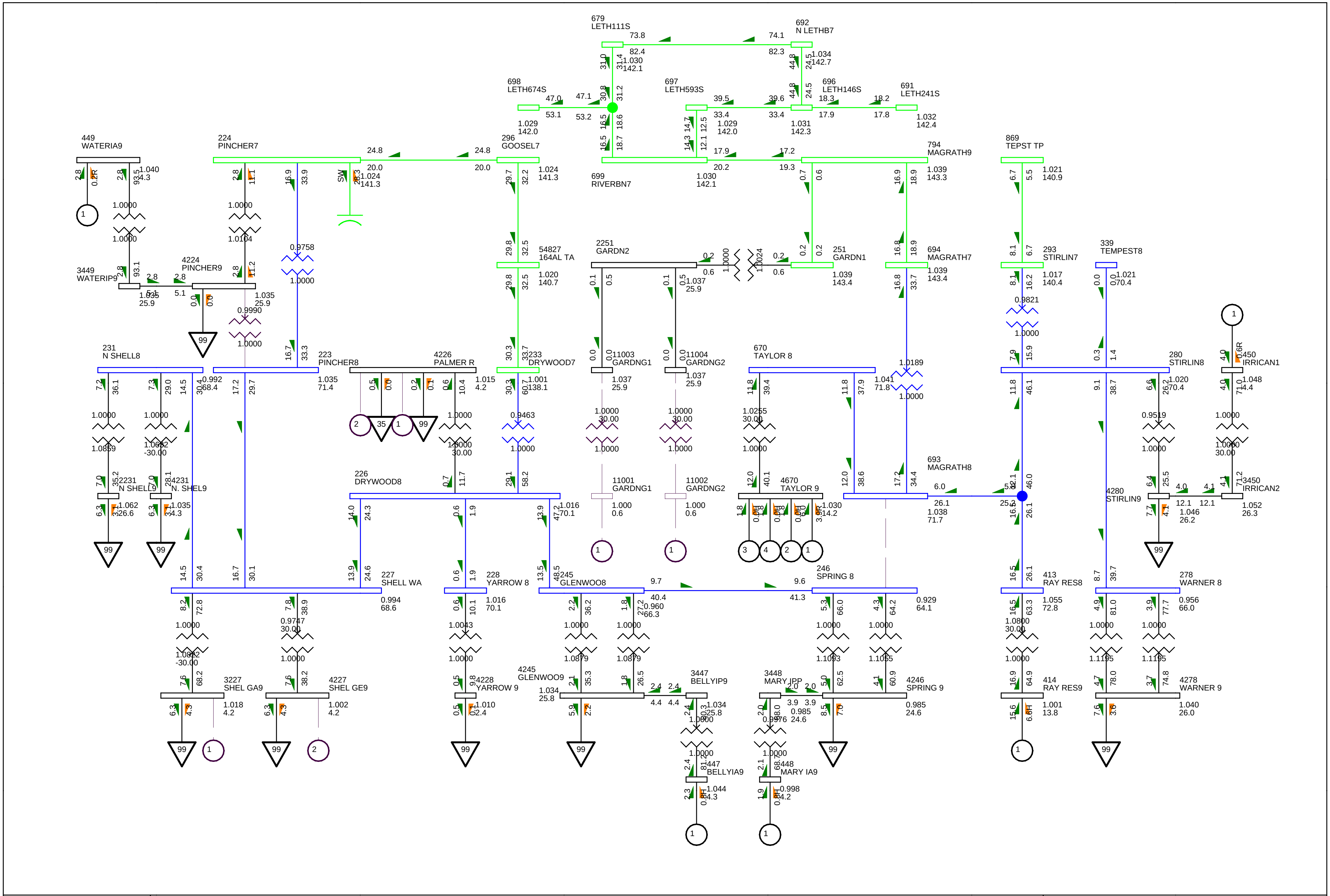
100.0%RATEA
1.100OV 0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2012 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 18:50

Fig D-11

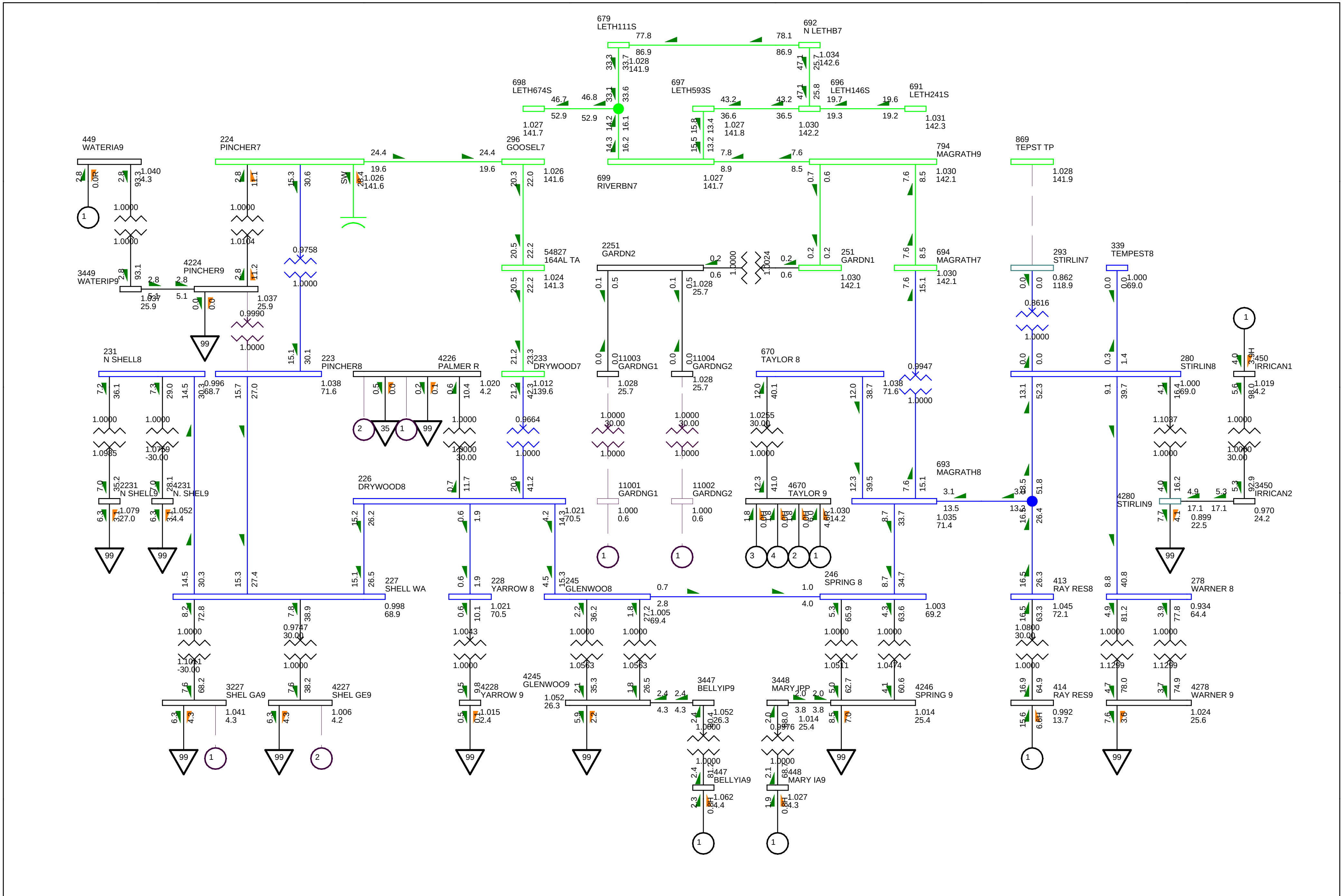
Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV 0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2012 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 18:55

Fig D-12

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV 0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2012 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 19:03

Fig D-13

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV 0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000

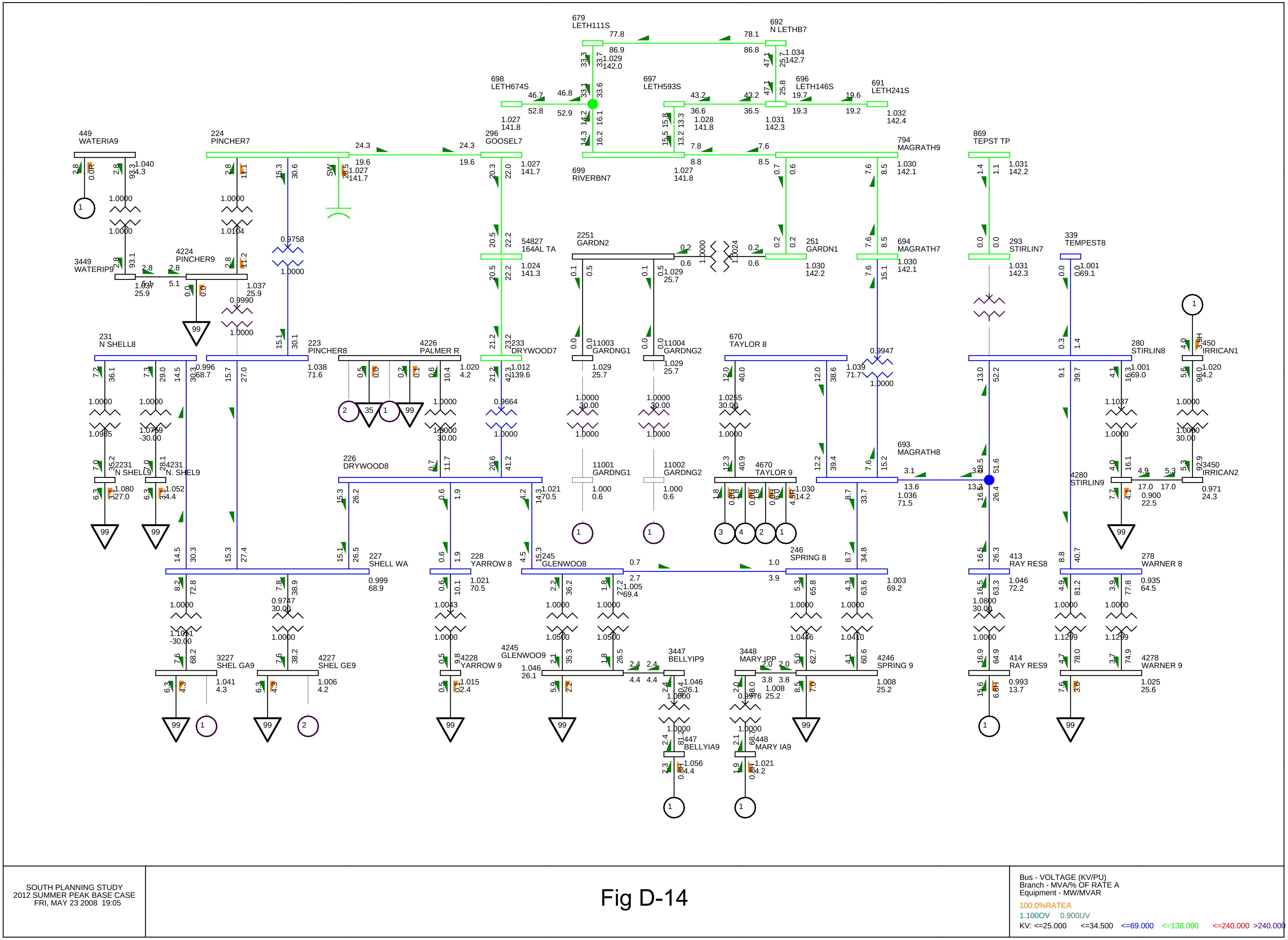
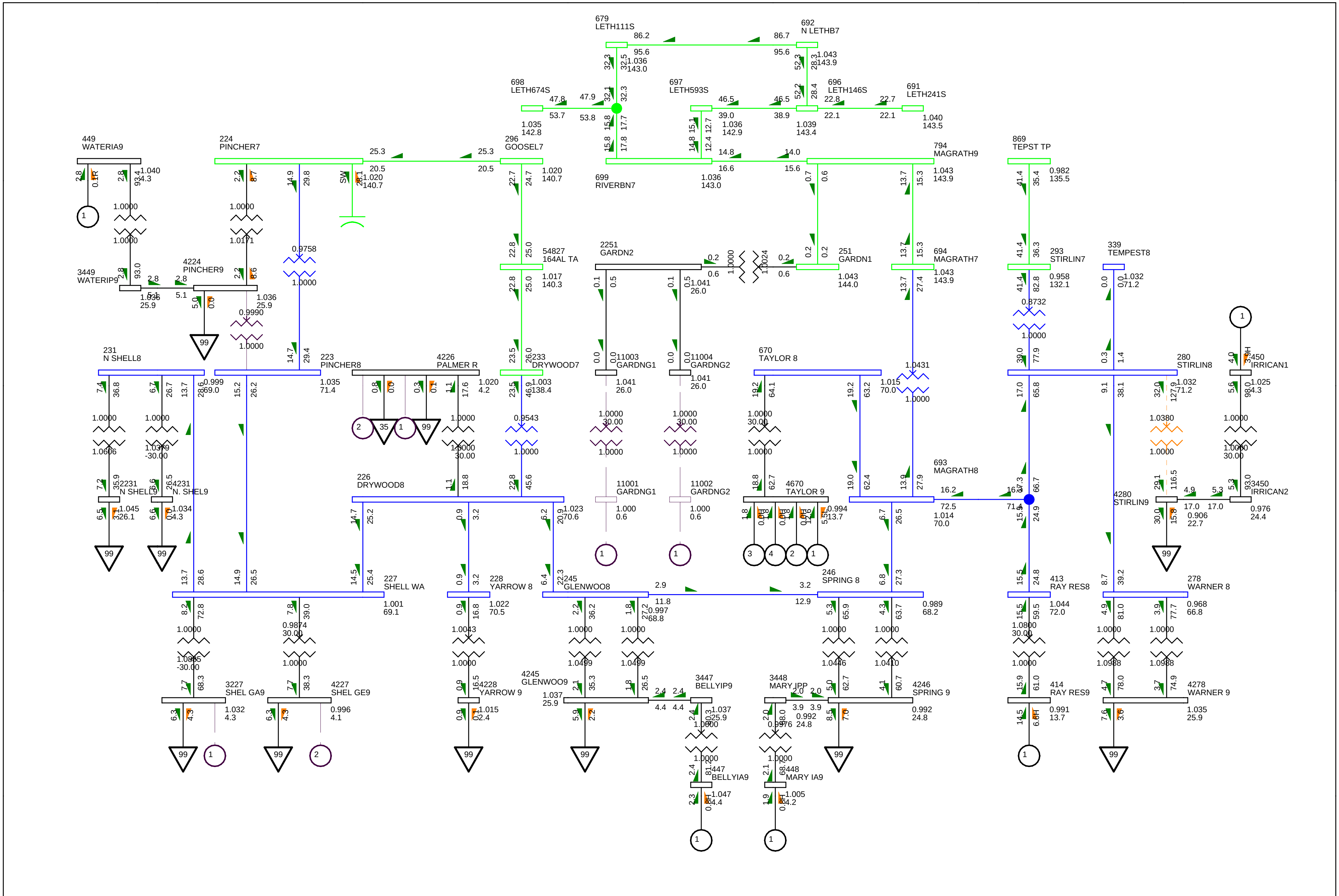

SOUTH PLANNING STUDY
2012 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 19:05
Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV 0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000

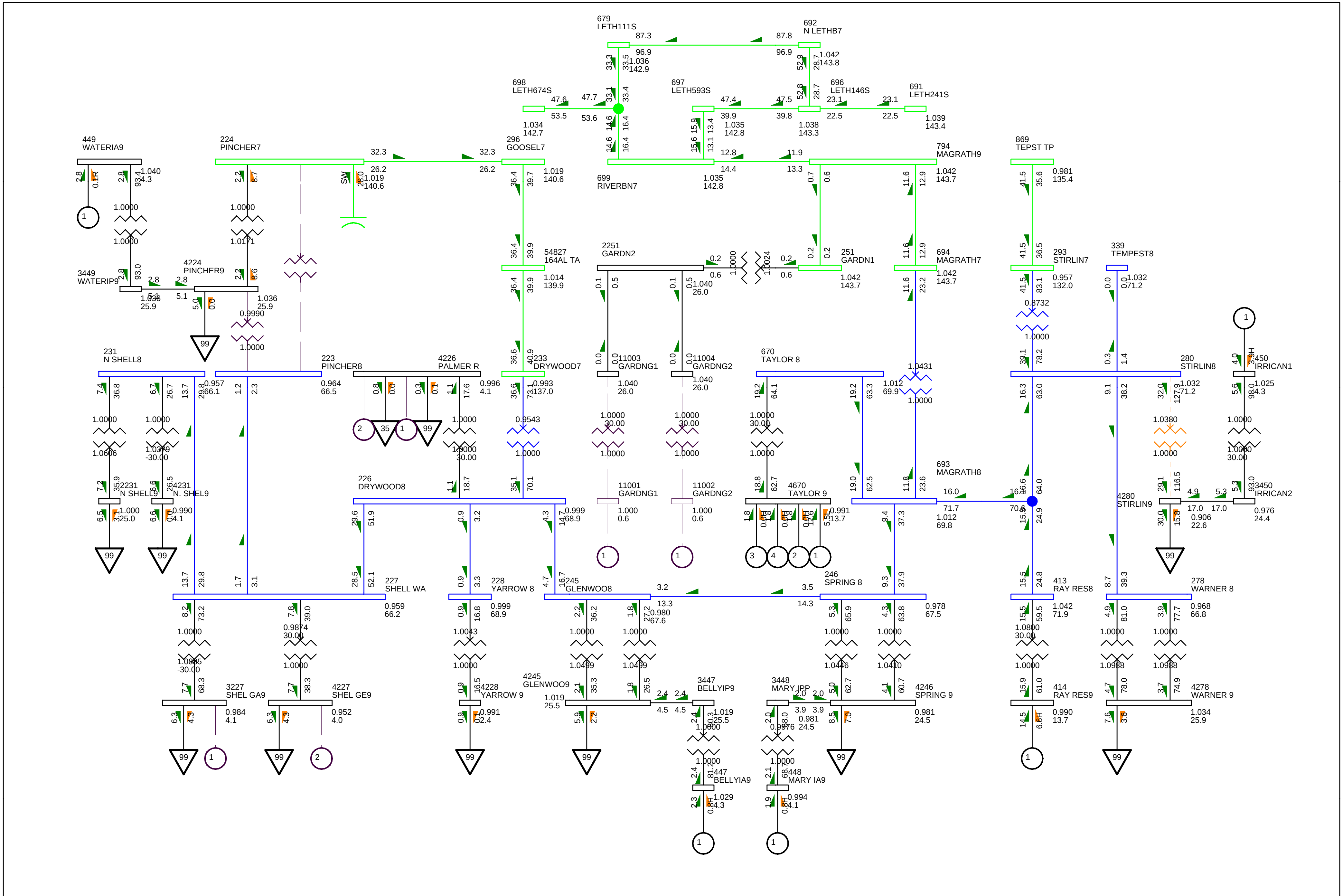
Fig D-14



SOUTH PLANNING STUDY
2017 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 19:06

Fig D-15

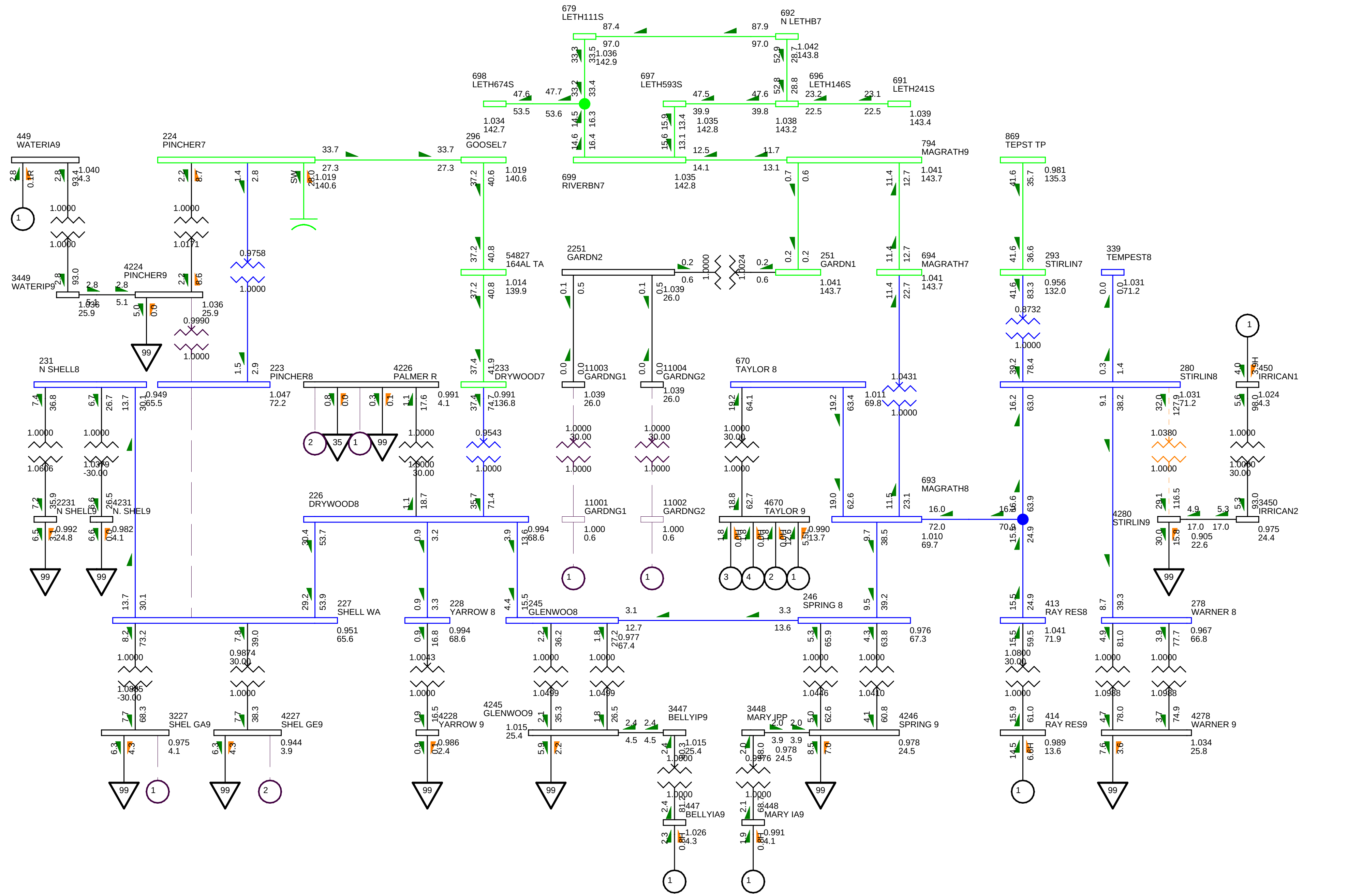
Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV 0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2017 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 19:10

Fig D-16

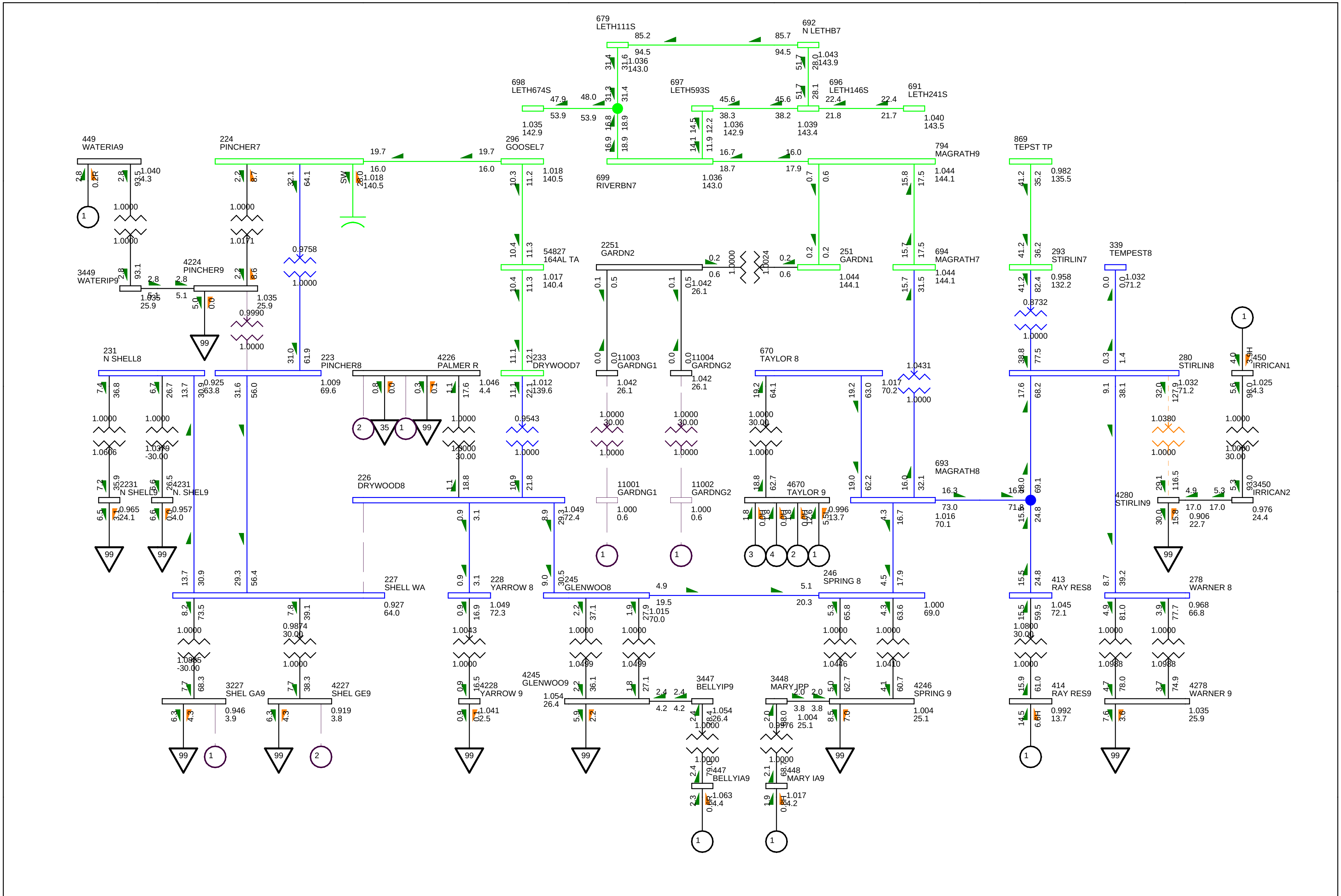
Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV 0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2017 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 19:12

Fig D-17

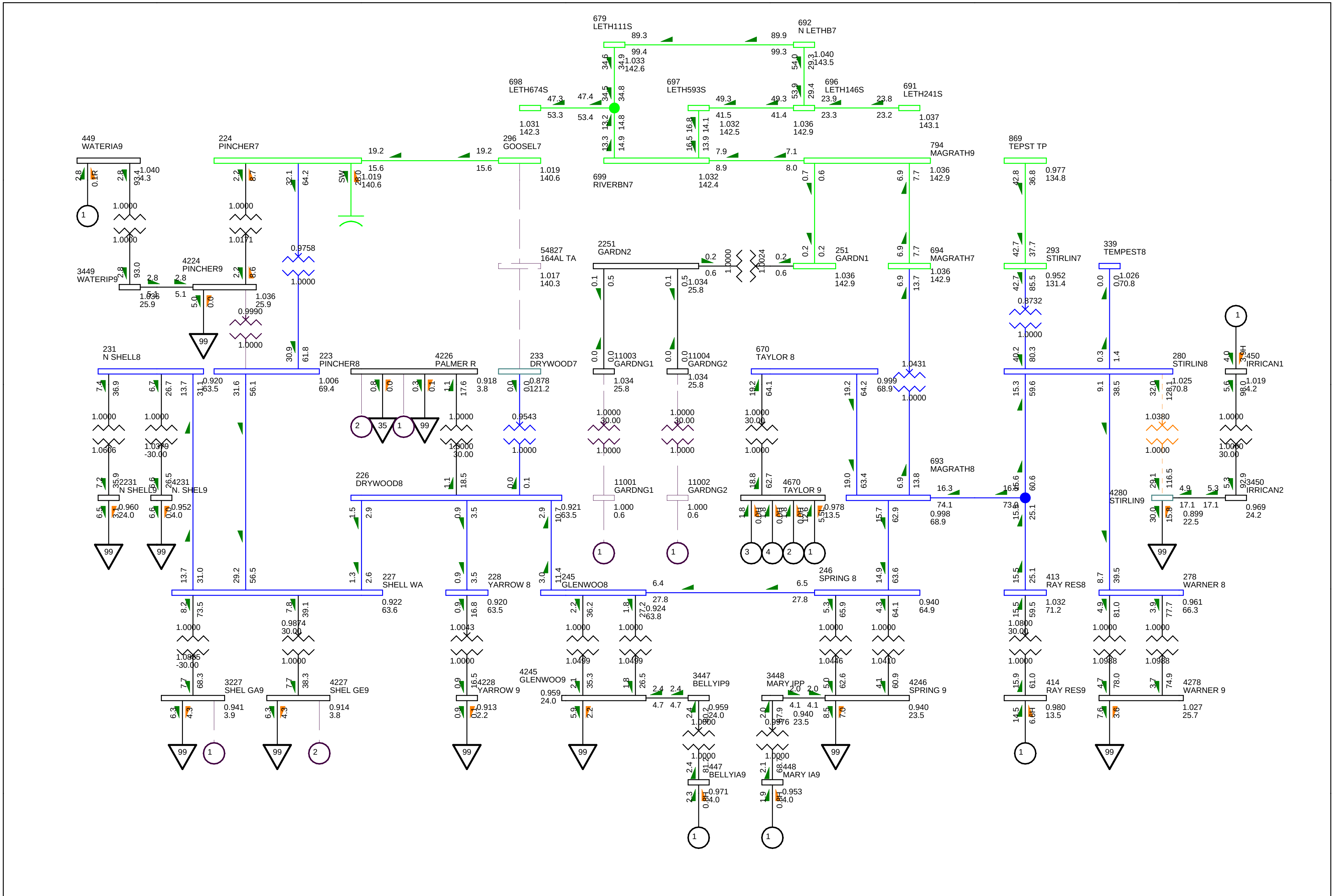
Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV 0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2017 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 19:13

Fig D-18

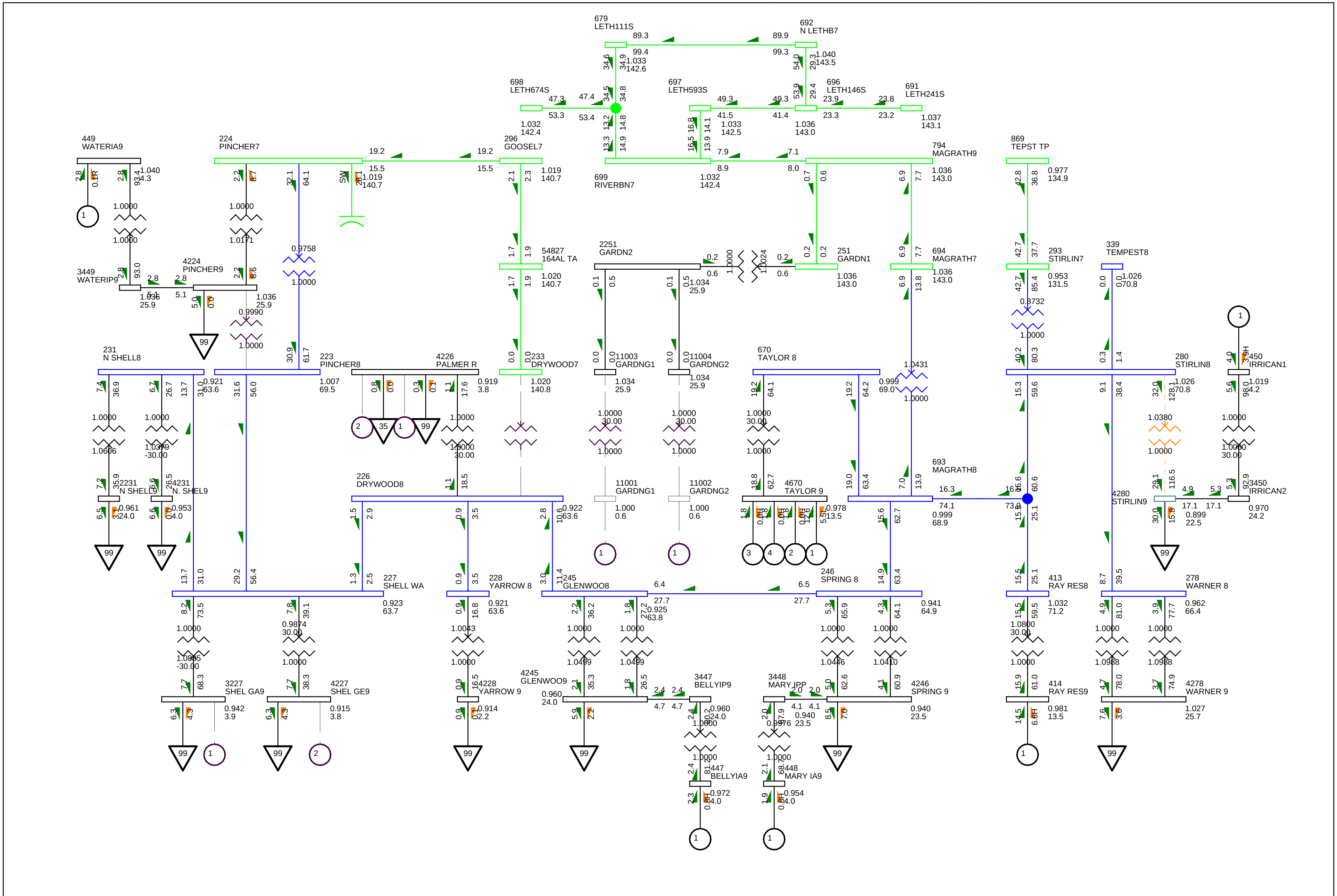
Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV 0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2017 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 19:14

Fig D-19

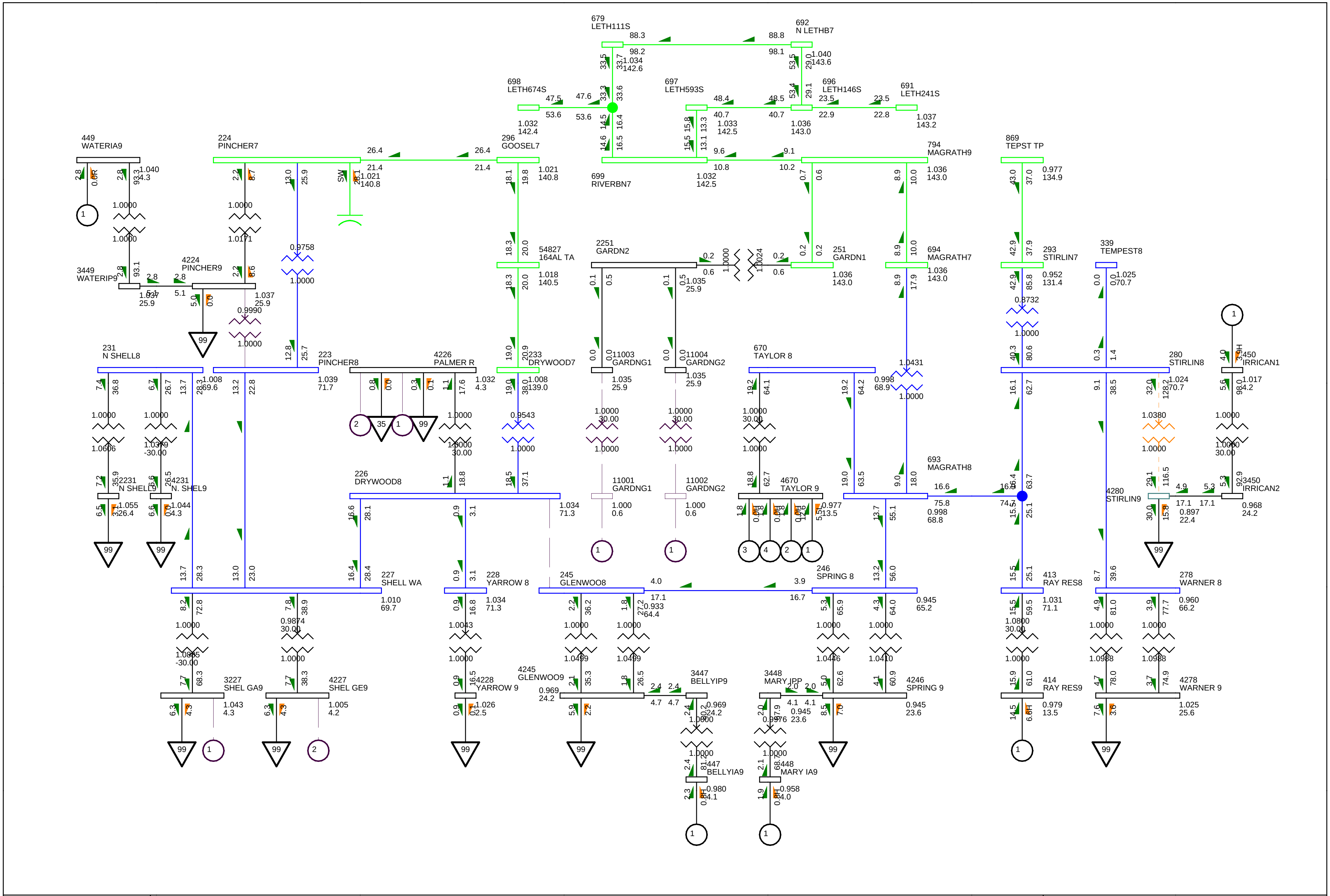
Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV 0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2017 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 19:16

Fig D-20

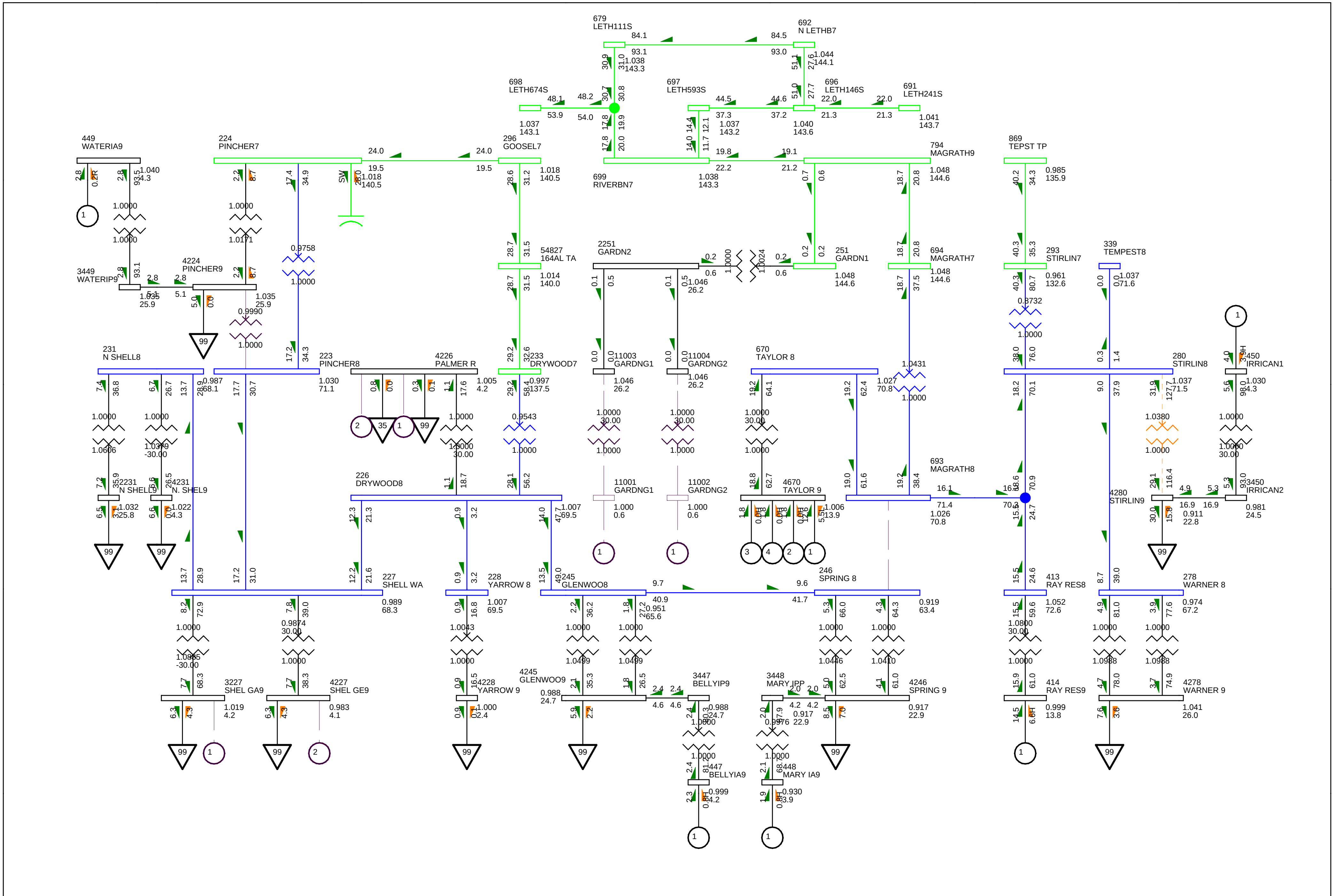
Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV 0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2017 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 19:17

Fig D-21

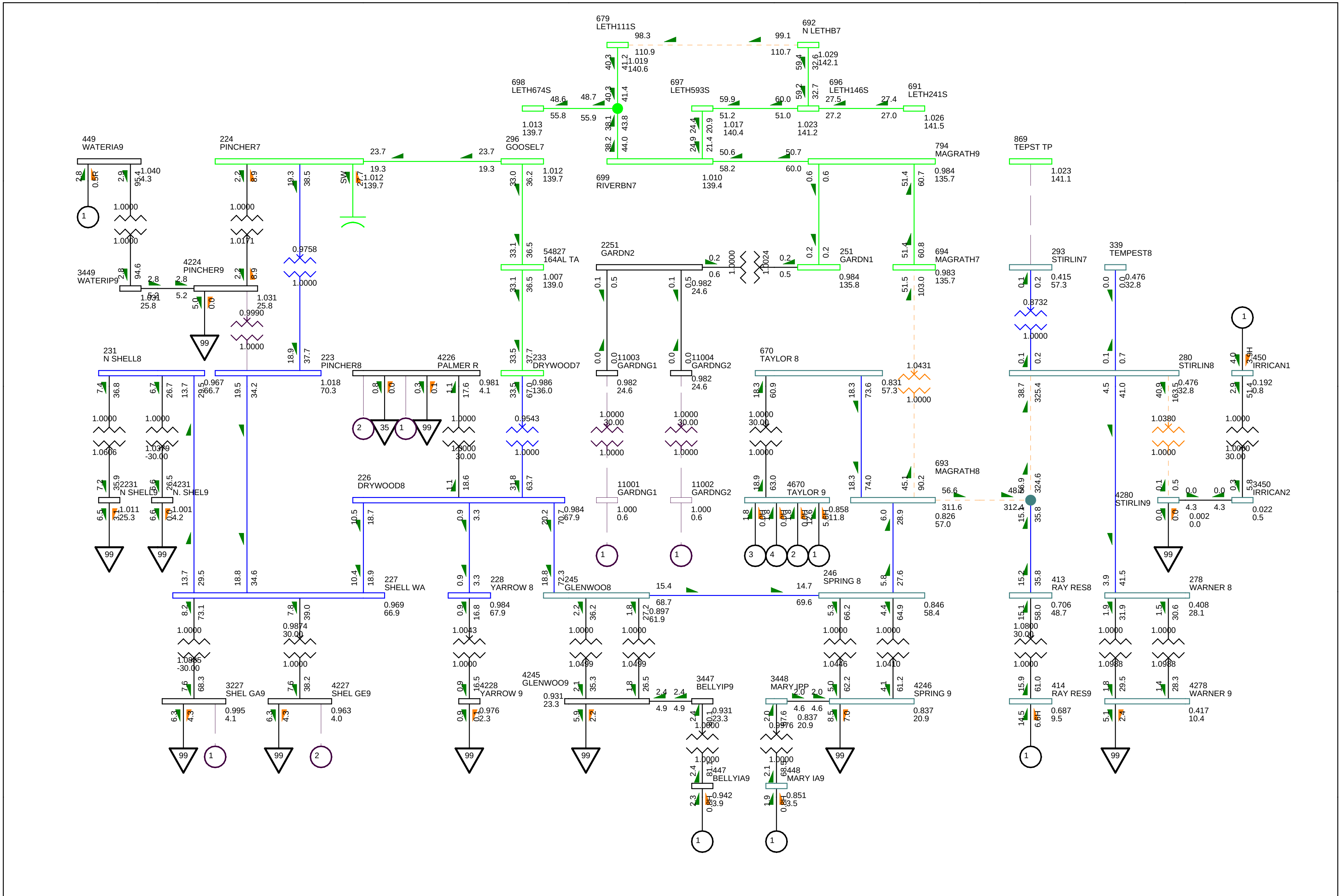
Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV 0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2017 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 19:19

Fig D-22

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV 0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000

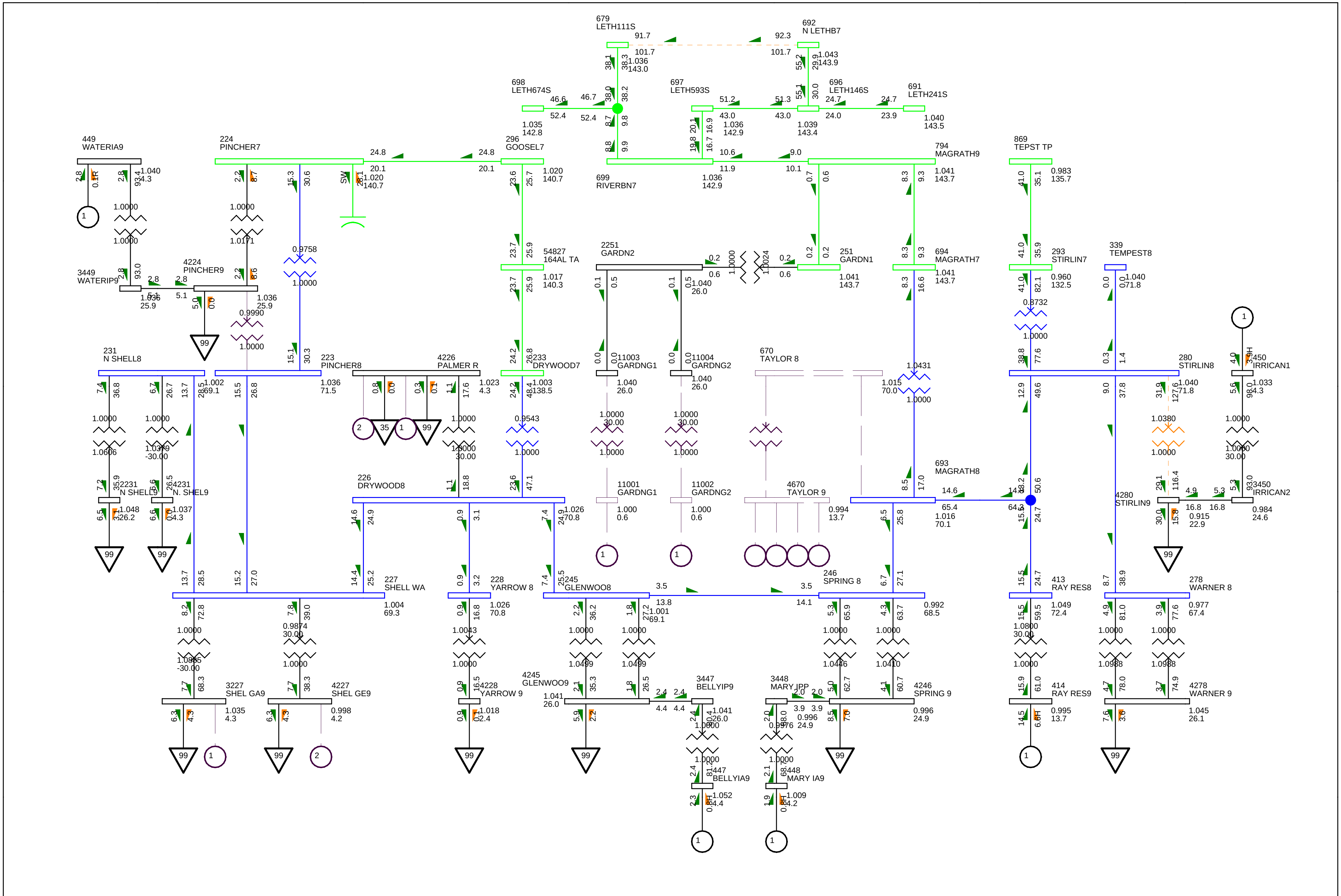


SOUTH PLANNING STUDY
2017 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 19:20

Fig D-23

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR

100.0%RATEA
1.100OV 0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2017 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 19:25

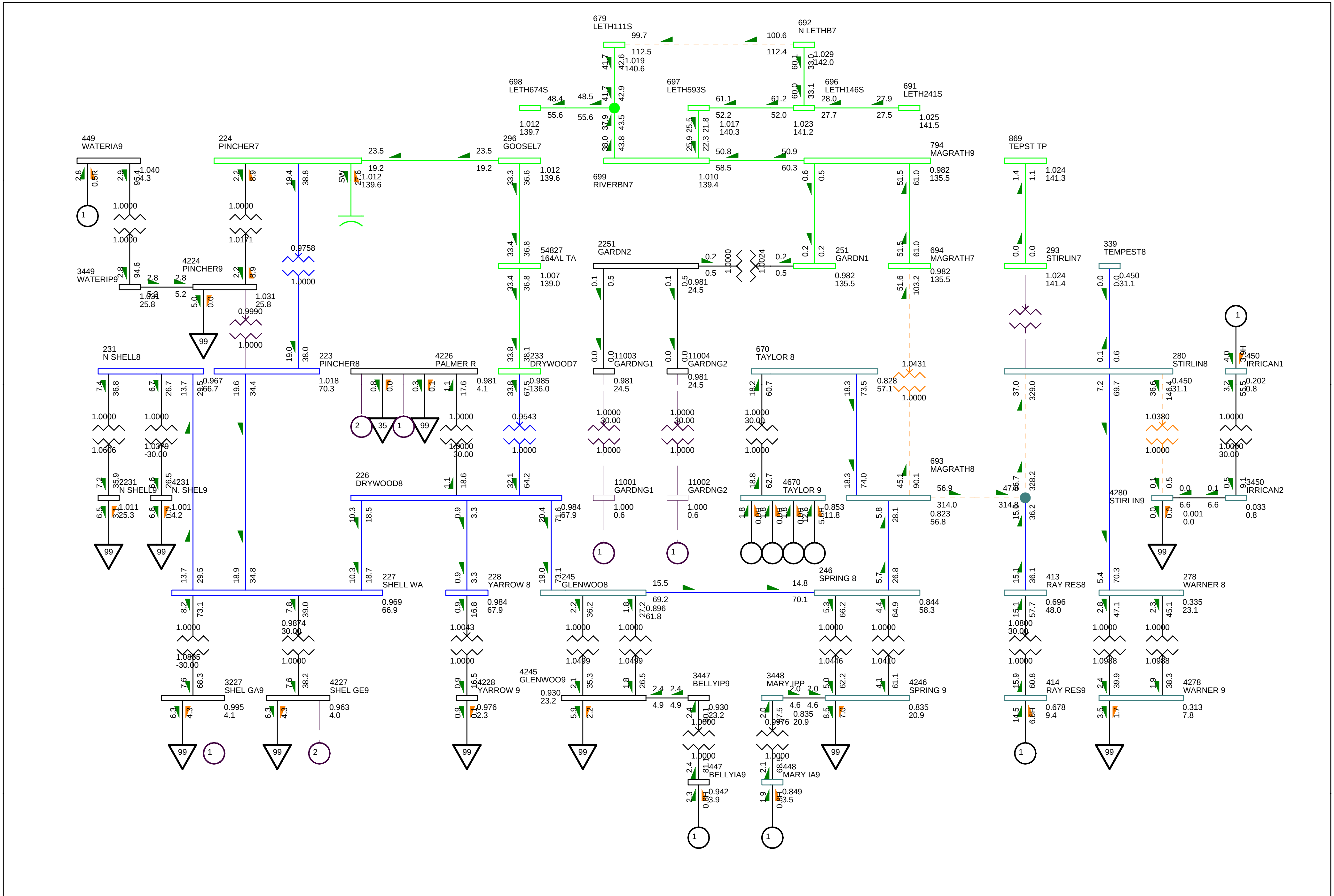
Fig D-24

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR

100.0%RATEA

1.100OV 0.900UV

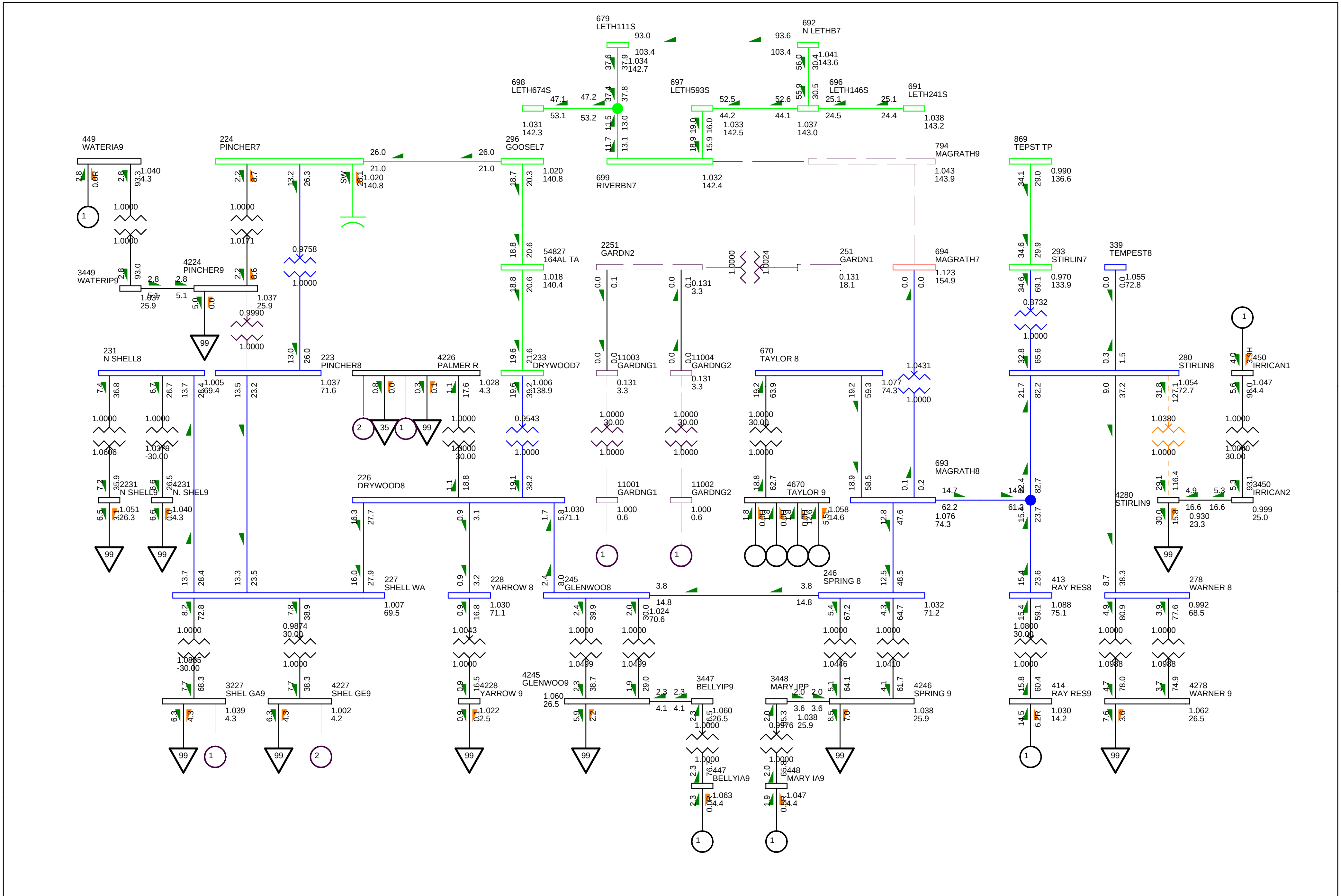
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2017 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 19:27

Fig D-25

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR
100.0%RATEA
1.100OV 0.900UV
KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000



SOUTH PLANNING STUDY
2017 SUMMER PEAK BASE CASE
FRI, MAY 23 2008 19:30

Fig D-26

Bus - VOLTAGE (KV/PU)
Branch - MVA/% OF RATE A
Equipment - MW/MVAR

100.0%RATEA

1.100OV 0.900UV

KV: <=25.000 <=34.500 <=69.000 <=138.000 <=240.000 >240.000