EXHIBIT NO. _______ (WAG-4)
DOCKET NO.____________
2003 POWER COST ONLY RATE CASE
WITNESS: WILLIAM A. GAINES

**BEFORE THE**

**WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION**

| | |
|---|---|
| WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION,<br><br>Complainant,<br><br>v.<br><br>PUGET SOUND ENERGY, INC.,<br><br>Respondent. | Docket No. ____________ |

**DIRECT TESTIMONY OF**
**WILLIAM A. GAINES**
**ON BEHALF OF PUGET SOUND ENERGY, INC.**

# Overview of PSE Loads and Resources 2001-2010

PUGET SOUND ENERGY

## Load Resource Balance
February 2002

# Load Forecast Assumptions

- On peak/off peak average demand for 2001-2010 based on Villamor's forecast and adjusted by Energy Supply for GPI and PEM.
- PSE Customer and Sales Forecasts 2002-2010 (attached as Appendix 1).

# Resource Forecast Assumptions

- Forecasted on peak/off peak average energy based on information submitted for the rate case.
- Colstrip: energy = capacity x forced outage rate (seven year average). Maintenance schedule based on last three years.
- PSE Hydro based on 30 year average.
- Mid-C hydro based on NWPP 60 year average.
- QF Hydro based on average annual energy.
- PSE CTs: = 4% forced outage rate.
- PG&E Seasonal Exchange terminated 12/31/2006.

# Significant Loss of Contract Resources

- PSE's percentage of Rock Island II declined by 5% in 2000 and will further decline annually to a maximum aggregate reduction of 50%.
- By the end of 2003, PSE will lose 265 MW capacity; 160 aMW.
- At the end of 2006, PSE will lose 300 MW winter capacity due to termination of PG&E exchange.
- By the end of 2010, PSE will lose 107 MW capacity; 94 aMW.
- *Note:* At the end of 2011, contracts expire for March Point I, March Point II, and Tenaska - 385 MW capacity; 357 aMW.

# Significant Loss of Contract Resources

| Expiring Resources | Capacity MW | Energy aMW | Resource Type | Expiration |
|---|---|---|---|---|
| Avista | 33 | 25 | Thermal | 12/31/2002 |
| CSPE | 20 | 19 | Hydro | 3/31/2003 |
| Supplemental & Entitlement Capacity | 10 | 0 | Hydro | 3/31/2003 |
| PacifiCorp | 200 | 120 | Thermal | 10/31/2003 |
| Port Townsend Paper | 0.4 | 0.3 | Hydro-QF | 12/31/2003 |
| Powerex/Pt.Roberts | 8 | 3 | Hydro | 9/30/2004 |
| Hutchison Creek | 0.9 | 0.2 | Hydro-QF | 9/30/2004 |
| Baker Replacement | 7 | 1 | Hydro | 9/30/2006 |
| PG&E Seasonal Exchange-PSE | 300 | 0 | Thermal | 12/31/2006 |
| Puyallup Energy Recovery Co.(PERC) | 2 | 1.8 | Biomass-QF | 4/15/2009 |
| Conservation Credit - SnoPUD | 10 | 10 | Hydro | 2/28/2010 |
| Montana Power | 97 | 84 | Colstrip | 12/29/2010 |

# Significant Loss of Contract Resources

| Expiring Resources Annualized | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Cumulative Total |
|---|---|---|---|---|---|---|---|---|---|---|
| (aMW) Energy | 25 | 139.3 | 3.2 | 0 | 1 | 0 | 0 | 1.8 | 94 | 264.3 |
| (MW) Capacity | 33 | 230.4 | 8.9 | 0 | 307 | 0 | 0 | 2 | 107 | 688.3 |

# Load/Resource Balance

- PSE is deficit for 2002-2010 on peak if CTs are not assumed.
- By the end of 2006, the deficit for on peak increases to approximately 500 MW if CTs are not assumed.
- Based on PIRA's 2002-2005 price forecast of $3.24 per MMBtu and $31.50 per MW for gas and on peak electric, PSE's CTs would not clear the market.

*[Source: PIRA Oct 2001, Table VIII-30; U.S. Electricity Prices, On Peak 1998-2015; North American Gas Prices 1990-2015]*

# Load/Resource Balance - Without CTs

| Surplus/Deficit (-) (aMW) | | | | | | |
|---|---|---|---|---|---|---|
| | On Peak | | | Off Peak | | |
| Year | Load | Resources | Surplus (Deficit) | Load | Resources | Surplus (Deficit) |
| 2002 | 2587 | 2478 | -109 | 2025 | 2062 | 37 |
| 2003 | 2623 | 2481 | -142 | 2058 | 2127 | 69 |
| 2004 | 2611 | 2306 | -305 | 2049 | 2105 | 56 |
| 2005 | 2680 | 2296 | -384 | 2102 | 2080 | -22 |
| 2006 | 2735 | 2264 | -471 | 2145 | 2043 | -102 |
| 2007 | 2789 | 2254 | -535 | 2185 | 2032 | -153 |
| 2008 | 2851 | 2246 | -605 | 2193 | 2027 | -166 |
| 2009 | 2912 | 2247 | -665 | 2253 | 2028 | -225 |
| 2010 | 2974 | 2239 | -735 | 2300 | 2020 | -280 |

# Load/Resource Balance - With CTs (588 MW)

Surplus/Deficit (-)
*(aMW)*

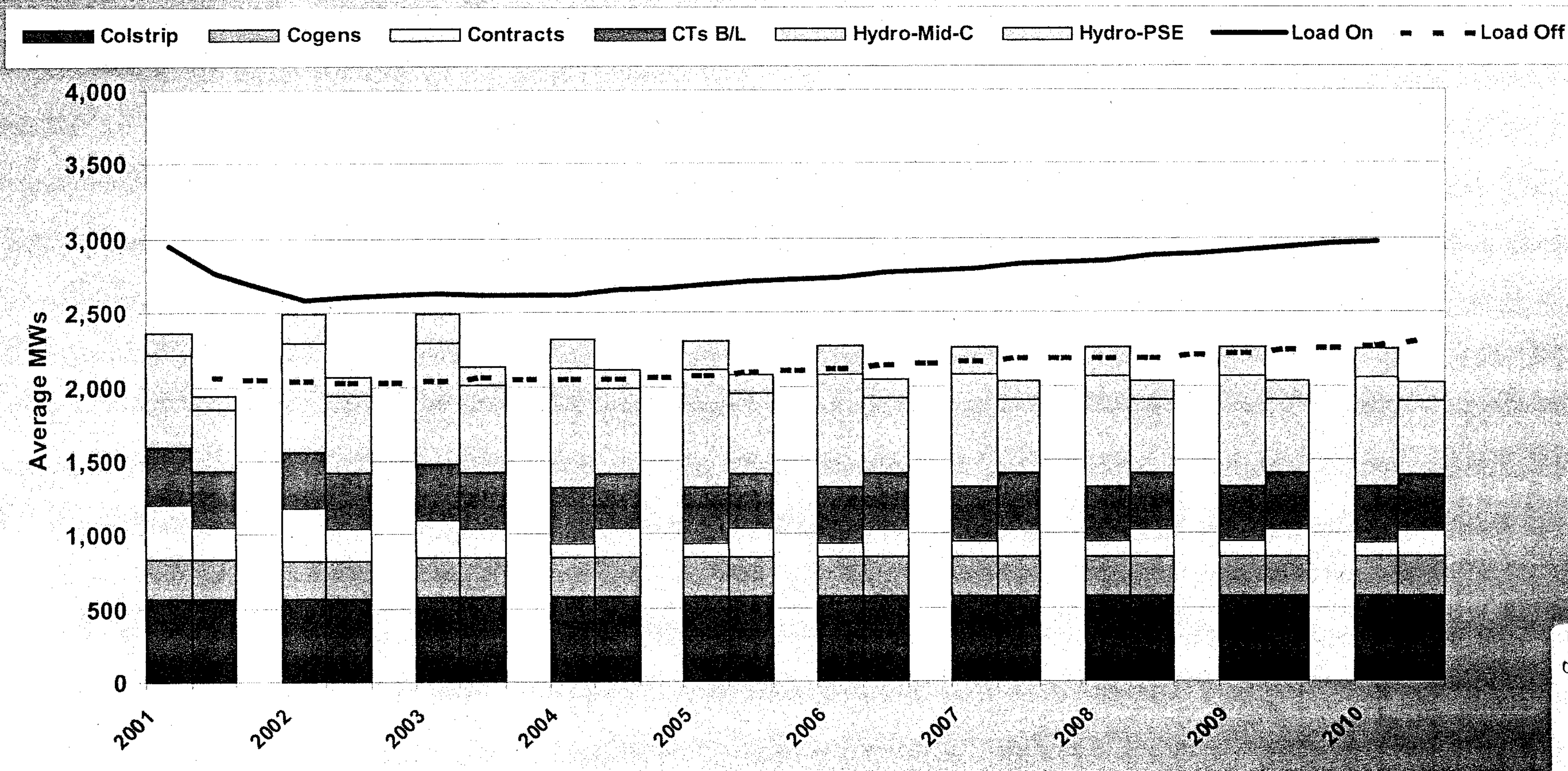
| | *On Peak* | | | *Off Peak* | | |
|---|---|---|---|---|---|---|
| Year | Load | Resources | Surplus (Deficit) | Load | Resources | Surplus (Deficit) |
| 2002 | 2587 | 3066 | 479 | 2025 | 2650 | 625 |
| 2003 | 2623 | 3069 | 446 | 2058 | 2715 | 657 |
| 2004 | 2611 | 2894 | 283 | 2049 | 2693 | 644 |
| 2005 | 2680 | 2884 | 204 | 2102 | 2668 | 566 |
| 2006 | 2735 | 2852 | 117 | 2145 | 2631 | 486 |
| 2007 | 2789 | 2842 | 53 | 2185 | 2620 | 435 |
| 2008 | 2851 | 2834 | -17 | 2193 | 2615 | 422 |
| 2009 | 2912 | 2835 | -77 | 2253 | 2616 | 363 |
| 2010 | 2974 | 2827 | -147 | 2300 | 2608 | 308 |

# Load Resource Balance - Resource Key

- Colstrip: Colstrip 1&2, Colstrip 3&4
- Cogens: March Point Phase I, Phase II, Sumas
- Contracts:
  - Other: BC Hydro-Pt. Roberts, Baker Replacement, CSPE, Canadian Entitlement & Extension, Snohomish Conservation, North WASCO, Montana Power, Pacificorp, PERC, PG&E Exchange, WWP, WNP3 Exchange
  - QF's: Hutchinson Creek, Kingdom Energy-Sygitowicz, Koma Kulshan, Port Townsend Paper, Spokane, Twin Falls, Weeks Falls
- CTs - Baseload: Encogen, Tenaska
- Hydro:
  - Mid C: Wells, Rocky Reach, Rock Island I, Rock Island II, Wanapum, Priest Rapids
  - PSE: Baker (Upper/Lower), White River, Snoqualmie Falls, Electron
- CTs - Peaking: Frederickson, Fredonia, Whitehorn, Crystal Mountain

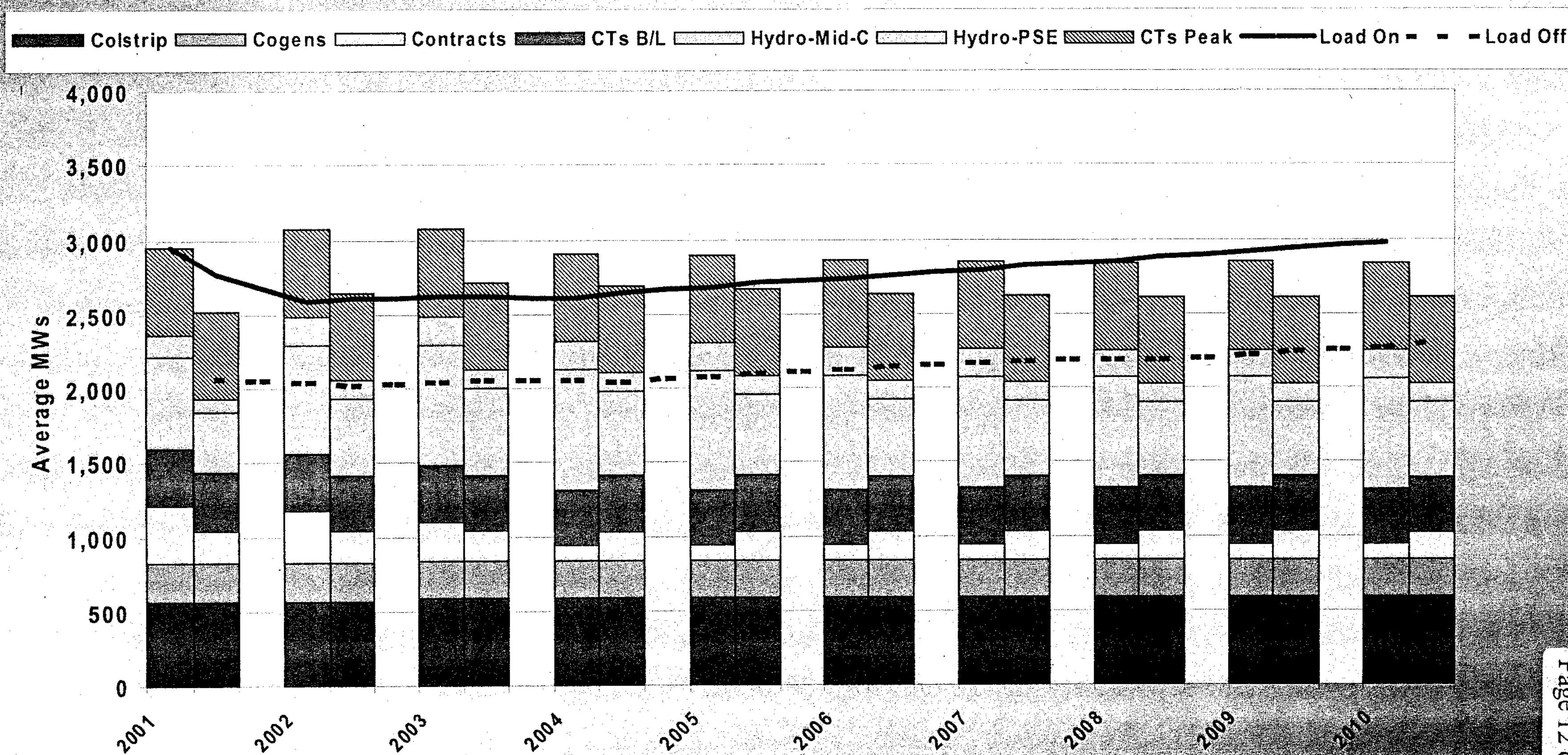
# Load/Resource Balance - On Peak/Off Peak 2001-2010

## Without CTs - average water

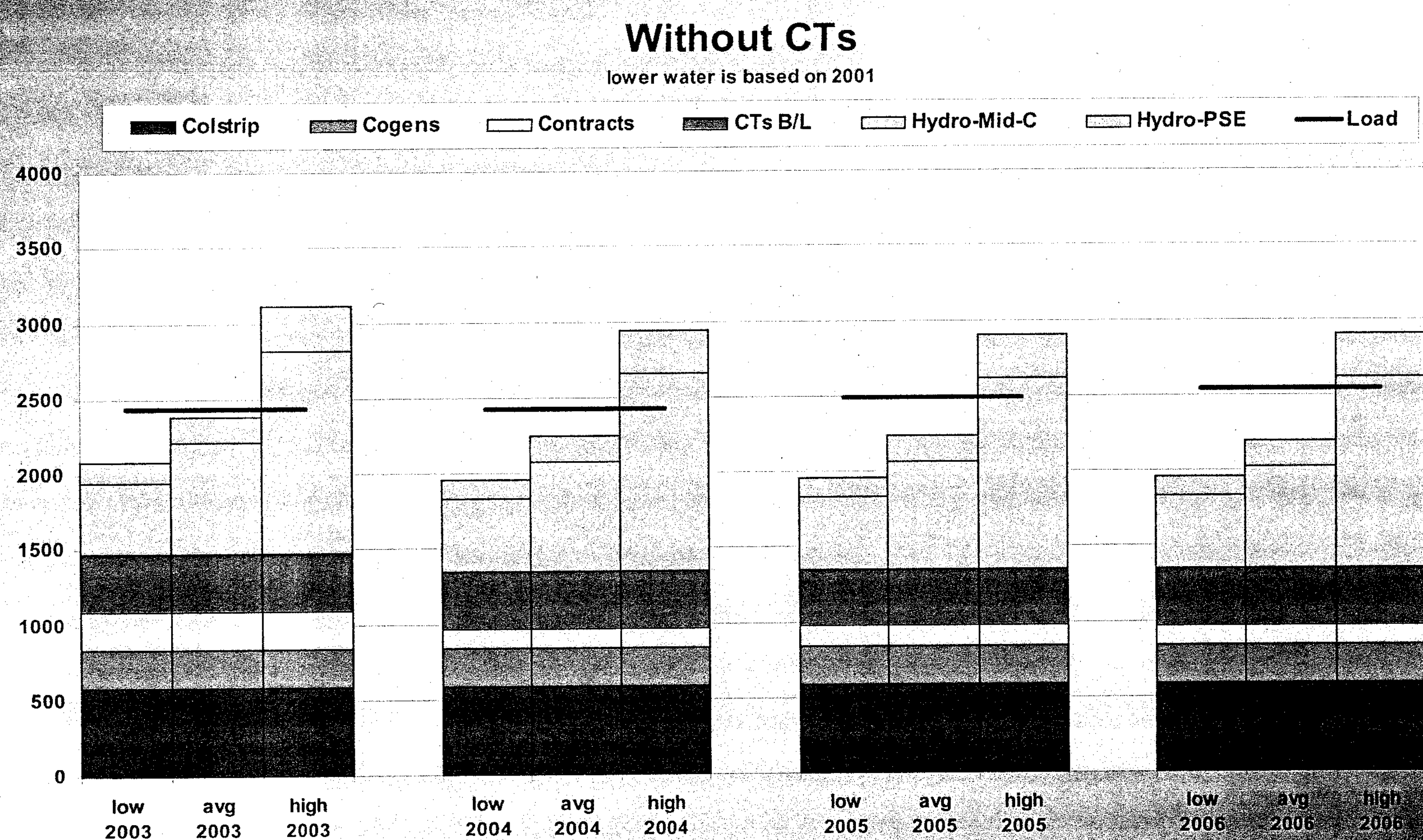


# Load/Resource Balance - On Peak/Off Peak 2001-2010

## With CTs - average water



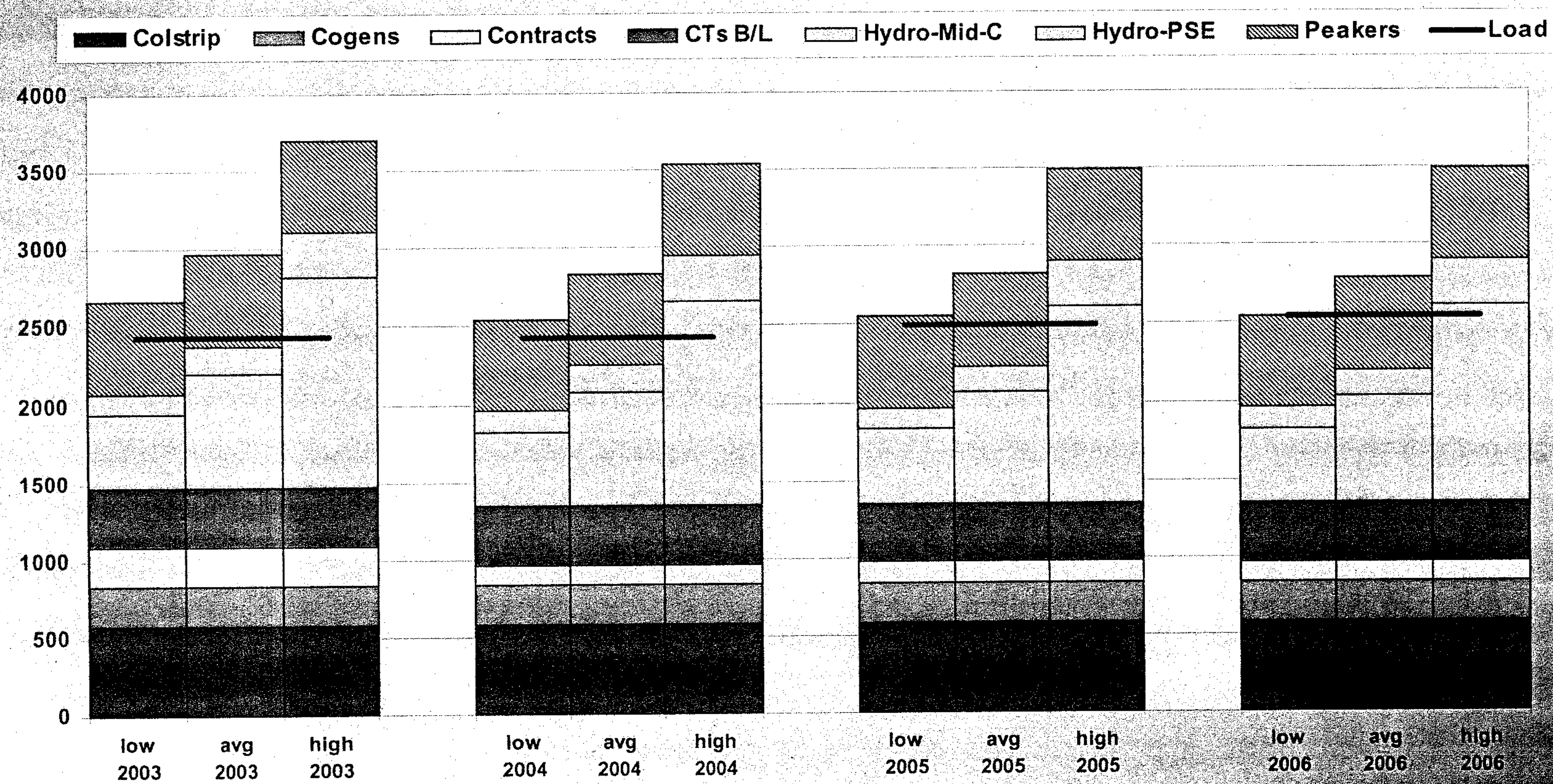
# Load/Resource Balance - Water Sensitivity 2003-2006



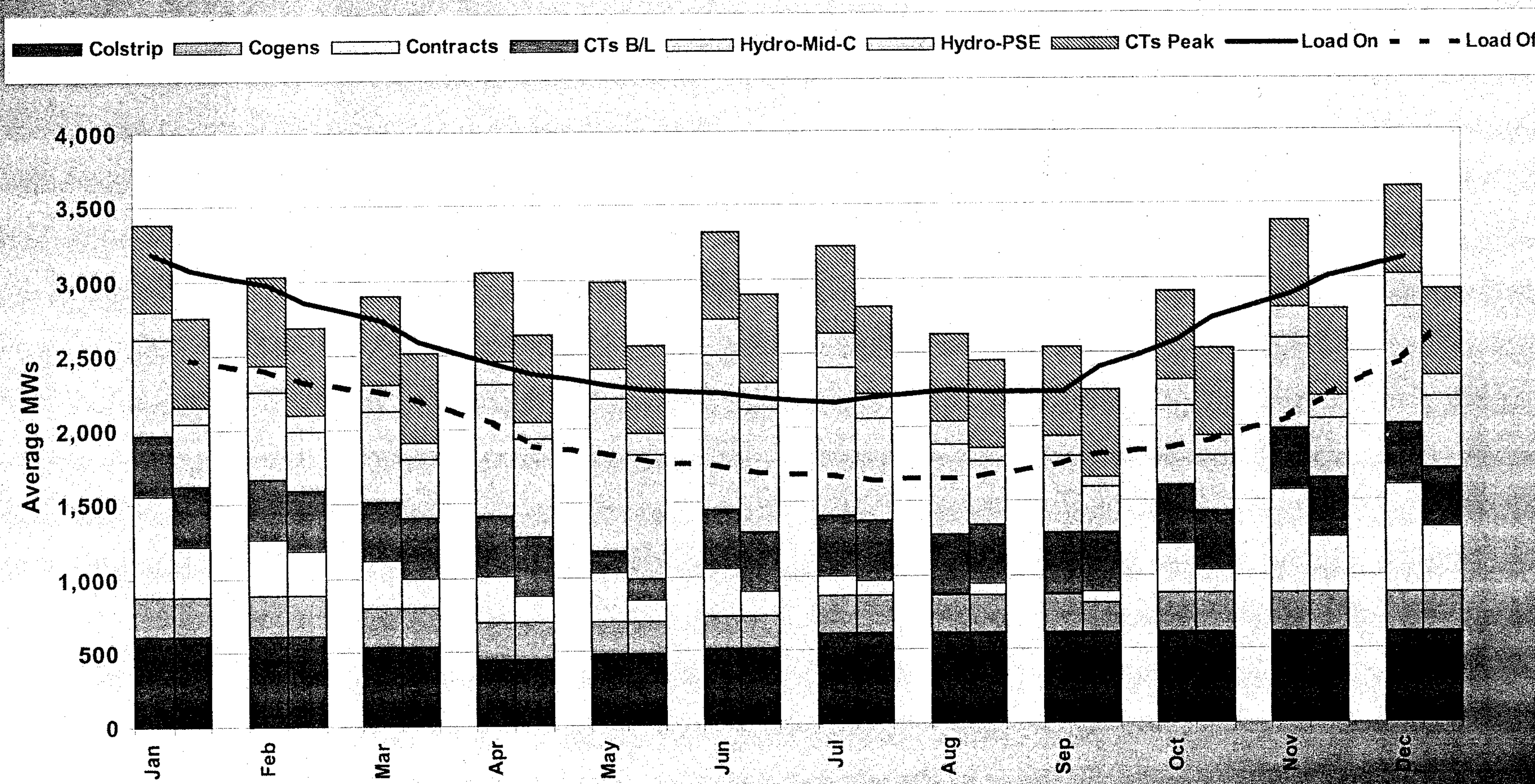
# Load/Resource Balance - Water Sensitivity 2003-2006

## With CTs

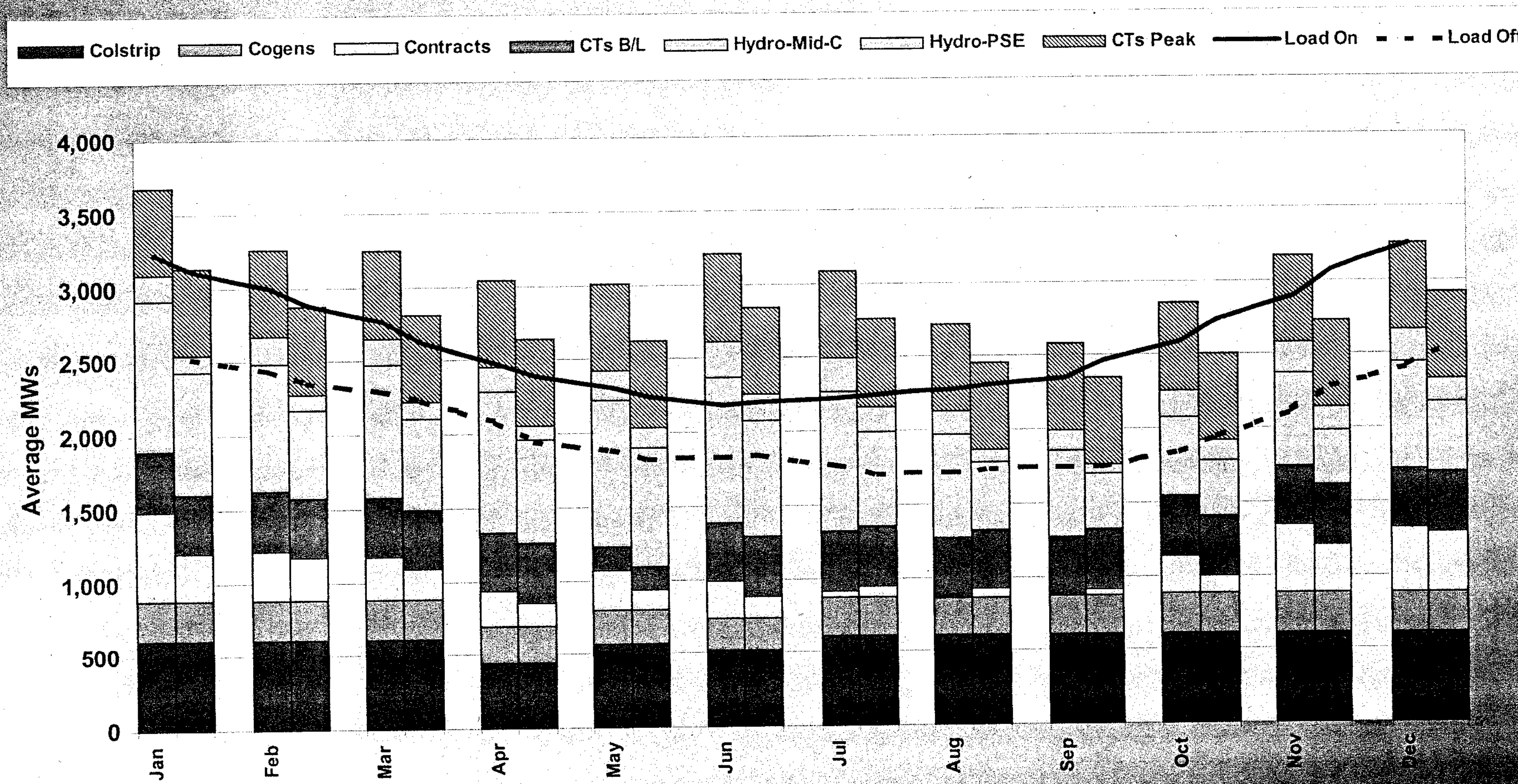
lower water is based on 2001

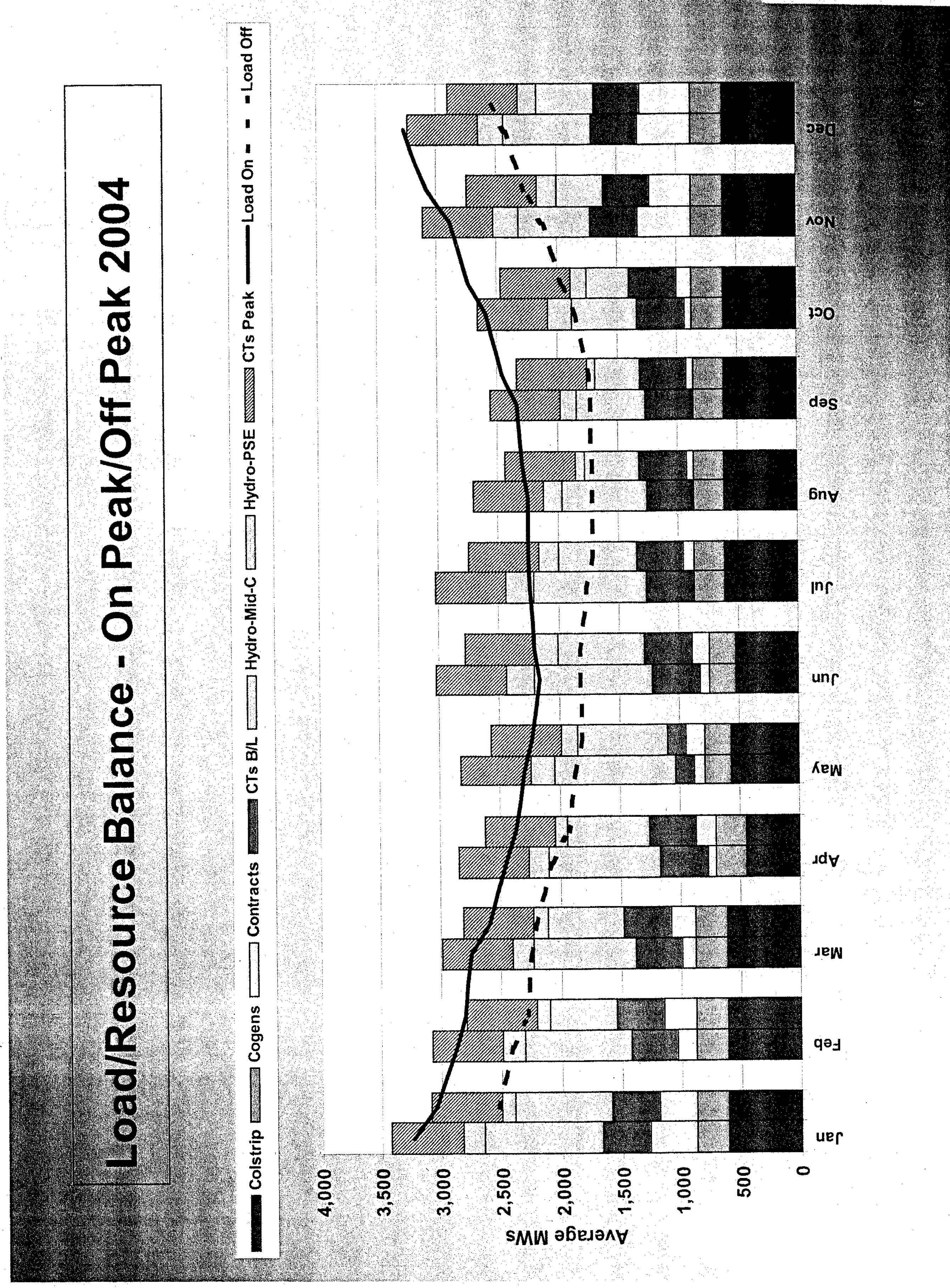


# Load/Resource Balance - On Peak/Off Peak 2002

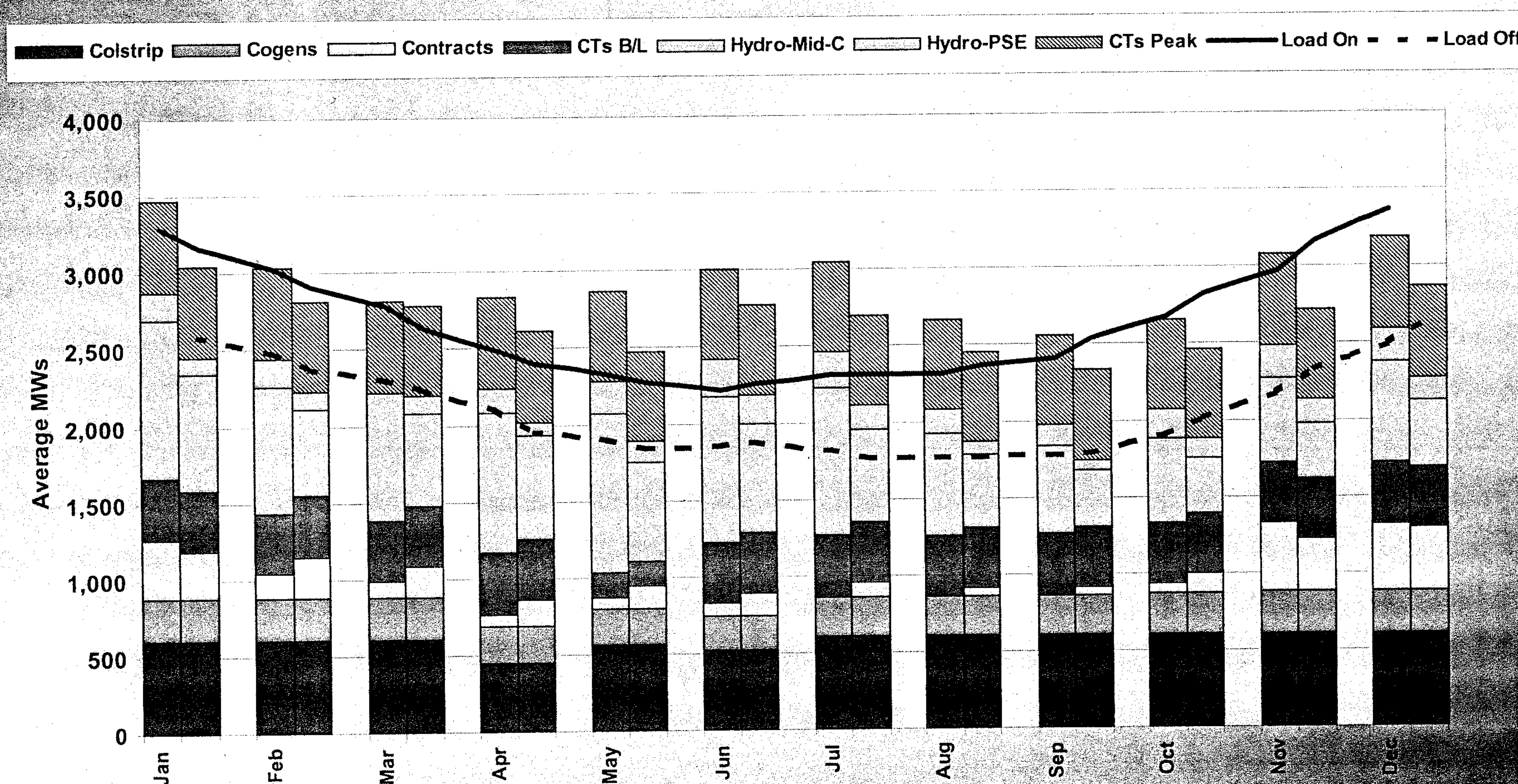


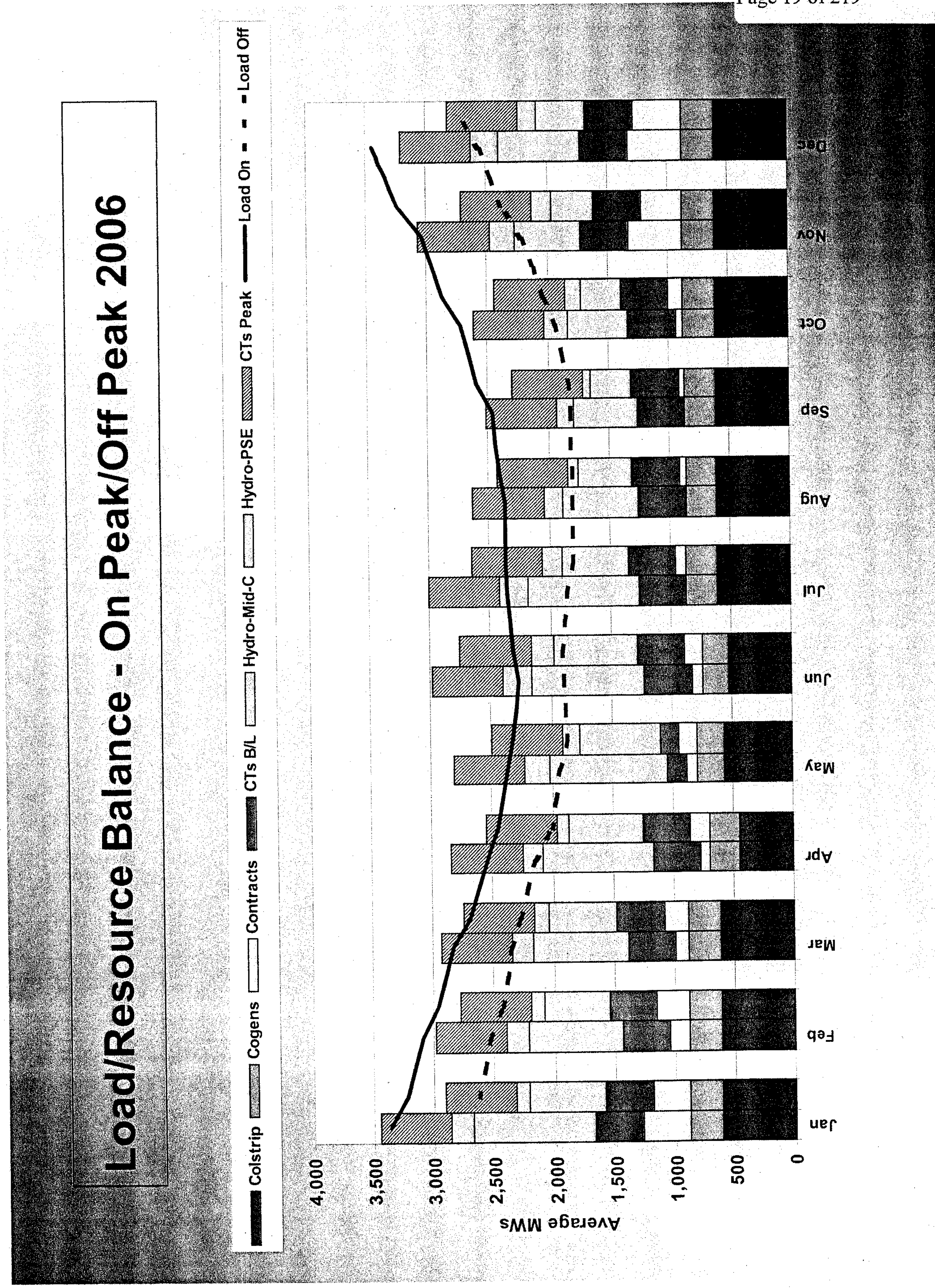
# Load/Resource Balance - On Peak/Off Peak 2003




Load/Resource Balance - On Peak/Off Peak 2004
Colstrip
Cogens
Contracts
CTs B/L
Hydro-Mid-C
Hydro-PSE
CTs Peak
Load On
Load Off
Average MWs
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

# Load/Resource Balance - On Peak/Off Peak 2005




Load/Resource Balance - On Peak/Off Peak 2006
Colstrip
Cogens
Contracts
CTs B/L
Hydro-Mid-C
Hydro-PSE
CTs Peak
Load On
Load Off
Average MWs
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Jan
Feb
Mar
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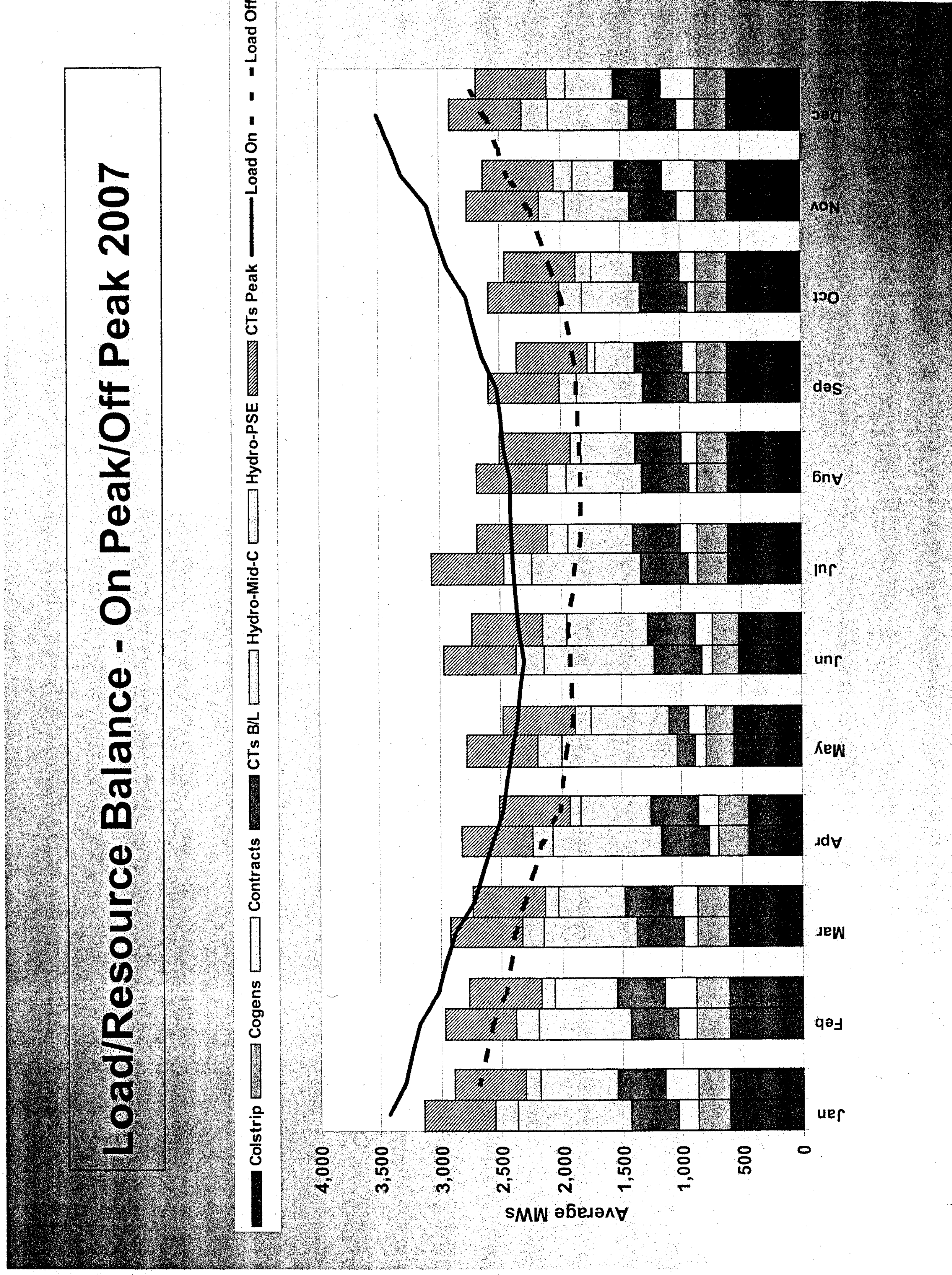
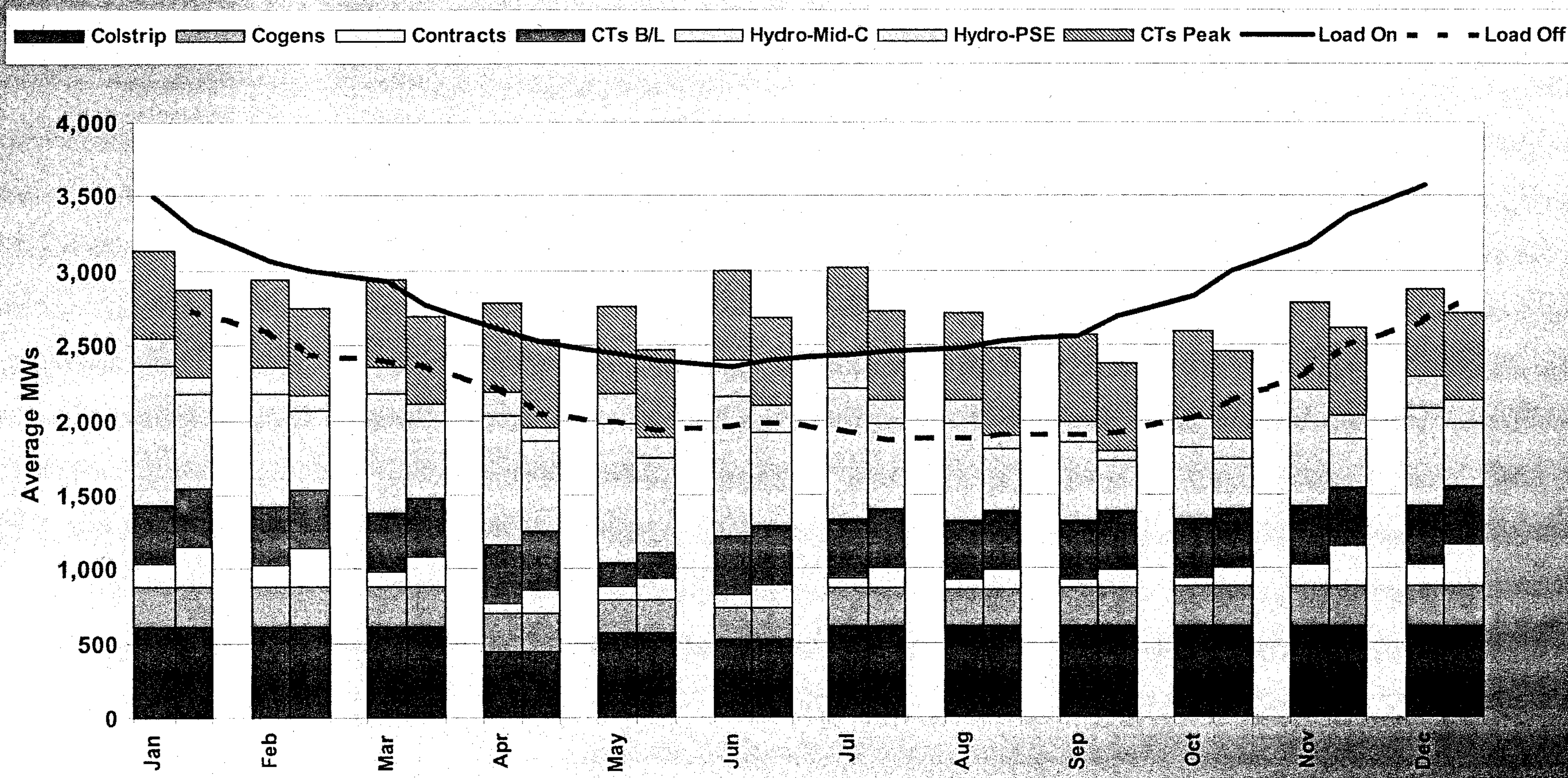
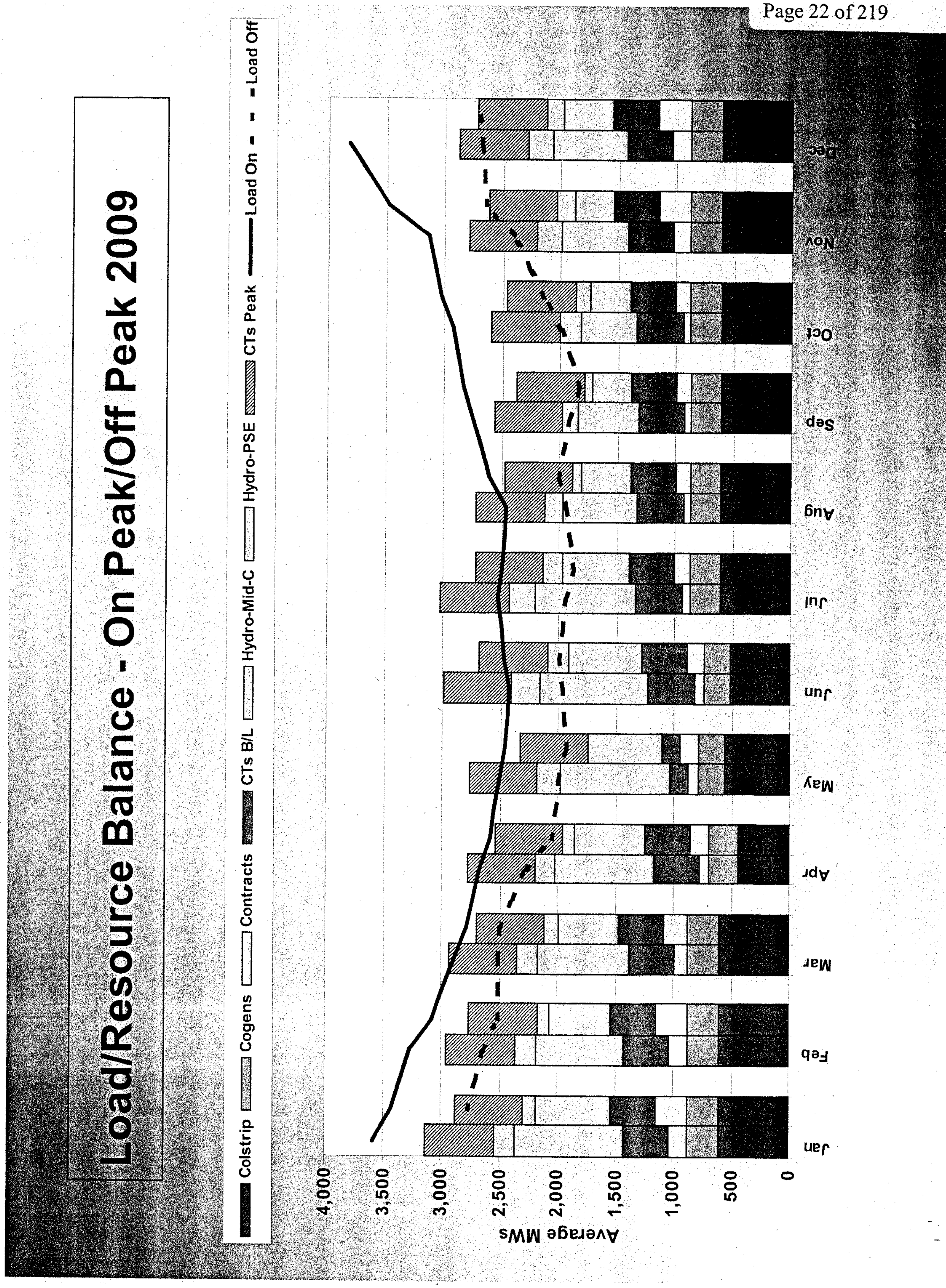
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Load/Resource Balance - On Peak/Off Peak 2007
Colstrip
Cogens
Contracts
CTs B/L
Hydro-Mid-C
Hydro-PSE
CTs Peak
Load On
Load Off
Average MWs
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

# Load/Resource Balance - On Peak/Off Peak 2008




Load/Resource Balance - On Peak/Off Peak 2009
Colstrip
Cogens
Contracts
CTs B/L
Hydro-Mid-C
Hydro-PSE
CTs Peak
Load On
Load Off
Average MWs
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Jan
Feb
Mar
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Jun
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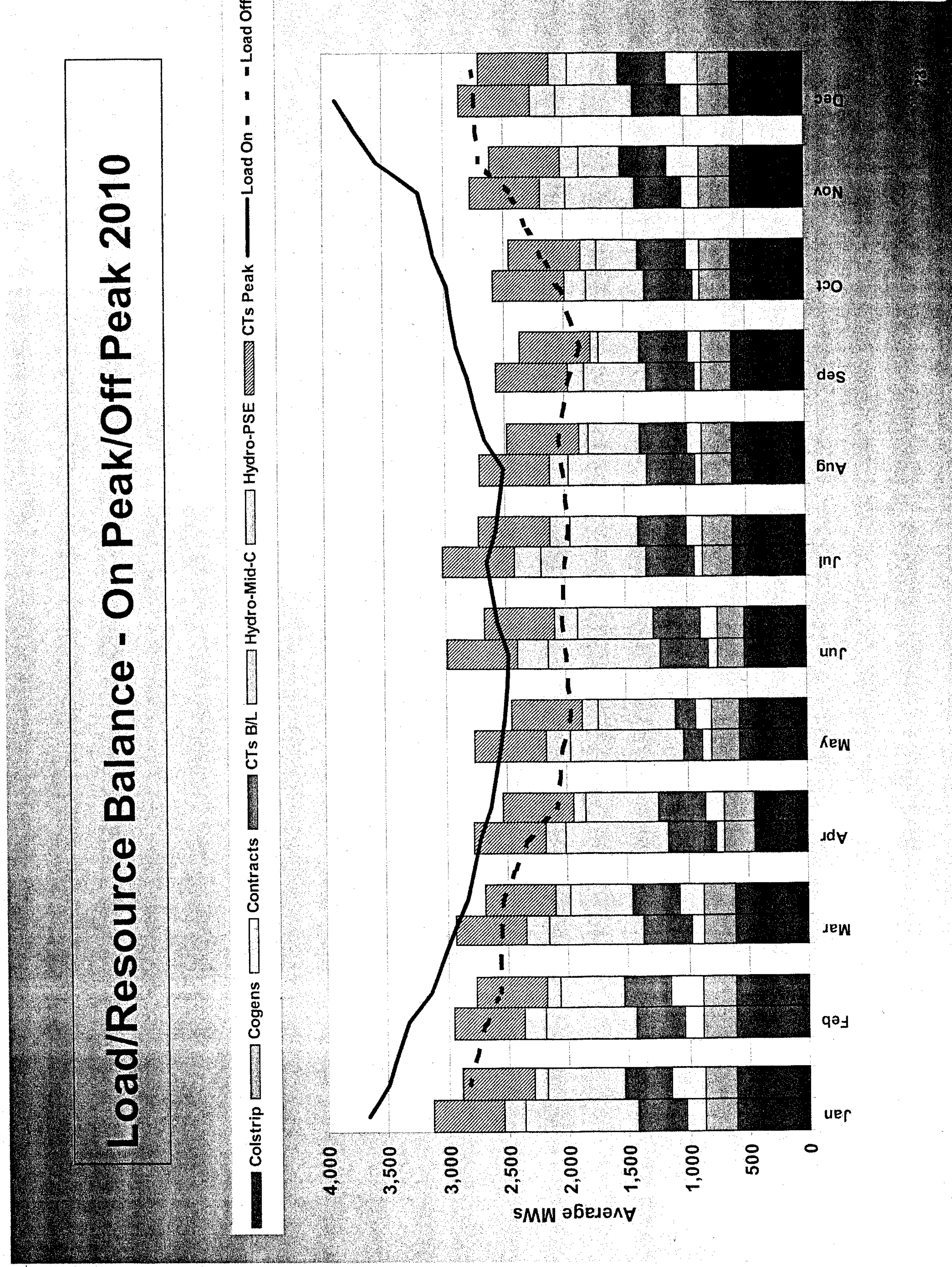
Sep
Oct
Nov
Dec


Load/Resource Balance - On Peak/Off Peak 2010
Colstrip
Cogens
Contracts
CTs B/L
Hydro-Mid-C
Hydro-PSE
CTs Peak
Load On
Load Off
Average MWs
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Jan
Feb
Mar
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May
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Jul
Aug
Sep
Oct
Nov
Dec

# Transmission - Summary

Development/Purchase of new resources must include analysis of transmission issues due to current system constraints and unknown congestion management design of RTO-West.

- Delivery constrained from North (Whatcom/Skagit) due to PSE and BPA systems.
- Delivery from East constrained due to West of Hatwai cutplane.
- Delivery from South (Oregon) constrained subject to Northern Cascade flows/constraints.

# Transmission - System Constraints

- **PSE Constraints**
  - Whatcom and Skagit Counties
- **BPA Constraints Affecting PSE**
  - West of Hatwai
  - Northwest to Canada (BPA Treaty Obligation)
  - Canada to Northwest
  - Cross Cascades North
  - California Oregon Interconnect (COI)

# PSE System Constraints

- **Whatcom and Skagit Constraints**
  - Issue: Generation greater than load. PSE has a limited amount of transfer capacity between Whatcom, Skagit and King Counties. PSE has a right to transmit between 625 MW and 700 MW from the north into King County via PSE's ownership of 230kV and 115kV transmission lines and contracts with BPA.
  - Magnitude: There is no more transmission capacity available to bring additional generation out of Whatcom and Skagit Counties.
  - Cost: The cost to integrate a 700 MW resource into PSE's system has been determined to be between $50 and $80 million. That cost may be mitigated by work BPA is contemplating.

# BPA Constraints Affecting PSE

- **West of Hatwai**
  - Issue: Inability to transmit Colstrip to PSE system
  - Magnitude: 150 MW to 200 MW max
  - Cost: Approximately $1,000,000 per week of curtailment at 175 MW and $35/MWh.
- **Northwest to Canada (BPA Treaty Obligation)**
  - Issue: May require the operation of PSE generation in Whatcom and Skagit Counties at PSE expense to fix a BPA problem.
  - Magnitude: 280 MW max over the next few years, increasing to 420 MW max when all Canadian Entitlement must be returned.
  - Cost: Approximately $25,000 per day of forced out of market operation of the CTs.

# BPA Constraints Affecting PSE (cont.)

- **Canada to Northwest**
  - Issue: Inability to import energy from Canada. This is an issue for our balancing purchases not a limitation on PSE's firm power supplies or PSE's ability to meet load.
- **Cross Cascades North**
  - Issue: Inability to transmit all Mid-Columbia and Colstrip into the Puget Sound area. However, currently there is transfer capability in excess of firm commitments, so there is not an issue with imports. BPA has received requests for transfers over the path that, when added to the existing firm commitments, exceed the transfer capability.

# BPA Constraints Affecting PSE (cont.)

- **California Oregon Interconnect (COI)**
  - Issue: Limits ability to transfer energy to or from PG&E. Deliveries from PG&E affect PSE's ability to meet its Puget Sound area loads.
  - Magnitude: Up to 150 MW on any hour
  - Cost: Less than $200,000 annually because of the contractual flexibility to have energy delivered on any hour. The $200,000 is based on the difference between HLH and LLH prices.

# Generation Opportunities

- **PSE Alternatives**
  - BP Amoco - Whitehorn
  - Frederickson Power - Enhanced Cogeneration
  - PSE Development of Frederickson site
  - PSE Development of Jackson Prairie site
- **Large Merchant Plants**
  - BP Amoco
  - Calpine Corporation
  - Duke Energy of North America
  - Engage Energy
  - Mirant Corporation
  - Reliant Energy
  - Westward Power Project
- **Renewable Resources**
  - Zilkha -- wind
  - King County -- methane/landfill
  - Farmatic -- methane

# PSE Alternatives

- **BP Amoco/PSE Participation**
  - Whitehorn - upgrade from 150 MW to 200 MW.
- **Frederickson Power Enhanced Cogeneration**
  - Waste heat from PSE's existing combustion turbines can be utilized to generate steam, which can then be sold to the Frederickson Power facility. By displacing natural gas, this steam would be used to generate incremental electricity for shared economic benefit.
- **Development of Frederickson site**
- **Development of Jackson Prairie**

# Large Merchant Plants

- **Calpine Corporation**
  - Gas fired plant in Turner, OR
    - Heat Rate: 7,000 Btu/kWh
    - Output: 620 MW
    - COD: Q2, 2004
  - Gas fired plant in Hermiston, OR
    - Heat Rate: 6,900 Btu/kWh
    - Output: 630 MW
    - COD: Q2, 2002
  - Gas fired plant in Goldendale, WA
    - Heat Rate: 7,100 Btu/kWh
    - Output: 248 MW
    - COD: Q3, 2002

# Large Merchant Plants (cont.)

- **Duke Energy of North America**
  - Satsop
    - POD: 600 MW plant in Grays Harbor County, WA
    - Heat Rate: 7,160 Btu/kWh
    - Output: 600 MW
    - COD: Q3, 2003

# Large Merchant Plants (cont.)

- **Engage Energy**
  - Frederickson Power 1:
    - POD: BPA 230 kV system, S. Tacoma main grid
    - Heat Rate: 7,100 Btu/kWh (guaranteed)
    - Output: 249 MW (base; 270 MW w/duct firing and steam augmentation
    - COD: 7-1-2002 (estimated)
  - Frederickson Power 2:
    - POD: BPA 230 kV system, S. Tacoma main grid
    - Heat Rate: 7,100 Btu/kWh (average)
    - Output: 250 MW (base); 290 MW w/duct firing and steam augmentation
    - COD: Q3/Q4, 2003 (estimated)

# Large Merchant Plants (cont.)

- **Mirant**
  - Gas fired plant in Longview, WA
    - Heat Rate: 6,800 Btu/kWh
    - Output: 290 MW
    - COD: Q3, 2003
  - Gas fired plant in Boardman, WA (Coyote Springs II)
    - Heat Rate: 6,800 Btu/kWh
    - Output: 270 MW
    - COD: Q3, 2002

# Large Merchant Plants (cont.)

- **Reliant Energy**
  - Proposed gas-fired power plant in north central Oregon.
    - POD: BPA, close to three 500 kV lines, near Grizzley
    - Heat Rate: 7,100 Btu/kWh (average)
    - Output: 500 MW
    - COD: Q1, 2005 (estimated)
- **Westward Power Project**
  - Proposed gas-fired power plant in Clatskanie, OR.
    - POD: BPA system near Clatskanie
    - Heat Rate: 6,693 Btu/kWh
    - Output: 520 MW
    - COD: Q2, 2004

# Renewable Resources

- **Zilkha**
  - Wind
- **King County**
  - Methane Gas
    - Cedar Hills Landfill in Maple Valley, WA. Private company to build a plant. The County accepted proposals in January, 2002.
    - POD: PSE or BPA
    - Output: 22-26 MW
    - COD: Q1, 2004

# Renewable Resources (cont.)

- **Various**
  - Methane Gas (Farmatic)
    - POD: Whatcom/Skagit Counties
    - Output: 400 kW

# Appendix

# APPENDIX

## Customer Sales Forecast

## Resources Summaries

### Resources

### Contract Abstracts

## Selected Transmission Studies

### Frederickson – 270 MW

### Frederickson – 50/100/150 MW

### Frederickson – 25 MW

### Fredonia – 110 MW

### March Point – 50 MW

### Sumas II – 720 MW

Customer Sales Forecast

# PUGET SOUND ENERGY
# CUSTOMER AND SALES FORECASTS
# (F2001)
# 2002-2009

## SALES FORECAST SUMMARY

Electric

- Electric sales from fixed rate schedules is expected to slightly decline by -0.4% in 2002 (-82 GWHs) including ISPs (-0.6% or -108 GWHs without ISPs), while customers are expected to increase by 1.5% or 14,341 customers over 2000.

- In F2000, sales was projected to increase by 5.9% (1,313 GWHs, including ISPs), while customers was expected to increase by 12,416 over 2001.

- 8 year forecast is 1.9% average annual sales growth with ISPs (1.7% without ISPs) versus 2.6% in F2000.

Gas

- Gas sales is expected to increase by 1.5% (14,781 Mtherms) in 2002 and customers are expected to rise by 18,410 (including sales and marketing goals) over 2001.

- F2000 sales forecast for 2002 was 0.5% growth (5,253 Mtherms) and customer addition of 19,243 over 2001.

- 8 year forecast of growth is 2.5% average annual versus 1.1% in F2000.

## KEY DRIVERS TO THE FORECAST

- F2001 is different from F2000 forecast due to the removal of schedule 48 (except for 3 small customers), special contract and Seatac from the projected loads, following the settlement agreement. A separate forecast for retail wheeling customers (schedule 449: all Boeing, Air Liquides, Air Products, Intel, Seatac and other small customers) is developed however.

- Forecast of further slowing in Puget Sound population and employment slightly declining in 2002 but slightly increasing in 2003. Adjustments were made for the negative impacts of the terrorist attacks on the national economy and the Boeing layoff on the Puget Sound regional economy.

- Projection of retail electric rates increasing in the near term and gas prices declining in real terms; for electric, rates were adjusted for the BPA credit on the residential and projected rate increases due to the emergency rate relief (18%) and a general rate case after that (22.5%); for gas, rates are projected to decline given the PGA adjustment plus a forecast of declining spot gas prices, even after increasing the margin by 5.1% after the general rate case.

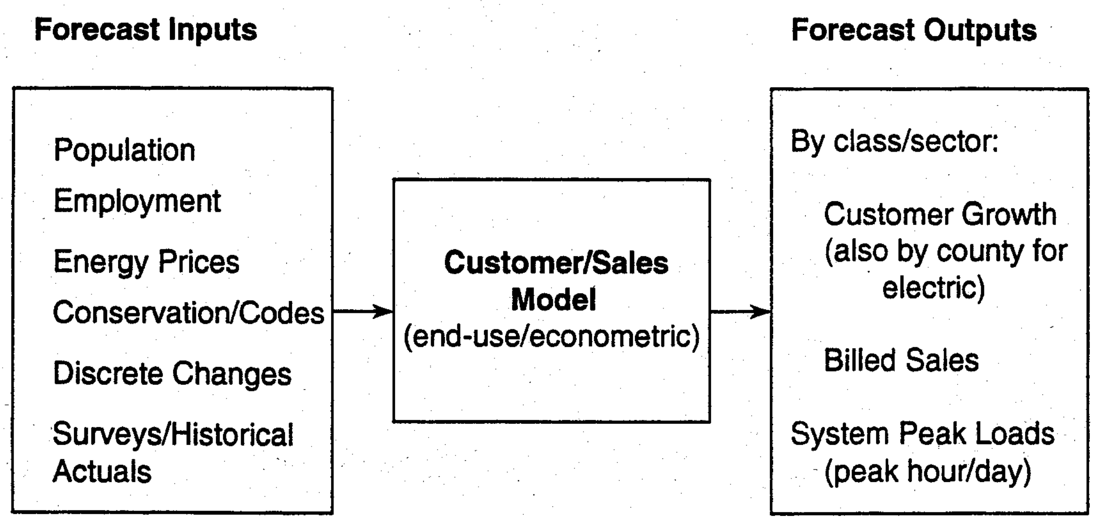
- Downward adjustment in the forecast of ISP loads (for 2002, F2001 forecast of ISP load is 51 GWHs versus 1,418 GWHs for F2000 and 184 GWHs in F2000R).

- Inclusion of the estimated effects of PEM/Conservation on the electric forecast. Based on GPI analysis, PEM/Conservation effects start at about 3% reduction in January 2001 and declining to zero by June 2003 spread over residential and commercial classes using monthly sales are relative weights. Time of use rates are assumed to affect load shifting only.

- Reductions in loads due to savings from conservation programs adjusted for average measure life and price overlap effects. New savings for 2001 is assumed to be 8.1 aMW and 5.5 aMW annually for 2002 and beyond.

- Additions to gas customers due to marketing programs. Marketing goal for 2002 is to add 2,050 customers over forecasted customer additions.

## FORECAST MODEL OVERVIEW




- F2000 models utilized combination of end-use and econometric models using quarterly or annual data at the 2 digit SIC level.

- F2001 models used econometric approach using monthly revenue class data. The basic structure of the equations are:

  Use per Customer = f(Weather, Prices, Economic/Demographic Variables)

  Customer Counts = f(Prices, Economic/Demographic Variables)

  Where prices or economic/demographic variables could enter as polynomial distributed lag variables

Estimated Price Elasticities:
Electric: Residential = -.18; Commercial = -.33; Industrial = -.46
Gas Core Sales: Residential = -.21; Commercial = -.26; Industrial = -.27

Other Model Revisions: Updated for new normal weather variables using the last 30 years up through first quarter of 2001 (F2000-4851, F2001-4847, HDD65); Streamlined the model runs and processing of model outputs.

# POPULATION AND EMPLOYMENT PROJECTIONS

### Comparison of Population and Employment Forecasts, F2000 vs. F2001(Revised)

| | Electric Service Area | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Population | | | | Employment | | | |
| | Forecasts(000) | | Growth Rates | | Forecasts(000) | | Growth Rates | |
| Year | F00 | F01 | F00 | F01 | F00 | F01 | F00 | F01 |
| 2000 | 3239.2 | 3229.6 | 1.28% | 1.01% | 1720.7 | 1740.2 | 2.3% | 3.3% |
| 2001 | 3280.2 | 3269.4 | 1.27% | 1.23% | 1753.5 | 1767.6 | 1.9% | 1.6% |
| 2002 | 3320.3 | 3279.1 | 1.22% | 0.29% | 1787.9 | 1762.0 | 2.0% | -0.3% |
| 2003 | 3359.2 | 3322.2 | 1.17% | 1.31% | 1818.5 | 1780.2 | 1.7% | 1.0% |
| 2004 | 3400.7 | 3365.4 | 1.24% | 1.30% | 1855.3 | 1818.4 | 2.0% | 2.1% |
| 2005 | 3446.2 | 3407.2 | 1.34% | 1.24% | 1894.4 | 1854.4 | 2.1% | 2.0% |
| 2006 | 3494.2 | 3449.6 | 1.39% | 1.24% | 1932.5 | 1889.6 | 2.0% | 1.9% |
| 2007 | 3542.5 | 3493.0 | 1.38% | 1.26% | 1969.9 | 1921.9 | 1.9% | 1.7% |
| 2008 | 3590.1 | 3535.3 | 1.35% | 1.21% | 2005.4 | 1949.1 | 1.8% | 1.4% |
| 2009 | 3637.0 | 3576.5 | 1.31% | 1.17% | 2036.8 | 1985.1 | 1.6% | 1.8% |

| | Gas Service Area | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Population | | | | Employment | | | |
| | Forecasts(000) | | Growth Rates | | Forecasts(000) | | Growth Rates | |
| Year | F00 | F01 | F00 | F01 | F00 | F01 | F00 | F01 |
| 2000 | 3210.9 | 3208.3 | 1.27% | 1.28% | 1725.9 | 1734.5 | 2.0% | 2.3% |
| 2001 | 3251.0 | 3248.9 | 1.25% | 1.26% | 1758.6 | 1763.3 | 1.9% | 1.7% |
| 2002 | 3290.0 | 3259.4 | 1.20% | 0.32% | 1793.6 | 1757.2 | 2.0% | -0.3% |
| 2003 | 3327.9 | 3303.2 | 1.15% | 1.34% | 1825.9 | 1775.4 | 1.8% | 1.0% |
| 2004 | 3368.3 | 3347.2 | 1.22% | 1.33% | 1865.0 | 1813.4 | 2.1% | 2.1% |
| 2005 | 3412.8 | 3389.8 | 1.32% | 1.27% | 1907.5 | 1850.8 | 2.3% | 2.1% |
| 2006 | 3459.6 | 3433.0 | 1.37% | 1.27% | 1948.3 | 1887.3 | 2.1% | 2.0% |
| 2007 | 3506.7 | 3477.3 | 1.36% | 1.29% | 1987.1 | 1920.5 | 2.0% | 1.8% |
| 2008 | 3553.2 | 3520.4 | 1.33% | 1.24% | 2023.4 | 1948.1 | 1.8% | 1.4% |
| 2009 | 3598.9 | 3562.6 | 1.29% | 1.20% | 2054.9 | 1984.5 | 1.6% | 1.9% |

- Macroeconomic forecasts are based on DRI-WEFA's First Quarter 2001 Long Term Projections which before the terrorist attacks, assumed no recession but a slower GDP growth in 2001 (1.8%) and a faster growth in 2002 (3.1%).
- Also before the terrorist attacks and despite of the February earthquake, the Boeing shuffle, energy price spikes, dot com meltdown, and the burst in stock market bubble, the Puget Sound regional economy was expected to grow 1.7% in employment in 2002 with the help of steady Boeing and Microsoft employment and assuming that the national economy avoids recession.
- With the terrorist attacks, recession is now projected for the national economy, with the US economy declining in the last two quarters of 2001 and recovering immediately after that. Boeing has also recently announced layoffs of about 30,000 jobs given the decline in air travel. Given these, service area employment is now expected to decline by .3% in 2002 but increases by 1.0% in 2003. The implication is that the full effects of Boeing's layoff will be spread over two years. Population is expected to be close to flat and income growth will be zero.

# RETAIL ELECTRIC AND GAS PRICES

Comparison of Forecasts of Retail Rates (nominal)

| Electric Rates, cents/kwh | | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | aarg |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Residential | F2000 | 6.35 | 6.35 | 6.43 | 6.50 | 6.59 | 6.69 | 6.81 | 6.94 | 7.08 | 1.4% |
| | F2001 | 6.47 | 7.09 | 7.07 | 7.07 | 7.07 | 7.07 | 7.07 | 7.07 | 7.07 | 1.1% |
| Commercial | F2000 | 6.49 | 6.48 | 6.54 | 6.60 | 6.69 | 6.80 | 6.92 | 7.05 | 7.19 | 1.3% |
| | F2001 | 6.62 | 7.63 | 7.88 | 7.88 | 7.88 | 7.88 | 7.88 | 7.88 | 7.88 | 2.2% |
| Industrial* | F2000 | 7.27 | 6.35 | 5.94 | 5.53 | 5.60 | 5.69 | 5.79 | 5.90 | 6.02 | -2.3% |
| | F2001 | 6.09 | 7.03 | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 | 2.2% |

aarg - aver annual rate of growth * Industrial includes Sch 48 in F2000, but not in F2001

| Gas Rates,$/therm | | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | aarg |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Residential | F2000 | 0.97 | 0.95 | 0.96 | 0.99 | 1.00 | 1.01 | 1.03 | 1.05 | 1.07 | 1.3% |
| | F2001 | 0.96 | 0.92 | 0.84 | 0.83 | 0.83 | 0.83 | 0.83 | 0.85 | 0.86 | -1.3% |
| Commercial | F2000 | 0.91 | 0.89 | 0.89 | 0.93 | 0.94 | 0.94 | 0.96 | 0.98 | 1.00 | 1.2% |
| | F2001 | 0.89 | 0.86 | 0.77 | 0.75 | 0.76 | 0.75 | 0.75 | 0.77 | 0.78 | -1.7% |
| Industrial | F2000 | 0.86 | 0.82 | 0.82 | 0.87 | 0.87 | 0.88 | 0.90 | 0.91 | 0.94 | 1.1% |
| | F2001 | 0.68 | 0.67 | 0.59 | 0.58 | 0.58 | 0.58 | 0.58 | 0.59 | 0.60 | -1.5% |

- Retail electric rates are expected to rise due to the emergency rate relief (18% over current rates from Nov. 2001 to October 2002) and then due to the general rate case (22.5% over current rates starting November 2002), even after the residential BPA credit. They are assumed to be flat beyond 2003.

- Gas retail rates account for the most recent PGA filing reducing rates by 11%, then following DRI-WEFA's projection of retail rates for 2003 and beyond. The decline is mitigated by the expected rate increase (5.1%) due to the general rate case effective November 2002. DRI-WEFA expects gas retail rates to decline in the next 2-3 years. In F2000, gas retail rates were expected to increase over time.

# HISTORICAL GROWTH AND SHARES

| Electric Sales and Customers | | | | |
|---|---|---|---|---|
| | 5 Yr Avg Growth | | 2000 Shares | |
| Class | Sales | Customer | Sales | Customer |
| Residential | 0.9% | 1.9% | 45% | 88.6% |
| Commercial | 2.9% | 2.5% | 36% | 10.8% |
| Industrial | 1.1% | 1.0% | 18% | 0.4% |
| St Lights/Resale | 1.5% | 2.8% | 1% | 0.2% |
| Total | 1.6% | 1.9% | 100% | 100.0% |

| Gas Sales and Customers | | | | |
|---|---|---|---|---|
| | 5 Yr Avg Growth | | 1999 Shares | |
| Class | Sales | Customer | Sales | Customer |
| Residential | 2.3% | 4.4% | 46% | 91.68% |
| Commercial | 1.9% | 2.9% | 19% | 7.68% |
| Industrial | 3.2% | 0.6% | 4% | 0.48% |
| Total Core | 2.3% | 4.3% | 69% | 99.84% |
| Interruptibles | -1.0% | -1.8% | 11% | 0.14% |
| Transportation | 6.1% | 3.7% | 20% | 0.02% |
| Total NonCore | 0.0% | -1.3% | 31% | 0.16% |
| Total | 1.5% | 4.3% | 100% | 100.00% |

The tables above show a summary of the five year (1976-2000) average growth rate by class and load shares in 2000.

- Electric sales have grown an average of 1.6% per year in the last five years with growth coming mostly from non-residential sector.

- Residential electric customers account for 45% of sales and about 90% of total number of customers.

- Gas sales have grown about 1.5% per year in the last five years with growth accounted for mostly by core sales sector.

- Again, residential gas customers account for 46% of sales and 92% of total customers. Non-core customers (interruptibles and transports) account for 30% of gas sales but less .2% of total customers.

# ELECTRIC CUSTOMER AND SALES FORECASTS

## F2001 Electric Forecasts

Forecast of Customers (year end)

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | aarg* |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total - Fixed Sched** | 939,665 | 954,006 | 968,890 | 985,752 | 1,003,497 | 1,020,970 | 1,038,659 | 1,056,682 | 1,074,403 | 1.7% |
| Additions | 16,055 | 14,341 | 14,883 | 16,863 | 17,745 | 17,473 | 17,689 | 18,023 | 17,721 | |
| % Change | 1.7% | 1.5% | 1.6% | 1.7% | 1.8% | 1.7% | 1.7% | 1.7% | 1.7% | |
| **Residential** | 831,400 | 843,904 | 856,155 | 870,422 | 885,634 | 900,572 | 915,738 | 931,250 | 946,464 | 1.6% |
| **Commercial** | 102,408 | 104,206 | 106,744 | 109,182 | 111,583 | 113,984 | 116,371 | 118,741 | 121,087 | 2.1% |
| **Industrial** | 4,038 | 4,003 | 4,012 | 4,077 | 4,105 | 4,122 | 4,129 | 4,124 | 4,120 | 0.3% |
| **Street Lights** | 1,810 | 1,886 | 1,970 | 2,063 | 2,167 | 2,283 | 2,414 | 2,560 | 2,725 | 5.3% |
| **Resale** | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 0.0% |
| **Retail Whlng Svcs**** | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 0.0% |

*aver annual rate of growth from 2002 to 2009 ** Not icluded in Total Fixed Sched

Forecast of Billed Sales with ISPs (GWHs)

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | aarg* |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total - Fixed Sched** | 19,117 | 19,035 | 19,309 | 19,636 | 20,173 | 20,591 | 20,980 | 21,377 | 21,800 | 1.7% |
| % Change | 0.4% | -0.4% | 1.4% | 1.7% | 2.7% | 2.1% | 1.9% | 1.9% | 2.0% | |
| **Residential** | 9,476 | 9,593 | 9,748 | 9,846 | 10,015 | 10,179 | 10,342 | 10,510 | 10,681 | 1.5% |
| **Commercial** | 8,010 | 8,018 | 8,170 | 8,346 | 8,545 | 8,760 | 8,974 | 9,190 | 9,430 | 2.1% |
| **Industrial** | 1,434 | 1,276 | 1,204 | 1,209 | 1,231 | 1,241 | 1,249 | 1,256 | 1,264 | -1.5% |
| **Street Lights** | 85 | 88 | 93 | 96 | 100 | 104 | 108 | 113 | 118 | 4.2% |
| **Resale** | 87 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | -9.7% |
| **ISPs** | 25 | 51 | 84 | 129 | 273 | 297 | 297 | 297 | 297 | 42.5% |
| **Retail Whlng Svcs**** | 376 | 1,034 | 1,047 | 1,072 | 1,096 | 1,115 | 1,120 | 1,119 | 1,110 | 22.8% |

*aver annual rate of growth from 2002 to 2009 ** Not icluded in Total Fixed Sched

**F2001 and F2000 Comparisons**

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | aarg* |
|---|---|---|---|---|---|---|---|---|---|---|
| **Customer Additions** | (year end) | | | | | | | | | |
| **F2000** | 14,912 | 12,416 | 12,416 | 12,775 | 13,134 | 13,328 | 13,620 | 13,714 | 13,368 | |
| % Change | 1.6% | 1.3% | 1.3% | 1.3% | 1.3% | 1.3% | 1.4% | 1.3% | 1.3% | 1.3% |
| **F2001** | 16,055 | 14,341 | 14,883 | 16,863 | 17,745 | 17,473 | 17,689 | 18,023 | 17,721 | |
| % Change | 1.7% | 1.5% | 1.6% | 1.7% | 1.8% | 1.7% | 1.7% | 1.7% | 1.7% | 1.7% |
| **Sales in GWHs** | | | | | | | | | | |
| **F2000 with ISP** | 22,238 | 23,551 | 24,470 | 24,918 | 25,388 | 25,866 | 26,329 | 26,855 | 27,371 | |
| % Change | 3.4% | 5.9% | 3.9% | 1.8% | 1.9% | 1.9% | 1.8% | 2.0% | 1.9% | 2.6% |
| **F2000 no ISP** | 21,759 | 22,133 | 22,574 | 23,021 | 23,492 | 23,969 | 24,432 | 24,959 | 25,474 | |
| % Change | 1.4% | 1.7% | 2.0% | 2.0% | 2.0% | 2.0% | 1.9% | 2.2% | 2.1% | 2.0% |
| **F2000R with ISP** | 20,294 | 19,605 | 20,672 | 21,489 | 22,258 | 22,880 | 23,305 | 23,798 | 24,286 | |
| % Change | -5.5% | -3.4% | 5.4% | 3.9% | 3.6% | 2.8% | 1.9% | 2.1% | 2.1% | 2.3% |
| **F2000R no ISP** | 20,254 | 19,421 | 20,165 | 20,614 | 21,031 | 21,456 | 21,881 | 22,374 | 22,863 | |
| % Change | -5.7% | -4.1% | 3.8% | 2.2% | 2.0% | 2.0% | 2.0% | 2.3% | 2.2% | 1.6% |
| **F2001 with ISP** | 19,117 | 19,035 | 19,309 | 19,636 | 20,173 | 20,591 | 20,980 | 21,377 | 21,800 | |
| % Change | 0.4% | -0.4% | 1.4% | 1.7% | 2.7% | 2.1% | 1.9% | 1.9% | 2.0% | 1.7% |
| **F2001 no ISP** | 19,092 | 18,984 | 19,225 | 19,507 | 19,900 | 20,294 | 20,683 | 21,080 | 21,503 | |
| % Change | 0.3% | -0.6% | 1.3% | 1.5% | 2.0% | 2.0% | 1.9% | 1.9% | 2.0% | 1.5% |

*aver annual rate of growth from 2002 to 2009 ** Not icluded in Total Fixed Sched
F2000R - Revised F2000 forecast for Sched 48, PEM and ISPs in March 2001.

- Average sales growth in the next 8 years is about 1.7%/yr, but growth pattern follows forecast of the economy and assumptions about rates, PEM and ISPs. Customer growth also follows growth pattern in economy.
- Main source of growth continues to be the commercial sector, although residential and the remaining industrial are expected to grow slightly.
- Load levels, even without ISPS, in 2001 are lower in F2001 vs F2000 by about 12% due to lower use per customer and the exclusion of schedule 48, special contracts and Seatac in F2001.

# GAS CUSTOMER AND SALES FORECASTS

## F2001 Gas Forecasts

Forecast of Customers (year end)

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | aarg* |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | 607,991 | 626,401 | 644,690 | 663,238 | 681,406 | 699,247 | 716,832 | 734,031 | 750,642 | 2.7% |
| Additions | 19,081 | 18,410 | 18,289 | 18,548 | 18,168 | 17,841 | 17,585 | 17,199 | 16,612 | |
| % Change | 3.2% | 3.0% | 2.9% | 2.9% | 2.7% | 2.6% | 2.5% | 2.4% | 2.3% | |
| **Residential** | 558,443 | 576,383 | 594,303 | 612,308 | 629,860 | 647,051 | 664,014 | 680,637 | 696,654 | 2.8% |
| **Commercial** | 45,978 | 46,529 | 46,797 | 47,220 | 47,791 | 48,423 | 49,005 | 49,559 | 50,136 | 1.1% |
| **Industrial** | 2,615 | 2,545 | 2,638 | 2,745 | 2,769 | 2,769 | 2,788 | 2,789 | 2,782 | 0.8% |
| **Coml Interrupt** | 796 | 784 | 789 | 803 | 823 | 841 | 861 | 880 | 903 | 1.6% |
| **Ind Interrupt** | 47 | 47 | 49 | 49 | 50 | 51 | 52 | 53 | 54 | 1.8% |
| **Coml Transpo** | 20 | 20 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 0.6% |
| **Ind Transpo** | 92 | 93 | 93 | 92 | 92 | 92 | 92 | 92 | 92 | 0.0% |

*aver annual rate of growth from 2002 to 2009

Forecast of Billed Sales (Mtherms)

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | aarg* |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | 1,002,278 | 1,017,059 | 1,056,147 | 1,096,481 | 1,125,767 | 1,155,726 | 1,183,010 | 1,203,572 | 1,224,500 | 2.5% |
| % Change | -5.2% | 1.5% | 3.8% | 3.8% | 2.7% | 2.7% | 2.4% | 1.7% | 1.7% | |
| **Residential** | 473,873 | 488,444 | 505,644 | 524,230 | 537,865 | 550,973 | 563,474 | 574,075 | 584,233 | 2.7% |
| **Commercial** | 202,288 | 207,165 | 215,393 | 219,815 | 223,225 | 227,686 | 231,614 | 234,353 | 237,290 | 2.0% |
| **Industrial** | 41,561 | 39,166 | 41,234 | 43,980 | 45,601 | 46,333 | 47,016 | 47,111 | 46,785 | 1.5% |
| **Coml Interrupt** | 89,193 | 86,880 | 92,389 | 98,738 | 105,536 | 113,615 | 121,846 | 129,308 | 137,544 | 5.6% |
| **Ind Interrupt** | 16,569 | 14,935 | 15,185 | 16,269 | 17,128 | 17,885 | 18,454 | 18,732 | 18,893 | 1.7% |
| **Coml Transpo** | 22,638 | 25,636 | 27,467 | 28,336 | 28,858 | 29,401 | 29,798 | 30,067 | 30,384 | 3.7% |
| **Ind Transpo** | 156,156 | 154,834 | 158,835 | 165,113 | 167,554 | 169,833 | 170,808 | 169,926 | 169,370 | 1.0% |

*aver annual rate of growth from 2002 to 2009

**F2001 and F2000 Comparisons**

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | aarg* |
|---|---|---|---|---|---|---|---|---|---|---|
| **Customer Additions** | (year end) | | | | | | | | | |
| **F2000** | 20,061 | 19,243 | 17,442 | 18,190 | 18,053 | 18,912 | 19,281 | 17,331 | 17,373 | |
| % Change | 3.4% | 3.1% | 2.8% | 2.8% | 2.7% | 2.8% | 2.7% | 2.4% | 2.5% | 2.7% |
| **F2001** | 19,081 | 18,410 | 18,289 | 18,548 | 18,168 | 17,841 | 17,585 | 17,199 | 16,612 | |
| % Change | 3.2% | 3.0% | 2.9% | 2.9% | 2.7% | 2.6% | 2.5% | 2.4% | 2.3% | 2.7% |
| **Sales in Mtherms** | | | | | | | | | | |
| **F2000** | 1,091,375 | 1,096,628 | 1,105,376 | 1,122,808 | 1,133,909 | 1,149,865 | 1,166,609 | 1,181,629 | 1,195,199 | |
| % Change | 0.8% | 0.5% | 0.8% | 1.6% | 1.0% | 1.4% | 1.5% | 1.3% | 1.1% | 1.1% |
| **F2001** | 1,002,278 | 1,017,059 | 1,056,147 | 1,096,481 | 1,125,767 | 1,155,726 | 1,183,010 | 1,203,572 | 1,224,500 | |
| % Change | -5.2% | 1.5% | 3.8% | 3.8% | 2.7% | 2.7% | 2.4% | 1.7% | 1.7% | 2.5% |

*aver annual rate of growth from 2002 to 2009

- Average growth in gas sales is 2.5%/yr in the next 8 years, higher than last 5 year history due to expected decline in gas rates. Near term growth pattern in sales and customers is influenced by assumptions about rates, marketing goals, and economic factors.
- There is a decline in load levels from in 2000 to 2001 because of fuel switching in transport/interruptibles and lower residential use per customer.
- F2000 and F2001 differences are due to different forecast of rates, economy and marketing goals.

The next two tables compare F2001 forecasts vs. normalized actuals, and 2001 forecasts vs. 2000 actuals for each class and by month and year, hence, shows monthly shapes and model calibration effects.

**Comparison of F2001 Electric Sales Forecasts versus Weather Adjusted Actuals**

(GWHs)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jul/YTD | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | | | | | | | | | | | | | | |
| 2000 Actuals | 1956.4 | 1898.9 | 1840.3 | 1532.6 | 1405.8 | 1395.7 | 1329.0 | 1439.0 | 1409.1 | 1475.6 | 1553.7 | 1798.6 | 11358.7 | 19034.8 |
| 2000-F01 | 1967.8 | 1902.9 | 1800.2 | 1544.6 | 1453.3 | 1395.1 | 1338.1 | 1419.9 | 1395.6 | 1411.1 | 1572.6 | 1799.4 | 11402.0 | 19000.7 |
| %Dif,ActvF01 | -0.58% | -0.21% | 2.22% | -0.78% | -3.27% | 0.05% | -0.68% | 1.35% | 0.97% | 4.57% | -1.20% | -0.05% | -0.38% | 0.18% |
| 2001 Actuals | 1999.2 | 1969.5 | 1707.8 | 1655.7 | 1505.1 | 1408.0 | 1366.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 11611.4 | |
| 2001-F01 | 1996.3 | 1955.8 | 1714.4 | 1623.6 | 1479.1 | 1430.8 | 1393.6 | 1328.3 | 1385.2 | 1379.5 | 1578.7 | 1852.1 | 11593.6 | 19117.3 |
| %Dif,ActvF01 | 0.15% | 0.70% | -0.38% | 1.98% | 1.76% | -1.60% | -1.97% | -100.00% | -100.00% | -100.00% | -100.00% | -100.00% | 0.15% | |
| **Residential** | | | | | | | | | | | | | | |
| 2000 Actuals | 1132.8 | 1061.8 | 987.4 | 822.1 | 705.8 | 653.3 | 609.0 | 600.4 | 601.6 | 639.5 | 792.9 | 1022.5 | 5972.2 | 9629.0 |
| 2000-F01 | 1140.5 | 1047.8 | 982.6 | 836.2 | 721.1 | 651.5 | 607.4 | 580.8 | 601.5 | 644.3 | 799.1 | 1021.8 | 5987.2 | 9634.5 |
| %Dif,ActvF01 | -0.68% | 1.34% | 0.49% | -1.68% | -2.12% | 0.27% | 0.26% | 3.38% | 0.02% | -0.74% | -0.78% | 0.07% | -0.25% | -0.06% |
| 2001 Actuals | 1152.5 | 1040.6 | 920.8 | 834.7 | 742.5 | 634.4 | 591.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5917.2 | |
| 2001-F01 | 1138.5 | 1041.1 | 912.3 | 820.6 | 717.6 | 654.9 | 612.2 | 568.2 | 588.8 | 630.9 | 797.2 | 993.8 | 5897.2 | 9476.0 |
| %Dif,ActvF01 | 1.23% | -0.05% | 0.94% | 1.73% | 3.47% | -3.13% | -3.36% | -100.00% | -100.00% | -100.00% | -100.00% | -100.00% | 0.34% | |
| **Commercial(net of ISPs)** | | | | | | | | | | | | | | |
| 2000 Actuals | 675.9 | 672.2 | 694.7 | 564.7 | 551.6 | 591.0 | 580.3 | 679.7 | 640.8 | 672.8 | 608.9 | 630.4 | 4330.4 | 7563.0 |
| 2000-F01 | 682.3 | 693.4 | 663.0 | 565.8 | 587.0 | 595.3 | 593.9 | 683.6 | 631.0 | 607.1 | 624.6 | 635.9 | 4380.8 | 7563.0 |
| %Dif,ActvF01 | -0.94% | -3.05% | 4.78% | -0.21% | -6.04% | -0.71% | -2.29% | -0.56% | 1.55% | 10.82% | -2.51% | -0.86% | -1.15% | 0.00% |
| 2001 Actuals | 701.9 | 772.4 | 653.2 | 683.3 | 624.4 | 635.0 | 633.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4703.6 | |
| 2001-F01 | 712.9 | 758.0 | 667.4 | 665.2 | 624.0 | 636.9 | 640.2 | 628.2 | 659.0 | 624.4 | 653.9 | 740.3 | 4704.5 | 8010.3 |
| %Dif,ActvF01 | -1.54% | 1.91% | -2.12% | 2.72% | 0.06% | -0.29% | -1.07% | -100.00% | -100.00% | -100.00% | -100.00% | -100.00% | -0.02% | |
| **Industrial** | | | | | | | | | | | | | | |
| 2000 Actuals | 129.1 | 146.4 | 140.4 | 127.1 | 130.4 | 134.0 | 121.7 | 140.6 | 147.7 | 144.8 | 133.6 | 125.3 | 929.1 | 1621.1 |
| 2000-F01 | 126.1 | 143.0 | 137.1 | 124.2 | 127.4 | 130.8 | 118.8 | 137.3 | 144.3 | 141.4 | 130.4 | 122.4 | 907.4 | 1583.3 |
| %Dif,ActvF01 | 2.39% | 2.39% | 2.39% | 2.39% | 2.39% | 2.39% | 2.39% | 2.39% | 2.39% | 2.39% | 2.39% | 2.39% | 2.39% | 2.39% |
| 2001 Actuals | 124.5 | 136.2 | 114.9 | 117.4 | 117.3 | 118.8 | 120.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 849.7 | |
| 2001-F01 | 124.4 | 136.1 | 115.0 | 117.0 | 117.0 | 118.5 | 120.0 | 121.9 | 127.6 | 114.2 | 116.3 | 106.3 | 847.9 | 1434.2 |
| %Dif,ActvF01 | 0.05% | 0.04% | -0.06% | 0.31% | 0.30% | 0.21% | 0.58% | -100.00% | -100.00% | -100.00% | -100.00% | -100.00% | 0.20% | |
| **Street Lights** | | | | | | | | | | | | | | |
| 2000 Actuals | 6.4 | 6.1 | 6.7 | 6.6 | 6.5 | 6.2 | 6.1 | 6.2 | 6.4 | 6.5 | 6.6 | 7.0 | 44.6 | 77.4 |
| 2000-F01 | 6.7 | 6.5 | 6.5 | 6.4 | 6.3 | 6.3 | 6.2 | 6.2 | 6.3 | 6.3 | 6.7 | 7.1 | 44.8 | 77.4 |
| %Dif,ActvF01 | -4.57% | -5.71% | 3.60% | 2.82% | 2.54% | -1.45% | -0.51% | -0.19% | 2.08% | 3.13% | -0.90% | -0.54% | -0.50% | -0.01% |
| 2001 Actuals | 6.7 | 6.6 | 6.2 | 6.1 | 7.3 | 6.3 | 6.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 45.4 | |
| 2001-F01 | 7.3 | 7.1 | 7.0 | 7.0 | 6.9 | 6.8 | 6.8 | 6.8 | 6.9 | 7.0 | 7.4 | 7.8 | 48.9 | 84.7 |
| %Dif,ActvF01 | -7.76% | -7.28% | -12.38% | -12.53% | 5.25% | -8.37% | -6.01% | -100.00% | -100.00% | -100.00% | -100.00% | -100.00% | -7.04% | |
| **Resale** | | | | | | | | | | | | | | |
| 2000 Actuals | 12.3 | 12.4 | 11.2 | 12.1 | 11.4 | 11.3 | 11.9 | 12.2 | 12.6 | 11.9 | 11.8 | 12.0 | 82.6 | 143.0 |
| 2000-F01 | 12.2 | 12.3 | 11.1 | 12.0 | 11.4 | 11.2 | 11.8 | 12.1 | 12.5 | 11.8 | 11.7 | 11.9 | 81.9 | 141.9 |
| %Dif,ActvF01 | 0.79% | 0.79% | 0.79% | 0.79% | 0.79% | 0.79% | 0.79% | 0.79% | 0.79% | 0.79% | 0.79% | 0.79% | 0.79% | 0.79% |
| 2001 Actuals | 12.6 | 12.6 | 11.4 | 12.3 | 11.6 | 11.4 | 12.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 83.9 | |
| 2001-F01 | 12.5 | 12.5 | 11.3 | 12.2 | 11.5 | 11.3 | 12.0 | 0.6 | 0.5 | 0.3 | 1.2 | 0.9 | 83.3 | 86.8 |
| %Dif,ActvF01 | 0.79% | 0.79% | 0.79% | 0.79% | 0.79% | 0.79% | 0.79% | -100.00% | -100.00% | -100.00% | -100.00% | -100.00% | 0.79% | |
| **ISPs** | | | | | | | | | | | | | | |
| 2000 Actuals | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 0.0 | 1.3 |
| 2000-F01 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.4 | 0.0 | 0.7 |
| %Dif,ActvF01 | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | #DIV/0! | -100.00% | -100.00% | 203.79% | #DIV/0! | 83.16% |
| 2001 Actuals | 1.0 | 1.2 | 1.3 | 1.9 | 2.0 | 2.1 | 2.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 11.6 | |
| 2001-F01 | 0.8 | 1.0 | 1.4 | 1.7 | 2.1 | 2.3 | 2.5 | 2.6 | 2.6 | 2.7 | 2.7 | 2.9 | 11.8 | 25.4 |
| %Dif,ActvF01 | 36.32% | 17.41% | -8.74% | 12.53% | -4.42% | -10.39% | -15.98% | -100.00% | -100.00% | -100.00% | -100.00% | -100.00% | -1.63% | |

**Comparison of F2001 Gas Sales Forecasts versus Weather Adjusted Actuals**
**(Mtherms)**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | JulYTD | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | | | | | | | | | | | | | | |
| 2000 Actuals | 148,775 | 141,261 | 119,745 | 101,570 | 74,416 | 59,432 | 45,770 | 41,332 | 44,381 | 59,960 | 92,103 | 126,727 | 690,969 | 1,055,472 |
| 2000-F01 | 142,606 | 136,399 | 121,408 | 97,650 | 76,655 | 61,742 | 46,389 | 42,925 | 48,327 | 55,751 | 96,580 | 130,958 | 682,848 | 1,057,388 |
| %Dif,ActvF01 | 4.33% | 3.56% | -1.37% | 4.01% | -2.92% | -3.74% | -1.33% | -3.71% | -8.16% | 7.55% | -4.64% | -3.23% | 1.19% | -0.18% |
| 2001 Actuals | 138,879 | 136,089 | 109,346 | 97,528 | 75,577 | 55,330 | 43,066 | 0 | 0 | 0 | 0 | 0 | 655,816 | |
| 2001-F01 | 133,364 | 142,550 | 118,379 | 96,567 | 70,468 | 53,307 | 40,407 | 35,607 | 39,240 | 52,134 | 89,474 | 130,781 | 655,042 | 1,002,278 |
| %Dif,ActvF01 | 4.14% | -4.53% | -7.63% | 1.00% | 7.25% | 3.80% | 6.58% | -100.00% | -100.00% | -100.00% | -100.00% | -100.00% | 0.12% | |
| **Residential** | | | | | | | | | | | | | | |
| 2000 Actuals | 79,432 | 72,791 | 59,580 | 46,160 | 30,268 | 19,954 | 13,647 | 10,880 | 12,263 | 23,028 | 44,066 | 68,753 | 321,833 | 480,822 |
| 2000-F01 | 77,249 | 68,506 | 62,749 | 43,904 | 31,703 | 21,792 | 13,344 | 9,803 | 13,741 | 19,953 | 46,537 | 69,761 | 319,247 | 479,042 |
| %Dif,ActvF01 | 2.83% | 6.26% | -5.05% | 5.14% | -4.53% | -8.44% | 2.27% | 10.99% | -10.76% | 15.41% | -5.31% | -1.44% | 0.81% | 0.37% |
| 2001 Actuals | 77,735 | 74,906 | 57,691 | 46,299 | 31,138 | 20,064 | 12,530 | 0 | 0 | 0 | 0 | 0 | 320,363 | |
| 2001-F01 | 71,954 | 77,259 | 61,389 | 46,063 | 29,947 | 19,514 | 11,888 | 7,919 | 10,135 | 19,662 | 44,340 | 73,804 | 318,013 | 473,873 |
| %Dif,ActvF01 | 8.04% | -3.05% | -6.02% | 0.51% | 3.98% | 2.82% | 5.41% | -100.00% | -100.00% | -100.00% | -100.00% | -100.00% | 0.74% | |
| **Commercial** | | | | | | | | | | | | | | |
| 2000 Actuals | 29,672 | 27,597 | 23,997 | 19,980 | 13,735 | 10,610 | 8,918 | 8,042 | 8,582 | 10,568 | 17,227 | 24,698 | 134,509 | 203,626 |
| 2000-F01 | 28,061 | 26,458 | 24,423 | 18,334 | 14,368 | 11,226 | 8,826 | 7,838 | 9,145 | 10,319 | 17,383 | 25,684 | 131,696 | 202,064 |
| %Dif,ActvF01 | 5.74% | 4.31% | -1.74% | 8.98% | -4.40% | -5.49% | 1.04% | 2.60% | -6.15% | 2.41% | -0.90% | -3.84% | 2.14% | 0.77% |
| 2001 Actuals | 28,949 | 27,976 | 23,813 | 20,204 | 15,034 | 10,872 | 8,098 | 0 | 0 | 0 | 0 | 0 | 134,945 | |
| 2001-F01 | 28,854 | 29,896 | 25,912 | 18,982 | 13,477 | 9,777 | 7,618 | 6,661 | 7,692 | 10,117 | 17,190 | 26,112 | 134,516 | 202,288 |
| %Dif,ActvF01 | 0.33% | -6.42% | -8.10% | 6.43% | 11.55% | 11.20% | 6.29% | -100.00% | -100.00% | -100.00% | -100.00% | -100.00% | 0.32% | |
| **Industrial** | | | | | | | | | | | | | | |
| 2000 Actuals | 5,708 | 5,065 | 4,754 | 4,083 | 3,368 | 2,840 | 2,633 | 2,501 | 2,472 | 2,775 | 3,703 | 4,580 | 28,452 | 44,483 |
| 2000-F01 | 5,399 | 5,140 | 4,933 | 4,123 | 3,484 | 3,001 | 2,712 | 2,484 | 2,692 | 2,824 | 3,836 | 4,564 | 28,791 | 45,192 |
| %Dif,ActvF01 | 5.73% | -1.46% | -3.61% | -0.97% | -3.34% | -5.35% | -2.90% | 0.67% | -8.17% | -1.76% | -3.46% | 0.36% | -1.18% | -1.57% |
| 2001 Actuals | 5,211 | 4,965 | 3,609 | 3,725 | 3,812 | 2,753 | 2,742 | 0 | 0 | 0 | 0 | 0 | 26,817 | |
| 2001-F01 | 5,280 | 5,427 | 3,977 | 3,936 | 3,117 | 2,582 | 2,391 | 2,175 | 2,333 | 2,574 | 3,382 | 4,388 | 26,709 | 41,561 |
| %Dif,ActvF01 | -1.31% | -8.51% | -9.24% | -5.36% | 22.30% | 6.64% | 14.67% | -100.00% | -100.00% | -100.00% | -100.00% | -100.00% | 0.40% | |
| **Coml Interr/LV** | | | | | | | | | | | | | | |
| 2000 Actuals | 11,806 | 13,313 | 10,542 | 10,092 | 7,641 | 6,456 | 4,864 | 4,299 | 4,191 | 5,792 | 7,588 | 10,254 | 64,713 | 96,838 |
| 2000-F01 | 11,379 | 15,272 | 10,418 | 9,206 | 8,097 | 7,298 | 5,267 | 6,527 | 4,768 | 5,542 | 8,736 | 10,694 | 66,939 | 103,206 |
| %Dif,ActvF01 | 3.75% | -12.83% | 1.18% | 9.62% | -5.63% | -11.53% | -7.65% | -34.13% | -12.11% | 4.52% | -13.15% | -4.12% | -3.32% | -6.17% |
| 2001 Actuals | 11,147 | 10,583 | 7,934 | 9,716 | 7,743 | 5,853 | 4,958 | 0 | 0 | 0 | 0 | 0 | 57,933 | |
| 2001-F01 | 10,963 | 11,540 | 10,064 | 8,816 | 7,272 | 5,811 | 4,364 | 4,617 | 4,200 | 4,952 | 7,069 | 9,525 | 58,830 | 89,193 |
| %Dif,ActvF01 | 1.68% | -8.29% | -21.17% | 10.21% | 6.47% | 0.72% | 13.62% | -100.00% | -100.00% | -100.00% | -100.00% | -100.00% | -1.52% | |
| **Indust Interr/LV** | | | | | | | | | | | | | | |
| 2000 Actuals | 1,980 | 2,283 | 1,949 | 2,151 | 1,943 | 1,755 | 1,665 | 1,330 | 1,664 | 1,431 | 1,587 | 1,384 | 13,726 | 21,122 |
| 2000-F01 | 1,755 | 1,837 | 1,694 | 1,801 | 1,631 | 1,628 | 1,493 | 1,466 | 1,782 | 1,489 | 1,599 | 1,727 | 11,840 | 19,904 |
| %Dif,ActvF01 | 12.82% | 24.28% | 15.03% | 19.42% | 19.10% | 7.78% | 11.55% | -9.32% | -6.60% | -3.94% | -0.74% | -19.88% | 15.93% | 6.12% |
| 2001 Actuals | 1,250 | 1,298 | 1,340 | 1,499 | 1,767 | 1,483 | 1,208 | 0 | 0 | 0 | 0 | 0 | 9,845 | |
| 2001-F01 | 1,533 | 1,601 | 1,458 | 1,510 | 1,308 | 1,290 | 1,228 | 1,194 | 1,209 | 1,316 | 1,415 | 1,505 | 9,928 | 16,569 |
| %Dif,ActvF01 | -18.44% | -18.91% | -8.11% | -0.70% | 35.04% | 14.94% | -1.66% | -100.00% | -100.00% | -100.00% | -100.00% | -100.00% | -0.84% | |
| **Coml Transport** | | | | | | | | | | | | | | |
| 2000 Actuals | 1,778 | 1,867 | 1,636 | 1,650 | 1,626 | 1,524 | 1,394 | 1,360 | 1,380 | 1,361 | 1,578 | 1,905 | 11,476 | 19,059 |
| 2000-F01 | 1,541 | 1,748 | 1,566 | 2,045 | 1,629 | 1,399 | 1,338 | 1,341 | 1,365 | 1,418 | 2,154 | 2,905 | 11,265 | 20,448 |
| %Dif,ActvF01 | 15.38% | 6.85% | 4.50% | -19.31% | -0.13% | 8.92% | 4.17% | 1.40% | 1.10% | -3.99% | -26.76% | -34.44% | 1.87% | -6.79% |
| 2001 Actuals | 1,625 | 1,806 | 1,676 | 1,990 | 2,151 | 1,581 | 1,450 | 0 | 0 | 0 | 0 | 0 | 12,279 | |
| 2001-F01 | 2,217 | 2,283 | 2,067 | 2,213 | 1,924 | 1,669 | 1,583 | 1,565 | 1,536 | 1,472 | 1,909 | 2,200 | 13,957 | 22,638 |
| %Dif,ActvF01 | -26.72% | -20.90% | -18.95% | -10.08% | 11.80% | -5.22% | -8.39% | -100.00% | -100.00% | -100.00% | -100.00% | -100.00% | -12.02% | |
| **Indust Transport** | | | | | | | | | | | | | | |
| 2000 Actuals | 18,399 | 18,343 | 17,286 | 17,455 | 15,834 | 16,293 | 12,649 | 12,921 | 13,830 | 15,006 | 16,354 | 15,153 | 116,259 | 189,523 |
| 2000-F01 | 17,221 | 17,437 | 15,625 | 18,237 | 15,742 | 15,397 | 13,409 | 13,465 | 14,834 | 14,206 | 16,335 | 15,623 | 113,070 | 187,533 |
| %Dif,ActvF01 | 6.84% | 5.19% | 10.63% | -4.29% | 0.58% | 5.82% | -5.67% | -4.04% | -6.77% | 5.63% | 0.12% | -3.01% | 2.82% | 1.06% |
| 2001 Actuals | 12,962 | 14,555 | 13,284 | 14,096 | 13,933 | 12,724 | 12,081 | 0 | 0 | 0 | 0 | 0 | 93,633 | |
| 2001-F01 | 12,563 | 14,545 | 13,513 | 15,047 | 13,423 | 12,664 | 11,335 | 11,477 | 12,134 | 12,040 | 14,169 | 13,246 | 93,089 | 156,156 |
| %Dif,ActvF01 | 3.17% | 0.07% | -1.69% | -6.32% | 3.80% | 0.47% | 6.58% | -100.00% | -100.00% | -100.00% | -100.00% | -100.00% | 0.58% | |

# Resources Summaries

# RESOURCES

## Power Supply Resources - 2002
**( resources that terminate over next 9 years)**

| | Location | Fuel | Nameplate/ Capacity | Capacity Degrad | Average Energy ('01) | Average Energy ('99-'01) | Average Energy Price | Heat Rate | Power Purchase Contract Term | Emissions Restrictions | # of Units | % Ownership | Baseload/ Peaking | Expiration Date |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PSE OWNED GENERATION** | | | | | | | $/MWh | | | | | | | |
| **Baseload:** | | | (In MW) | | | | | | | | | | | |
| Colstrip Units 1&2 | Colstrip | coal | 330.00 | 295.00 | 267.2 | 256.9 | $10.08 | 11.1 | | | 2 | 50 | baseload | |
| Colstrip Units 3&4 | Colstrip | coal | 370.00 | 370.00 | 307.8 | 293.5 | $9.61 | 10.6 | | | 2 | 25 | baseload | |
| Encogen (acq. 11/99) | Bellingham | gas/oil | 160.00 | 160.00 | 162.8 | 114.7 | $56.02 | 8.7 | | 8760 permitted | 2 | 100 | peaking | |
| Upper Baker River (1959) | Concrete | hydro | 103.00 | 103.00 | | | | | | | 2 | 100 | baseload | |
| Lower Baker River (1960) | Concrete | hydro | 71.40 | 71.40 | | | | | | | 1 | 100 | baseload | |
| Electron (1929) | Electron | hydro | 26.40 | 21.00 | | | | | | | 4 | 100 | baseload | |
| Snoqualmie Falls (1910/1957) | Snoqualmie | hydro | 44.00 | 42.00 | | | | | | | 7 | 100 | baseload | |
| White River (1911/1924) | Dieringer | hydro | 63.40 | 63.40 | | | | | | | 4 | 100 | baseload | |
| Subtotal Hydro: | | | | | 125.6 | 153.7 | $7.97 | | | | | | | |
| ***Subtotal Baseload:*** | | | **1168.20** | **1125.80** | **863.4** | **818.8** | | | | | | | | |
| | | | | | | | | | | | | | | |
| **Peaking:** | | | | | | | | | | | | | | |
| Whitehorn 2 | Ferndale | gas/oil | 74.00 | 66.40 | | | | 11.7 | | 8760 permitted | 1 | 100 | peaking | lease exp. 8/04 |
| Whitehorn 3 | Ferndale | gas/oil | 74.00 | 68.00 | 68.4 | 52.7 | | 11.7 | | 8760 permitted | 1 | 100 | peaking | lease exp. 8/04 |
| Frederickson 1 | Spanaway | gas/oil | | 70.00 | | | | 11.7 | | | | | | |
| Frederickson 2 | Spanaway | gas/oil | 144.00 | 71.00 | 65.7 | 35.9 | | 11.7 | | NOX restrictions | 1 | 100 | peaking | |
| Fredonia 1 | Burlington | gas/oil | 104.00 | 101.40 | | | | 11.5 | | Unit 1 restricted | 1 | 100 | peaking | |
| Fredonia 2 | Burlington | gas/oil | 104.00 | 100.70 | 108.8 | 108.8 | | 11.5 | | Unit 2 unrestricted | 1 | 100 | peaking | |
| Fredonia 3 & 4 (Oct-Dec) | Burlington | gas/oil | 108.00 | 108.00 | 12.8 | | | 10.4 | | Unit 3 unrestricted | 1 | 100 | peaking | lease exp. 2011 |
| Crystal Mountain | Crystal Mtn | oil | 2.75 | 2.75 | 1.1 | 0.4 | | | | Unit 4 unrestricted | 1 | 100 | peaking | |
| Pierce Power | Fredrickson | gas/oil | 154.00 | 154.00 | | | | | | | | | | 11/30/02 |
| ***Subtotal Peaking:*** | | | 764.75 | 742.25 | 256.8 | 197.8 | | | | | | | | |

**Total PSE Owned Generation:** **1932.95** **1868.05**

## Power Supply Resources - 2002
**(▭ resources that terminate over next 9 years)**

| | Location | Fuel | Nameplate/ Capacity | Capacity Degrad | Average Energy ('01) | Average Energy ('99-'01) | Average Energy Price | Heat Rate | Power Purchase Contract Term | Emissions Restrictions | # of Units | % Ownership | Baseload/ Peaking | Expiration Date |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *PURCHASED POWER CONTRACTS* | | | | | | | | | | | | | | |
| **Mid C receipt:** | | | | | | | | | | | | | | |
| Douglas PUD-Wells (261) | Douglas PUD | hydro | 263.00 | | 86.7 | 132.6 | $11.50 | | 9/18/63-8/31/2018 | | 10 | 31.3 | baseload | 8/31/2018 |
| Chelan PUD - Rocky Reach | Chelan PUD | hydro | 505.00 | | 171.2 | 254.2 | $17.87 | | 11/14/57-11/1/2011 | | 11 | 38.9 | baseload | 11/1/2011 |
| Chelan PUD - Rock Island I | Chelan PUD | hydro | 124.00 | | 11.9 | 4 | $90.57 | | 12/20/1995-6/7/2012 | | 10 | 50 | baseload | 6/7/2012 |
| Chelan PUD - Rock Island II | Chelan PUD | hydro | 333.00 | | 144.6 | 234.8 | $22.40 | | 12/20/1995-6/7/2012 | | 8 | 95 | baseload | 6/7/2012 |
| Grant PUD - Wanapum | Grant PUD | hydro | 98 | | 38.4 | 52.7 | $11.60 | | 6/22/59-10/31/2009 | | 10 | 10.8 | baseload | 10/31/2039 |
| Grant PUD - Priest Rapids | Grant PUD | hydro | 72 | | 31.1 | 41.1 | $7.26 | | 5/21/56-10/31/2005 | | 10 | 8 | baseload | 10/31/2035 |
| ***Subtotal Mid-C:*** | | | **1395.00** | | **483.9** | **719.4** | | | | | | | | |
| | | | | | | | | | | | | | | |
| **System Delivery Receipt:** | | | | | | | | | | | | | | |
| Avista | | thermal | 33.00 | | 50.2 | 86.7 | $23.40 | | 1/1/1988-12/31/2002 | | | | baseload | 12/31/2002 |
| BPA-Baker Replacement | | hydro | 7 | | 0.8 | 1 | | | 9/30/2000-9/30/2006 | | | | seasonal | 9/30/2006 |
| BPA-Snohomish Conservation | | hydro | 21 | | 8.2 | 6.7 | $37.42 | | 3/1/90-2/28/2010 | | | | baseload | 2/28/2010 |
| BPA-CSPE | | hydro | 29 | | 12.7 | 18.5 | $0.00 | | 4/1/88-3/31/2003 | | | | baseload | 3/31/2003 |
| BPA-Supplemental Capacity | | hydro | 9 | | 0.5 | 0.6 | $18.13 | | 4/1/88-3/31/2003 | | | | peaking | 3/31/2003 |
| BPA-WNP3 BPA Exchange(LCP) | | thermal | 82 | | 44.4 | 54.1 | $27.70 | | 9/30/2000-6/30/2017 | | | | baseload | 6/30/2017 |
| Canadian Entitlements (Mid-C) Exist | | hydro | -10 | | -6 | | | | | | | | return | 3/31/2003 |
| Canadian Entitlements (Mid-C)Ext | | hydro | -41 | | -20 | | | | 4/1/1998-9/15/2024 | | | | return | 9/15/2024 |
| Montana Power Company (AR) | Colstrip | unit cont. | 97 | | 81.8 | 79.3 | $42.06 | | 10/1/1989-12/31/2010 | | | | baseload | 12/29/2010 |
| Pacific Power & Light/PacifiCorp | | thermal | 200 | | 119.8 | 119.7 | $48.52 | | 11/1/1988-10/31/03 | | | | baseload | 10/31/2003 |
| PG&E Exchange (Nov-Feb) | | thermal | 300 | | 0 | 0 | | | 1/1/1992thru | | | | exchange | 12/31/2006 |
| Powerex-Pt Roberts | | hydro | 3 | | 2.5 | 2.3 | $27.80 | | 10/01/2001-9/30/2004 | | | | baseload | 9/30/2004 |
| North Wasco | The Dalles | hydro | 5 | | 5.1 | 4.5 | $63.79 | | 7/1/91-12/31/2012 | | | | baseload | 12/31/2012 |
| ***Subtotal System Delivery:*** | | | **735.00** | | **300** | **353.4** | | | | | | | | |
| | | | | | | | | | | | | | | |
| **QF Contracts - Cogens:** | | | | | | | | | | | | | | |
| March Point Phase I | Anacortes | gas | 80 | | 81.7 | 80.2 | $53.69 | 8.5 | 10/1/1991-12/31/2011 | | 2 | | baseload | 12/31/2011 |
| March Point Phase II | Anacortes | gas/stean | 60 | | 53.6 | 52.4 | $60.48 | 8.5 | 11/1/91-12/31/2011 | | 2 | | baseload | 12/31/2011 |
| Sumas | Bellingham | gas | 123 | | 125.9 | 108.3 | $72.85 | 8.2 | 4/16/1993-12/31/2012 | | 2 | | baseload | 12/31/2012 |
| Tenaska | Bellingham | gas/oil | 245 | | 220.7 | 188.4 | $67.90 | 8.7 | 3/20/1991-12/31/2011 | | 3 | | baseload | 12/31/2011 |
| ***Subtotal Cogens:*** | | | **508** | | **481.9** | **429.3** | | | | | | | | |
| | | | | | | | | | | | | | | |
| **QF Contracts - Biomass & Hydro:** | | | | | | | | | | | | | | |
| Puyallup Energy Recovery Co | Puyallup | thermal | 2 | | 2 | 2 | | | 4/15/1999-4/15/2009 | | | | baseload | 4/15/2009 |
| Spokane Municipal Solid Waste | Spokane | thermal | 22.9 | | 15.6 | 16.1 | $86.76 | | 3/1/1990-3/1/2011 | | | | baseload | 11/1/2011 |
| STS Hydropower-Hutchinson Cr. | Bellingham | hydro | 0.9 | | 0.1 | 0.2 | $34.69 | | 10/1/84-9/30/04 | | 4 | | baseload | 9/30/2004 |
| Koma Kulshan | Concrete | hydro | 13.7 | | 3.5 | 4.2 | $74.68 | | 12/1/1990-12/31/2037 | | | | baseload | 12/31/2037 |
| Port Townsend Paper | Port Townsend | hydro | 0.375 | | 0.2 | 0.3 | $23.67 | | 1/1/99-12/31/03 | | | | baseload | 12/31/2003 |
| Kingdom Energy-Sygitowicz | Whatcom | hydro | 0.4 | | 0.1 | 0.1 | $47.80 | | 2/22/95-2/2/2014 | | 1 | | baseload | 2/2/2014 |
| Skookumchuk | Centrailia | hydro | 0.98 | | 0 | 0 | $16.00 | | 7/1/1993 - | | | | | ongoing |
| Twin Falls | Snoqualmie | hydro | 23 | | 6.2 | 6.4 | $75.00 | | 3/8/1990-3/2025 | | | | baseload | 3/8/2025 |
| Weeks Falls | Snoqualmie | hydro | 4.6 | | 1.2 | 1.4 | $75.00 | | 12/1/1987- 12/31/2022 | | | | baseload | 12/31/2022 |
| ***Subtotal Biomass/Hydro:*** | | | **68.855** | | **28.9** | **30.7** | | | | | | | | |

**Total Purchased Power:** **2706.86**

# CONTRACT ABSTRACTS

**CONTRACT ABSTRACTS:**

**Avista**
Description: Thermal
Delivery Point: Mid-C between Wells and Priest Rapids hydroelectric projects and any other point where WWP has available transmission
Firm Capacity = Contract Demand = 100MW (1988-2000); 67MW (2001); 33MW (2002)
Energy = Contract Demand x .75 x # of hours in contract year

75% annual load factor; 75% weekly load factor; PSE may schedule energy at a delivery rate of not < 30% of Contract Demand and must maintain weekly load factor;
Contingency for delivery interruption due to uncontrollable events: Seller shall make available the difference above 10%.

Scheduling: Preschedule by 12:00pm

Fifteen Year Agreement for Purchase & Sale of Firm Capacity and Energy dated 10/16/95
Price: $32.11/MWh Average /Power Cost for 1995-2002
Term: 1/1/1988-12/31/2002
**Expiration: 12/31/2002**

**Baker River Replacement Power**
Description: Hydro, Upper Baker flood control extension, PSE compensated for storage space provided in excess of 16,000 (11/1-3/1), + an additional 58,000 acre feet between 11/15-3/1). Compensation provided in the form of replacement energy (capacity + losses).
Point of Delivery: Sedro Woolley
Capacity: Not to exceed 7MW hourly rate, unless agreed to by PSE and BPA
Energy:
Scheduling: November-February, 1750 total MWhr/month

(7000 total MWhrs for the term 11/1-3/1)

Memorandum of Agreement between the Corps of Engineers, Department of the Army acting by and through the Division Engineer, Northwestern Division and PSE for Upper Baker Additional Flood Control dated 10/31/2000
(Agreement Between the Corps of Engineers and BPA for Replacement Power for Upper Baker Flood Control date 10/27/2000)
Price:

Capacity: Corps pays BPA for the firm capacity scheduled to PSE pursuant to BPA's wholesale firm capacity tariff
Energy: Corps pays BPA for non-firm energy at the higher of: 1)avg of the 16 highest days of the DJ Mid –C Index for HLH firm power or 2) avg of the 16 highest days average of hours 7-22 of the Cal PX Day Ahead Unconstrained Market Clearing Prices.

Term: 9/30/2000-9/1/2003; may be extended on an annual basis until 9/30/2006 to coincide with the issuance of a new FERC license.
**Expiration: 9/1/2003 or 2006**

**Columbia Storage Power Exchange (CSPE)**
Description: Hydro, entity was incorporated in 1964 with objective of purchasing for a term of years Canada's rights (one-half) of the downstream power benefits under the Columbia River Treaty (signed by the US 1/17/61) and incurring indebtedness to finance such purchase. CSPE assigns to Participants the Canadian Entitlement based on Participant's percentage. Participants pay BPA for use of BPA's transmission. The treaty and the notes exchanged provided pursuant to the Treaty provide for the construction, maintenance and operation by Canada of storage dams and reservoirs in B.C. on the Columbia River at Mica Creek, Arrow Lakes and near Duncan Lake. The benefits of the Treaty are created in the US due to the construction of the Projects ability to improve usability of water out of Canada.
Delivery Point: PSE's system or Rocky Reach Project
Capacity: approximately 20MW (2001-2002); 30MW (2002-2003)

Energy: approx. 20MW (2001-2002); 16MW (2002-2003)
Losses: Energy 3.5%; Peak 5.5%
Transmission: BPA to deliver energy and capacity less losses to the point of delivery. BPA capacity charge: $0.125/month x kilowatts of capacity
Term: 4/1/68 – 3/31/03

Agreements:
1. Canadian Entitlement Purchase Agreement between CSPE and BC Hydro dated 8/13/64 for purchase of Canada's entitlement benefit for a specified number of years (through 3/31/2003)
2. Canadian Entitlement Allocation Agreement – to implement the Treaty it is necessary for the Administrator to make available to the District certain amounts of capacity as stated in this agreement in order to return one-half of the dependable capacity resulting from the construction of the Canadian storage projects and to realize the benefits of such construction
3. Canadian Entitlement Exchange Agreements between BPA and CSPE dated 8/13/64 - provide for payments by the Participants to BPA for the use of the Government's transmission, transformation and related facilities in making capacity and energy available , also contains provisions describing the character of service and the scheduling arrangements for capacity and energy to be supplied by BPA and provisions whereby the participants and BPA may effect exchanges
Price:
Term: 8/13/64- 3/31/03
**Expiration: 3/31/03**

**CSPE - Supplemental and Entitlement Capacity**
Description: BPA to provide additional capacity rather than install additional units for capacity. Allows for shaping capability.
Capacity: approx.10MW (2001-2002); 9MW (2002-2003)
Energy: PSE returns 10MW on LLH and receives 9 MW on HLH – net transfer "0" at month end
Losses: Energy 3%; Capacity 5.5%
Transmission: BPA to deliver energy and capacity less losses to the point of delivery; $1.50/kw/month; transmission charge, $4.50/kw/month of supplemental capacity charge.
Term: 4/1/68 – 3/31/03
**Expiration: 3/31/03**

**Delivery of the Canadian Entitlement**
Description: Treaty terms: U.S. and Canada each entitled to receive one-half of the average annual usable energy and one-half of the dependable hydroelectric capacity for the next 60 years. (Canada sold its half for first 30 years to CSPE 4/1/68-4/1/98). BPA to deliver Canada's half from US projects.
Capacity: 2001- 41MW; 2002-38MW 2003-68MW 2004-68MW 2005-66MW 2006-61MW
Energy: approx. 40aMW
Points of Delivery: Nelway,Waneta, Blaine 1, Blaine 2
Scheduling: Daily preschedule basis; B.C. Hydro to provide a weekly and a mid-week estimate. Weekly provided by 10am Friday thru following Friday. Avg. annual energy prorated based on number of days. Total deliveries in any hour will not exceed Canadian Entitlement capacity
Term: 4/1/98-9/15/2024
Expiration: **9/15/2024**

**Conservation Credit with Snohomish PUD**
Description: Hydro, conservation transfer pilot program with certain utilities and BPA. The amount of power purchased will roughly match the conservation savings during the first 5 years. Beginning March 2001, Snohomish will sell supplemental power to PSE.
Delivery Point: BPA to deliver to Monroe/Sammish and Sedro Woolley (Murray/Bellingham) thru 2001; Beverly Park 2001-
Capacity/Energy: 12 MW during HLH (0600-2200) and 8 MW during LLH

| Contract Year | Energy in MWh | Supple-mental | Total |
|---|---|---|---|
| 3/01-2/02 | 52,563 | 27,921 | 80,484 |
| 3/02-2/03 | 52,563 | 20,288 | 72,851 |
| 3/03-2/04 | 52,747 | 40,429 | 93,176 |
| 3/04-2/05 | 52,563 | 40,288 | 92,851 |
| 3/05-2/06 | 52,563 | 40,288 | 92,851 |
| 3/06-2/07 | 52,563 | 40,288 | 92,851 |
| 3/07-2/08 | 52,747 | 40,429 | 93,176 |
| 3/08-2/09 | 52,563 | 40,288 | 92,851 |
| 3/09-2/10 | 52,563 | 40,288 | 92,851 |

Conservation Power Sales Agreement dated 12/11/89
Amendment No.2 to the Conservation power Sales Agreement dated 12/28/2001 – establishes new price methodology
Price: Base Rate-$32.00 + Adder

***$/MWH***

| | |
|---|---|
| 2002 | $40.50 |
| 2003 | $40.80 |
| 2004 | $41.10 |
| 2005 | $41.40 |
| 2006 | $41.70 |

Term: 3/1/90-2/28/2010
**Expiration: 2/28/2010**

**<u>Montana Power Company</u>**
Description: 10 year contract; Montana has 30% share (210MW) in Colstrip 4 (700MW), not dedicated to serve Montana's jurisdictional load
Delivery Point: Montana Power has the obligation to provide firm contractual rights to transmission paths from Garrison to the Point of Delivery. PSE has IR Agreement with BPA which satisfies this obligation thru the Term.
Displacement: Yes
Contract Capacity: 97MW (Amendment 7/13/98 increasing capacity from 94 to 97MW). No additional fixed monthly charge for additional 3MW upon a one time payment of the lessor a) one-half of the capital cost of such replacement or b) $900,000
Energy: Amount scheduled shall be a) contract capacity or b) contract capacity x net generating /nominal rating. Supplemental energy up to 120MW
Scheduling: PSE submits hourly preschedule

Power Sales Agreement dated 10/1/89
Settlement Agreement dated 2/21/97 - monthly fixed charges reduced by $6500/mo.
Amendment No.1 to Power Sales Agreement – increases capacity
Price: Energy: Based on the Existing Coal Agreements or any modifications thereto
Monthly Fixed Charge Rate:
2002 - $24,935
2003 – $26,358
2004 – $27,692
2005 – $29,078
2006 – $30,434
2007 – $31,750
2008 – $33,040
2009 – $34,321
2010 – $35,574

Term: 10/1/89-12/29/2010
**Expiration: 12/29/2010**

**PacifiCorp**
Description: 15 year term
Delivery Point: Mid-C and additional points which PacifiCorp has available transmission rights or facilities
Contract Capacity: 200MW (8/1/91-10/31/03); 100 (12/1/88-7/31/91)
Energy: Monthly load factor of 70%, weekly load factor of 75%
Scheduling: By Feb 1, PSE shall submit to PacifiCorp a nonbinding monthly estimate for 12 mos. beg. 7/1. Preschedule by 12:00. PSE shall receive energy at a load factor of 60% for each year (Aug-July).

Fifteen Year Power Sales Agreement dated 10/27/88
Price:
Energy rate- approximately $18.00/MWh; calculation and data submitted by PacifiCorp. based on the Centralia production expense and Bridger production expense on PacifiCorp's FERC Form 1
Capacity rate-
2002 capacity rate = $15.08/kw/mo.
2003 capacity rate = $16.13/kw/mo.
Term: 11/1/88-10/31/03
**Expiration: 10/31/2003**

**PG&E Seasonal Exchange Agreement**
Description: Seasonal exchange of power, no monetary exchange
Delivery Point: BPA/Southern Intertie (COB or NOB), PSE holds transmission contract (network transmission) Puget/Bonneville Intertie & Network Transmission Agreement
Capacity: 300MW
Energy: PSE receives 413,000 MWh of energy Nov-Feb.
PSE delivers 413,000 MWh of energy to PG&E June-Sep
Scheduling: PG&E delivers to PSE November-February
PSE delivers to PG&E June –September
Most of the energy is delivered during HLH. Hourly energy schedule submitted for Monday-Sunday. Not to exceed 300 MW for any hour, nor more than 2 changes during any day (best efforts), and not less than 25% of the highest rate of delivery scheduled for any hour delivered for such day

Capacity and Energy Exchange Agreement dated 10/4/91
Puget/BPA Intertie Network Transmission Agreement dated 10/4/91
Mitigation Agreement between BPA and PG&E dated 10/4/91
Price: n/a
Term: 10/4/91-12/31/2006. PSE has given PG&E notice of termination as of 12/01
**Expiration: 12/31/2006**

**Point Roberts/BC Hydro/Powerex**
Description: power purchase to serve Pt. Roberts load (physically isolated from PSE's system)
Delivery Point: US/Canadian Border, south end of 56th Street, B.C. Canada where the electrical facilities of PSE and BC Hydro are interconnected.
Capacity: 8MW
Energy: 3 aMW
Scheduling: Full requirements

Agreement for Power Purchase dated 10/1/2001
Price: $67.00/MWh
Term: 10/1/01-9/30/2004
**Expiration: 9/30/2004**

**WNP3 Settlement Exchange Agreement**
Description: Settlement of BPA nuclear project whereby PSE had a 5% ownership and BPA terminated the project. Allows PSE to be in essentially the same power supply situation proportionate to its investment if construction had been completed by 1983.
***BPA Exchange:*** PSE receives an equivalent amount of power based on availability factor of 4 surrogate nuclear units Palo Verde, Unit 1, Arkansas Nuclear One- Unit 2, Waterford Unit 3, and San Onofre 3. The minimum amount of replacement energy PSE is entitled to receive is 5,833,333MWh.
Delivery Point: Maple Valley or Satsop
Scheduling: BPA delivers to PSE November-April. Rate of delivery Nov-Feb shall not exceed 82MW during HLH. During March and April HLH shall not exceed 41MW. Preschedule to BPA by 11:00am. Final preschedule by 2:00pm
PSE's price to BPA: Based on formula calculation in contract.
Transmission: 32,220 kw, transmission charge $0.375/kw/mo.; BPA's rate schedule FPT-02.1

***PSE Exchange***: BPA has a call on PSE's CTs except in the months of May, July and August and pursuant to resource availability.
BPA's price: all incremental generating costs including gas cost, pipeline transport, taxes, O&M
Scheduling: BPA submit preschedule by 9:00am, PSE shall respond by 11:00 am. Final preschedule by 2:00pm. Maximum rate of delivery 117MW

Settlement Exchange Agreement dated 1985
Term: 9/30/2000-6/30/2017
**Expiration: estimated to be 6/30/2017**

**WASCO**
Description: hydro
Generating Capacity: 5MW, 1 unit
Licensing: FERC license issued 12/31/87 (#7076-002)
Location: The Dalles Dam
Outages/Maintenance: May-July (coordinated with PSE), notice provided on or before Jan. 1 of each year for 18 month maintenance schedule
Point of Delivery: Where the project is interconnected with BPA (Klickitat switching station directly connected to BPA's Spearfish sub)
Transmission: from POD to PSE's system, wheeled by BPA under a separate wheeling contract

Agreement for Firm Power Purchase dated 10/24/88 - entire net electrical output. Operation of the project is limited by governmental agencies having jurisdiction over the project (i.e.Corps of Engineers)
Transmission Agreement between Klickitat and WASCO dated 7/25/89
Price: $.0077/kwh x escalation quotient + Exhibit C (below) x amount
WASCO reimburses PSE for losses plus any costs or expenses for wheeling
*Exhibit C*

| | Winter | Summer |
|---|---|---|
| 2001-2012 | $68.76 | $33.23 |

Term: 7/1/91 – 12/31/2012; 21 year contract
Expiration: 12/31/2012

## QUALIFYING FACILITIES (QF's)

### *Cogens*

**March Point Phase I**
Description: 20 year contract, cogeneration, 2 GE Frame 6 units each 35-45MW
Displacement: Yes. Prior to each delivery month Seller shall provide PSE with written notice of its incremental generation rate for such month. PSE shall displace Seller if it determines that replacement power may be less than the incremental generation rate and that such displacement shall not interfere with the operations of the Sellers facility
Generating Capacity: 80MW
Heat Rate: 8400-8500 full capacity; 11,200-11,700 under displacement conditions
Location: Anacortes, WA
Outages/Maintenance: May-July, scheduled 18 mos. in advance; notice provided 1/1 each year
Scheduling: Flat, around the clock
Point of Delivery: Where the project is interconnected with PSE's electrical system

Agreement for Firm Power Purchase dated 6/29/89 - entire net electrical output
Price: Summer (April-Aug) = quotient index x base rate of 7.70 mills+ Exhibit B rate
Winter (Sept-Mar) = quotient index x base rate of 7.70 mills + Exhibit B rate

***$/MWhr (Estimated)***

| | | |
|---|---|---|
| 2001 | 60.72 | 43.32 |
| 2002 | 61.03 | 43.63 |
| 2003 | 61.35 | 43.95 |
| 2004 | 61.67 | 44.27 |
| 2005 | 62.01 | 44.61 |
| 2006 | 62.35 | 44.95 |
| 2007 | 62.71 | 45.31 |
| 2008 | 63.07 | 45.67 |
| 2009 | 63.45 | 46.05 |
| 2010 | 63.84 | 46.44 |
| 2011 | 64.24 | 46.84 |

Term: 10/1/91-12-31/2011
**Expiration: 12/31/2011**

**March Point Phase II**
Description: 20 year contract, cogeneration, 1 GE Frame6 turbine 40MW, 1 steam turbine 20MW
Displacement: Yes. Prior to each delivery month Seller shall provide PSE with written notice of its incremental generation rate for such month. PSE shall displace Seller if it determines that replacement power may be less than the incremental generation rate and that such displacement shall not interfere with the operations of the Sellers facility
Excess Energy Sales Agreement - Yes
Generating Capacity: 60MW
Heat Rate: 8400-8500 full capacity; 11,200-11,700 under displacement conditions
Location: Anacortes, WA
Outages/Maintenance: May-July, scheduled 18 mos. submitted Jan1
Scheduling: Flat, around the clock
Point of Delivery: Where the project is interconnected with PSE's electrical system

Agreement for Firm Power Purchase dated 12/27/1990 - entire net electrical output
Price: Summer (April-Aug) = quotient index x base rate of 8.0 mills+ Exhibit B rate
Winter (Sept-Mar) = quotient index x base rate of 8.0 mills + Exhibit B rate

***$/MWhr (Estimated)***

| | | |
|---|---|---|
| 2001 | 63.52 | 52.92 |
| 2002 | 65.24 | 54.24 |
| 2003 | 66.97 | 55.57 |
| 2004 | 67.91 | 57.21 |
| 2005 | 68.65 | 58.25 |
| 2006 | 70.51 | 59.51 |
| 2007 | 71.48 | 61.48 |
| 2008 | 72.36 | 63.46 |
| 2009 | 73.45 | 65.35 |
| 2010 | 74.46 | 67.16 |
| 2011 | 76.57 | 69.27 |

Term: 11/1/91-12-31/2011
**Expiration: 12/31/2011**

**<u>Sumas</u>**
Description: 20 year contract, cogeneration, 1 gas turbine, 1 steam turbine
Displacement: Yes
Generating Capacity: 125MW; cannot exceed 135MW
Heat Rate: 8208 @ 125MW full capacity;
Location: Anacortes, WA
Outages/Maintenance: May-July, scheduled 18 mos. submitted Jan1
Scheduling: Flat, around the clock
Point of Delivery: Where the project is interconnected with PSE's electrical system

Agreement for Firm Power Purchase dated 2/24/1989 - entire net electrical output
Amendment to Agreement for Firm Power Purchase dated 9/30/91: operating period shall be 20 years after date of commercial operation.
Price: Summer (April-Aug) = quotient index x base rate of 7.70 mills+ Exhibit B rate
Winter (Sept-Mar) = quotient index x base rate of 7.70 mills + Exhibit B rate

***$/MWhr (Estimated)***

| | | |
|---|---|---|
| 2001 | 82.10 | 59.00 |
| 2002 | 81.22 | 58.32 |
| 2003 | 82.74 | 59.54 |
| 2004 | 84.28 | 60.88 |
| 2005 | 85.93 | 62.23 |
| 2006 | 87.59 | 63.6 |
| 2007 | 74.96 | 49.86 |
| 2008 | 76.34 | 50.94 |
| 2009 | 77.73 | 51.93 |
| 2010 | 79.23 | 53.03 |
| 2011 | 80.64 | 54.24 |
| 2012 | 81.07 | 54.67 |
| 2013 | 81.51 | 55.11 |

Term: 4/16/93 -12/31/2012
**Expiration: 12/31/2012**

**Tenaska/PSE**
Description: Qualifying Facility (QF), 2 combustion turbines, 1 steam turbine. 1998-Contract restructuring, PSE supplies natural gas (approx. 50,000 MMBtu)
Capacity: 245MW; Maximum of 280MW
Delivery Point: Where the project is interconnected with PSE's electrical system
Displacement: Yes
Energy: 117 aMW
Heat Rate: 8.7 full capacity; 11.4 for excess energy
Location: Ferndale, WA
Maintenance: May and June unless otherwise agreed to
Scheduling: Prescheduling by 9:00am, Tenaska shall notify PSE of hourly estimates of project generation for next 7 succeeding days.

Agreement for Firm Power Purchase dated 3/20/91 – entire net electrical output
Gas Purchase Agreement between PSE and Tenaska Washington Partners, L.P. dated 1/1/98
DCQ = 50,000 MMBtu; terminates 12/31/2011; coincident with Power Purchase; delivery point: 1) NWPL-Sumas; 2) NWPL/Cascade at Bellingham; 3) Westcoast/Cascade at Sumas; price is Gas Daily index for NWPL-Sumas + $.06/MMBtu
Amendment No. 2 to the Firm Power Purchase dated 1/1/98 – establishes new contract rate
Amendment No.3 to the Firm Power Purchase dated 12/1/99 – Displacement formula
Amended and Restated Excess Energy Sales Agreement dated 8/1/2001 – price = Excess Energy Generation Cost + (Market Price –EEGC)/2
Excess Sales Agreement 6/1/2001 – When not displaced then (a) if 1 gas turbine and 1 steam turbine on line then excess is quantities over 140MW (b) if 2 gas and 0 steam on line then excess is quantities over 164MW; (c) if 1 gas on line then excess is quantities over 85MW

Price/Contract Rate= rate+ (heat rate x fuel costs)/1000

| Year | Rate/$/MW | HeatRate |
|---|---|---|
| 2001 | 31.30 | 8303 |
| 2002 | 32.20 | 8340 |
| 2003 | 31.70 | 8377 |
| 2004 | 33.50 | 8414 |
| 2005 | 33.90 | 8450 |
| 2006 | 35.60 | 8266 |
| 2007 | 33.90 | 8303 |
| 2008 | 32.70 | 8340 |
| 2009 | 31.20 | 8377 |
| 2010 | 29.10 | 8414 |
| 2011 | 26.80 | 8450 |

Term: 4/1994-12/31/2011
Expiration: **12/31/2011**

**QUALIFYING FACITILITIES (CONT.)**

***Small Hydro/Biomass***

**Kingdom Energy Products - Sygitowicz Creek**
Description: small hydro, 1 generating unit
Generating Capacity: 400 kw
Licensing: 7/14/82; transferred to Kingdom (5069-001) Order Granting Exemption from licensing requirements under the Federal Power Act
Location: Van Zandt, Whatcom County
Outages/Maintenance: May-July or as otherwise requested by PSE; written notice of 12 month outage schedule
Point of Delivery: Where energy from Project is to be delivered to PSE's electrical system
Scheduling: N/A; Energy supply does not schedule volumes less than 1 MW

Agreement for Firm Power Purchase dated 1/1/95 – entire electrical output of the Project (less any energy used in connection with the operation of the Project)
Purchase Price:
- 2001 - $47.90
- 2002 - $49.60
- 2003 - $51.50
- 2004 - $53.50
- 2005 - $56.07
- 2006 - $58.76
- 2007 - $61.58
- 2008 - $64.54
- 2009 - $67.63
- 2010 - $70.88
- 2011 - $74.28
- 2012 - $77.85
- 2013 - $81.58

Term: 1/1/1/95-2/2/2014; 19 year agreement; can be extended
**Expiration: 2/2/2014**

**Koma Kulshan**
Description: small hydro, diversion dam
Generating Capacity: 13.7 MW nominal rating
Licensing: FERC license issued 4/13/87 (#3239)
Location: near Concrete, WA
Outages/Maintenance: May-July or as otherwise requested
Point of Delivery: where the Project is interconnected with PSE's system

Agreement for Purchase of power dated 2/21/85
Price: Capital component of 66.7mills/kwh + any additional capital costs + O&M (based on GDP implicit price deflator)+ taxes and insurance. Price is generally in a range of $74-$79/MWhr)
Term: 12/1/90 – expiration of FERC license 50 years
**Expiration: 12/1/2037**

**PERC**
Description: 3 units, 925 kw each (3516 Caterpillar uprated landfill gas engines)
Generating Capacity: not less than 2,775kw
Location: Puyallup, WA , Hidden Valley Landfill
Outages/Maintenance: May and June; submitted to PSE 60 days prior to the next calendar year
Point of Delivery: Interconnected to PSE, retail purchasers Land Recovery, Inc. and Puyallup Sand & Gravel, Inc.

Agreement for Firm Power Purchase – entire electrical output less energy used for project
Energy Price: Dow Jones on/off peak and 24 hour firm pricing, weighted average of the 3

Capacity Payment: $3.00/kw/month multiplied by the sum of the capacity of all the Units
Option Price: $5,000/monthly; $49,950.00 as an advance payment of part of the price for capacity for the first six calendar months of the Operating Period
Right of First Refusal: $15,000/month during Operating Period
Provision for Green Power

Term: 4/15/99-4/15/2009, 10 year contract
**Expiration: 4/15/2009**

**Port Townsend Paper Corporation**
Qualifying Facility (QF) status
Description: small hydro, 1 unit
Generating Capacity: 375 kw nominal rating
Licensing: Project is exempt from licensing requirements under the Federal Power Act
Location: Port Townsend, WA
Outages/Maintenance:
Point of Delivery: where the project is interconnected with PSE's electrical system
Scheduling: N/A; Energy supply does not schedule volumes less than 1 MW

Agreement for Firm Power Purchase dated 1/1/99- for entire net electrical output generated
Price: electrical output x long term avoided cost rate

***$/MWh***

| | 2001 | 2002 | 2003 |
|---|---|---|---|
| Jan | 30.7 | 32.4 | 33.6 |
| Feb | 28.1 | 30.7 | 31.9 |
| Mar | 22.8 | 24 | 25.4 |
| Apr | 20.1 | 20.9 | 21.9 |
| May | 17.6 | 19.2 | 20 |
| Jun | 18 | 19.3 | 21.4 |
| July | 24.5 | 26 | 27.3 |
| Aug | 26.1 | 27.6 | 31.4 |
| Sept | 28.3 | 31 | 34.6 |
| Oct | 26.5 | 28 | 29.6 |
| Nov | 28.5 | 29.6 | 30.9 |
| Dec | 30.3 | 31.7 | 34.1 |

Should PSE extend the contract beyond 2004, which is likely, Port Townsend Paper will be moved to Schedule 91 which prices the resource according to the lesser of (a) market (Mid-C firm for on peak/off peak) or (b) Sumas gas index for applicable month x heat rate proxy of 10.2

Term: 1/1/99 – 12/31/2003
**Expiration: 12/31/2003**

**STS Hydropower Ltd. –Hutchison Creek**
Qualifying Facility (QF) status
Description: small hydro, 4 generators, 225 kw each, diversion dam, uses Nooksack River
Generating Capacity: Approx. 900 kw
Licensing: FERC exemption from licensing
Location: Bellingham, WA
Outages/Maintenance:
Point of Delivery: Where the project is interconnected with PSE's electrical system
Scheduling: N/A; Energy supply does not schedule volumes less than 1 MW

Power Sales Agreement dated 9/20/84
Price: Winter (October-March) - $0.045/kw
Summer (April-September) - $0.027/kw

Penalty provision if Seller does not deliver as much energy during the second half of the Term as during the first half. Seller shall pay PSE $0.01 for each kilowatt hour undelivered.
Should PSE extend the contract beyond 2004, STS will be moved to Schedule 91 which prices the resource according to the lesser of (a) market (Mid-C firm for on peak/off peak) or (b) Sumas gas index for applicable month x heat rate proxy of 10.2

Term: 10/1/84 – 9/30/2004; 20 year contract
**Expiration: 9/30/2004**

**Spokane Project**
Qualifying Facility (QF) status; 21 year contract
Description: thermal, regional solid waste refuse combustion project
Generating Capacity: 22.9MW
Location: Spokane County, WA
Outages/Maintenance: Written notice shall be provided on or before Jan 1 of each year for all outages for next 18 months
Point of Delivery: interconnection with WWP's system
Scheduling: Hourly Preschedule submitted by PSE to BPA by 12:00pm
Transmission: Wheeled from project by BPA to Kitsap Substation
PSE incurs energy losses at a rate of 1.6% of the amount of all energy delivered to PSE by BPA under the Transmission Agreement, Spokane reimburses PSE for wheeling costs.

Agreement for Firm Power Purchase dated 1/4/88– purchase of entire net electrical output less plant use
Transmission Agreement by BPA, WWP,PSE and City of Spokane dated 7/28/88
Price: $0.0074/kwhr x escalation quotient (GDP/1987 base year) + Exhibit C (below)

***Exhibit C***

| | Winter (Sep-Mar) | Summer (Apr- Aug) |
|---|---|---|
| 2001-2008 | $96.40 | $52.80 |

Term: 3/1/90-2/28/2011
**Expiration: 2/28/2011**

**Twin Falls**
Description: hydro, 2 units, run of the river (Snoqualmie)
Generating Capacity: 20MW
Licensing: FERC license issued 9/22/86 (#4885-003)
Location: South Fork Snoqualmie River, King County, WA ( 5 miles east of North Bend)
Outages/Maintenance: May–September, generally August and September
Point of Delivery: where the project is interconnected to PSE's system

Agreement for the Purchase of Power dated 10/29/84 – for the entire net electrical output
Price: $75.00/MW
Term: 3/8/1990-3/8/2025, 35 year contract
**Expiration: 3/8/2025**

**Weeks Falls**
Description: hydro
Generating Capacity: 4.6MW
Licensing: FERC license issued 4/24/85 (#7563)
Location: South Fork Snoqualmie River, King County, WA
Outages/Maintenance: May-September, generally August and September with notice on or before January 1 of each year

Point of Delivery: Where the project is interconnected to PSE's system

Agreement for Purchase of Power dated 10/29/84 - entire net electrical output
Amendment No.1 to the Agreement for the Purchase of Power from the Weeks Falls Hydro Electric Project dated 12/12/85 increasing capacity, updating one line and delivery voltage
Price: $75.00/MW
Term: 12/1/87 (COD) - 12/31/2022; 35 year contract
**Expiration: 12/31/2022**

## CONTRACTS TO NOTE:

### BPA Residential Exchange

Description: NW Power Act establishes a Residential Exchange Program to provide benefits to residential and small farm consumers through the Residential Purchase and Sale Agreement. Pursuant to this Amended Settlement Agreement (Agreement), instead of delivering firm power to PSE, BPA will make cash payments to PSE during the period July 1, 2001- September 30, 2006. The Agreement also extends the term from 10/1/2006 thru 9/30/2011 on the same terms and conditions in the Residential Exchange Settlement Agreements and Firm Power Block Sales Agreements (monetary benefits and firm power). Unless notification is given to BPA by October 2005. BPA will use the power not sold to PSE to meet its firm load obligations in the PNW

**10/1/2001-9/30/2006: Monetary Benefit**
10/1/2001-9/30/2002 – Monthly Cash payment by BPA to PSE = $14,142,786
10/1/2002-9/30/2006 – Monthly Cash payment by BPA to PSE = $14,628,966
**10/1/2006 – 9/30/2011: Firm Power and Monetary Benefits**
BPA shall provide to PSE Firm Power or Monetary Benefit payments, or both. PSE must notify BPA by October 2005
Total of Firm Power and Monetary Benefit for Puget = 648 annual aMW

Amended Settlement Agreement executed by BPA and PSE date June 11, 2001
Term: 7/1/01-9/30/2011
Termination: **9/30/2011**

*Note condition in the Agreement for:*
Conservation and Renewables Discount = Total Net Requirements Loads (700aMW) x .5mill/kwh discount rate x 8760 = $3,066,000 annually = $255,500/monthly for 5 year term.
PSE is required to submit an annual C&R Discount report specifying the amount of expenditures claimed under the program and amount of C&R Discount received to date. First report is due 10/1/2002.

### MEGA- Merchant Energy Group of the Americas, Inc.

Description: (7) LM2500 turbine units to be operated by Pierce Power LLC
Capacity: 154MW
Energy: 50% of the Available Capacity
Point of Delivery: 115kv terminals at Fredrickson site
**Non Winter Supply Period: 3/1/2002-9/30/2002**
Scheduling: Not later than 5:30 am PPT on the Prescheduling Day Buyer may notify Seller that Buyer intends to purchase and take delivery of whatever energy is produced during that day in the amount associated with 50% of the available capacity.

Electric Capacity and Energy Confirmation Agreement dated July 31, 2001
Capacity Price -Supply Period: $1.00/month/turbine ($7.00)
Energy Price- Supply Period: Seller's actual costs including fuel and transportation
Variable O&M: $0.71/MWH
Term: 7/31/2001-9/30/2002
Termination: **9/30/2002**

Electric Capacity and Energy Confirmation Agreement dated April 20, 2001
**Winter Period: 12/1/2001- 2/28/2002**
Energy: 100% of the Available Capacity
Point of Delivery: Same as above
Market Charge: Dow Jones, Mid-C Index for Firm On-Peak, Firm Off-Peak and Sunday 24 Hour Firm for the period in which such hour occurs.
Outage Strike Price: $/mWh (payment for outages)
Variable O&M: $0.71/MWH

Capacity Price-Winter Period: $419,931.00/month /turbine for each month of the winter period. This amount shall be reduced prorata, MW for MW, day for day, if unable to generate normal rated output
Energy Price-Winter Period: Seller's actual costs including fuel and transportation
Scheduling: Same as above
Term: 5/2/01 – 11/30/2002
Termination: **11/30/2002**

**Black Creek Hydroelectric**

Description: Storage and Transmission. Letter Agreement between WWP and PSE dated 7/14/98 in which PSE shall store the power generated by Black Creek during the year (July-June period) and return all power to WWP during the month of August of each year. The Agreement for Power Sale is between WWP and Black Creek Hydro (HEDC, Hydroelectric Development Corporation, an affiliate of PSE)
Capacity: 3.7MW, 1 generating unit
Storage charge: PSE bills WWP $6.00/MWr
Scheduling: product is shaped when delivered to WWP
Term: 7/14/98-6/30/04
Termination: **6/30/2004**

**Skookumchuck**

Description: Thermal. Part of the Centrailia Steam Electric project, 2 year letter agreement with PacifiCorp expired on 10/31/95
Capacity: 980 kw
Location: Centralia, WA
Price: $16.00/MWhr
Transmission:
Agreement for Firm Power Purchase dated
Term: 7/1/93-10/31/95 or until a long term agreement can be agreed upon
Termination: Upon notice?

Selected Transmission Studies

# Selected Transmission Studies

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The following files represent a 2000 heavy winter case with north to south flows on the BC to Pacific Northwest intertie and north to south flows on the Pacific AC Intertie.

- HSNS4I - Compressed input and output file for a 2000 heavy summer case, North to South flows
- HSNS4O - Compressed input and output file for a 2000 heavy summer case, North to South flows
- HWNS2I - Compressed input and output files for a 2000 heavy winter case, North to South flows
- HWNS2O - Compressed input and output files for a 2000 heavy winter case, North to South flows

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The following files represent a study for generation integration at PSEI's Frederickson substation.

- FREDERICKSONI - Word
- FREDERICKSONI - Excel
- FREDERICKSONII - Word
- FREDERICKSONII - Excel

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The following file represent a study for generation integration at PSEI's Sumas substation.

- SumasII - Transmission Contraints Scoping Study

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The following file represent a study for transmission service from March Point Co-generation to the Mid-Columbia bus.

- MPCC Point-to-Point Service Request, System Impact Study

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The following PTI Must output files represent a preliminary assessment of PSEI's Whatcom/Skagit counties' transmission system for the summer 2001. This assessment is preliminary:

- Summer 2001, existing generation, SINGLECM Word file

- Summer 2001, existing generation, SINGLECM_FCITC Word file
- Summer 2001, existing generation, former loads, SINGLECM Word file
- Summer 2001, existing generation, former loads, SINGLECM_FCITC Word file
- Summer 2001, new Fredonia 100MW, IndAdj, PTIfixes, SINGLECM Word file
- Summer 2001, new Fredonia 100MW, IndAdj, PTIfixes, SINGLECM_FCITC Word file
- Summer 2001, new MPCC 50MW, new Fredonia 100MW, IndAdj, PTIfixes, SINGLECM Word file
- Summer 2001, new MPCC 50MW, new Fredonia 100MW, IndAdj, PTIfixes, SINGLECM_FCITC Word file

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The following zip file represents a study conducted as part of Electricity Captial, LCC's request for transmission service and generation integration near PSEI's Frederickson substation. The zip contains one Word document and three post-script power flow drawing files.

- Electricity Capital Study

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The following zip file contains a study conducted as part of Puget Sound Energy's merchant function's request for additional generation integration at Fredonia substation. The zip contains one Word document.

- Fredonia 100MW Study

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Back to PSEI's Documents

# FREDERICKSON

# 270 MW

Frederickson - 270 MW

# SYSTEM IMPACT STUDY
# OASIS Reference No. 17855
# 270 MW GENERATION ADDITION TO FREDERICKSON 115 kV BUS

September 29, 2000
PSE Electric Transmission

## INTRODUCTION

This study is in response to OASIS Reference No. 117855 and the System Impact Study Agreement executed by PSE's merchant function on May 17, 2000 requesting, among other things, 270 MW of Firm Point-to-Point Transmission Service for proposed new combined-cycle generation located at PSE's 115 kV Frederickson Substation located in Pierce County, Washington. This study summarizes the results of analyses done to develop reliable transmission alternatives that integrate the proposed generation at Frederickson. The generation studied includes six levels of generation: (1) 0 MW; (2) 149 MW of existing Frederickson generation; and (3) 200 MW; (4) 250 MW; (5) 270 MW; and (6) 300 MW from the proposed generators, with levels (3) – (6) all including 149 MW of existing Frederickson generation.

## CONCLUSION

With certain transmission improvements, the proposed generation at a 270 MW level can be reliably integrated into the transmission system through a 115 kV connection at PSE's Frederickson Substation. A single 115 kV line would be constructed between the proposed generator substation bus and the Frederickson Substation bus, with substation breakers at both ends of the line.

Two alternative transmission improvement plans have been identified. The preferred plan is: (a) construct a line from Frederickson Substation to Woodland Substation (north of Frederickson); (b) convert the Fern Hill-St. Clair 55 kV line to 115 kV; (c) install substation breakers for the lines; and (d) upgrade several other lines to higher ratings.

The alternative plan is: (a) reconductor the Frederickson-St. Clair 115 kV line; (b) reconductor the 4/0 copper portions of the Electron Heights-Blumaer line; and (c) upgrade several lines to higher ratings. The preferred plan is less expensive, can avoid the need to trip generation for most transmission outages, and can support generation output under a greater number of planned and unplanned transmission outages.

For the condition of highest flow across the Raver-Paul path, generator tripping is not required for a West Side Northern Intertie (WSNI) import up to 2850 MW. With pre-existing line outage conditions, the proposed generation may need to be tripped by an electronic signal supplied by BPA for high West Side Northern Intertie imports.

An estimate of the cost for transmission interconnection facilities and transmission improvements is $16,500,000 for the preferred plan, and $19,300,000 for the alternative plan. The major difference between the two plans is that the preferred plan provides a second transmission circuit west to St. Clair, and north to White River and Alderton. Therefore, the system will be able to sustain transmission system outages and continue to support generation output from the proposed generators much better under the preferred plan, than with the alternative plan.

## STUDY ASSUMPTIONS

Summer and winter seasons were studied with high Raver-Paul loading and high north to south flows on lines going through Pierce County. Flow conditions with high south to north flows to Canada were also checked for the summer. The summer season included heavy and light load conditions for both north to south and south to north. The winter season studies were with heavy loading. The existing two combustion turbines were included as generating 74.4 MW each in most of the simulations. The proposed 270 MW generation is in addition to the existing 149 MW from Frederickson.

The lines that cross Pierce County toward Thurston and Lewis Counties in the south are:

Raver-Paul 500 kV line
White River-Cowlitz-Olympia 230 kV line
Covington-Cowlitz-Chehalis 230 kV line
Frederickson-St. Clair 115 kV line
Electron Heights-Blumaer 115 kV line
White River-Fern Hill 57.5 kV line

The time frame used for simulations was 2002 with the following improvements assumed to be completed:

Chief Joe-Monroe #4 line re-converted to 345 kV operation.
Bothell-Snoking #2 and Snoking-Maple Valley #2 230 kV lines energized.
Schultz-Raver #2 500 kV line rerouted from Raver to Echo Lake.
Bothell #2 and #3 230-115 kV transformers replaced with 300 MVA transformers.
Novelty 115 kV substation bus.
Shelton-South Bremerton 230 kV line, South Bremerton 230-115 kV transformer.

Reactive power margin and voltage stability were not determined. It is anticipated that the addition of the proposed generation with full reactive capability will improve voltage regulation in the area. This can be confirmed with reactive margin studies. Transient stability was not confirmed, and would be done when stability models, and machine specific parameters are provided.

## OUTAGE ASSUMPTIONS

Outages taken included single contingency (N-1) outages and common mode outages. The single contingency outages are taken automatically, and include all lines in southern King, Pierce and Thurston Counties. The common mode outages are:

White River north 230 bus, south 230 bus, north115 bus, and south 115 bus
Alderton 115 bus, Frederickson 115 bus, Woodland 115 bus
Krain Corner 115 bus, Electron Heights 115 bus, Saint Clair 115 bus
Blumaer 115 bus, West Olympia 115 bus, Plum Street 57.5 bus
PSE Olympia north 115 bus, and south 115 bus, Tono 115 phase shifter
BPA Olympia east 230 bus, west 230 bus, and 115 bus
All 115 kV double circuit outages in Pierce County.

The following use governor load-flow following WSCC guidelines.

Raver-Paul 500 line; Trip BC Hydro, FDG/WHG
Raver-Paul 500 line; Trip BC Hydro, FDG/WHG, PG
Raver-Paul-Centralia G2 500 BKF; Trip BC Hydro, FDG/WHG
Raver-Paul-Centralia G2 500 BKF; Trip BC Hydro, FDG/WHG, PG
Raver-Paul-Centralia G2 500 BKF & Centralia G1; Trip BC Hydro, FDG/WHG
Raver-Paul-Centralia G2 500 BKF & Centralia G1; Trip BC Hydro, FDG/WHG, PG

Paul-Allston 1&2 500 lines on common right-of-way; Trip BC Hydro

The formula for tripping BC Hydro generation is:

Trip generation = 1.3 x (West Side NI north-to-south – 1450 MW)

FDG/WHG stands for tripping Fredonia and Whitehorn combustion turbines.
PG stands for tripping the proposed generation.
BKF stands for breaker failure.

**FINDINGS**

The Frederickson Substation 115 kV bus is currently interconnected to the local transmission system through three 115 kV lines. They are: Alderton - Frederickson, Electron Heights -Boeing Puyallup - Frederickson, and Frederickson - St. Clair. The usual flow on these lines is from the northeast to the southwest, corresponding to the flow pattern on the 230 and 500 kV lines across the same area. With the addition of 270 MW of generation connected at Frederickson, these three lines can become overloaded above their thermal capabilities, especially during conditions when other facilities are out-of-service. Out-of-service conditions may be those that are planned for maintenance needs, or those that are unplanned, such as due to wind or lightening.

To operate the system reliably, reliability criteria are used by WSCC member utilities that specify, among other things, single element outages, and common element outages that should be accommodated when planning transmission facilities. Operator actions and remedial action schemes (RAS) may be used to adjust the system to operate it in a reliable condition. One RAS used on this path is to automatically trip selected generators to the north, if the BPA Raver-Paul 500 kV line is lost from service during a period of high north to south flow on the Raver-Paul line. By tripping generation to the north, the flow that shifts from the 500 kV line to the underlying 230 and 115 kV line is reduced.

Two alternative transmission improvement plans were developed that will support the interconnection of the proposed generation to the Frederickson substation 115 kV bus. The preferred plan is: (a) construct a line from Frederickson Substation to Woodland Substation (north of Frederickson); (b) convert the Fern Hill-St. Clair 55 kV line to 115 kV; (c) install substation breakers for the lines; and (d) upgrade several lines to higher ratings. The alternative plan is: (a) reconductor the Frederickson-St. Clair 115 kV line to a much larger conductor; (b) reconductor the 4/0 copper portions of the Electron Heights-Blumaer line; and (c) upgrade several lines to higher ratings.

The preferred plan results in two paths from Frederickson to St. Clair, and from Frederickson to Alderton, whereas the other alternative plan results in single paths from Frederickson to St. Clair, and to Alderton. As a consequence, the preferred plan can support generation output under many planned and unplanned outages that the alternative plan cannot. The preferred plan can avoid generator RAS tripping for most transmission outages, and is less expensive. Line item details of both plans are given in the COSTS section that follows.

Simulation Results

The pre-outage flows on lines can be seen in Table 1, which shows MW flows before outages are taken for the preferred and alternative plans. Heavy and light summer cases are represented with WSNI in the north-to-south (at 2850 MW) and south-to-north (and 1500 MW) directions. In the winter cases the WSNI is 1450 MW north-to-south. Line flows on the Raver-Paul 500 kV line, as an example are about 1800 in the heavy summer north-to-south case, and 2000 MW in the light summer north-to-south case.

Raver-Paul 500 kV line in the winter case is goes down to about 1200 MW. When the winter import OTC rises above 1450 MW, then transmission through-flows will increase and loading on the Raver-Paul line will increase.

During the summer season the loading on lines in the Raver-Paul path is generally closer to their ratings than during other seasons. This is because the transmission through-flow is higher, and because the line ratings are often significantly lower in the summer, especially on lines having low conductor temperature ratings. The summer season then presented the worst case conditions and became the focus for developing alternative improvements.

The difference in distribution of MW loading on the transmission lines between the two plans can be seen by comparing the numbers separated by a slash "/" in Table 1. For example, in the heavy summer, north-to-south case with the proposed generation at 270 MW, the loading on the Frederickson-St. Clair 115 kV line (labeled FREDRICK – TILCM TP 115) is 135 / 184. Flow on this line under the preferred plan is 135 MW, and on the alternative plan, it is 184 MW.

The sensitivity of line loading to Raver-Paul flow levels can be determined from this table. For example, in the heavy summer north-to-south case, with the proposed generation at 270 MW, loading on the proposed Woodland-Fern Hill line is 109 MW, when loading on the Raver-Paul line is 1822 MW. In the heavy summer south-to-north case, loading on the Woodland-Fern Hill line is 49 MW, when loading on the Raver-Paul line is 723 MW. A 60% reduction of flow on the Raver-Paul line is accompanied by a 55% reduction of flow on the Woodland-Fern Hill line.

The results of outage simulations are given in Table 2, for single contingency outages (N-1), and common mode outages, except that the Raver-Paul 500 kV outage results for summer are given in Tables 3-6, and are discussed later. The outage results for other than the Raver-Paul 500 kV show that line loadings remain within their ratings up to an addition of 270 MW of generation. An exception is the double line loss of the Alderton-Frederickson and Frederickson-St. Clair 115 kV lines for the alternative plan. This outage is an N-1 outage only if one of the other two lines to Frederickson is already out for some reason. Because of the severity, a RAS should be installed to trip the proposed generation if the alternative plan is implemented and this outage occurs.

Other overloads in Table 2 are the Covington-Tacoma A 230 kV line and the White River-Tacoma B 230 kV line. These lines are actually both parts of separate three-corner lines. They are the Covington-Cowlitz-Chehalis (Tacoma A) and the White River-Cowlitz-Olympia (Tacoma B) 230 kV lines. These overloads would only occur in the event that either of the line breakers at Cowlitz Substation were to open without its entire three-corner line tripping. By installing relays to open the appropriate Covington or White River breaker or the appropriate Olympia or Chehalis 230 kV breaker when its Cowlitz breaker opens, these overloads would not occur. As indicated in the table, these overloads are insensitive to the existing Frederickson and proposed generation levels.

Raver-Paul 500 kV Outage

The most severe outage is the Raver-Paul 500 kV outage, and combination outages, in which the Raver-Paul 500 kV line is included. The combination outages studied are a breaker failure at Paul that trips both the Raver-Paul line and the Centralia #1 generator, and the same breaker failure when the Centralia #2 generator is also out-of-service. Results are given in Tables 3-6, and include heavy and light summer load with the preferred plan (Tables 3 & 4), and heavy and light summer load with the alternative plan

(Tables 5 & 6). The tables show when lines overload both without, and with tripping the proposed generators.

BPA arms a generator tripping RAS when there are high north to south flows on the Raver-Paul 500 kV line. The RAS sends trip signals to selected generators north of this line when the RAS detects that the line is lost from service. The generators that are armed are determined according to the flow level on the Raver-Paul line, and other factors, as described in BPA Dispatcher Standing Order (DSO) 307. In the power system simulations, for high flow levels on the Raver-Paul line, the generators that were tripped included Whitehorn, Fredonia, 1024 MW at Chief Joseph, and units in Canada following the formula:

$$MWtoTrip = 1.3(IngledowCusterflow - 1450MW)$$

The results indicate that for heavy or light summer loads, with the existing Frederickson CT's on, and with the proposed generators at 270 MW, the preferred plan will support a WSNI level that is 100 to 140 MW higher than the alternative plan. For the Raver-Paul single line outage, and Raver-Paul and Centralia Unit 2 breaker failure outage, tripping the proposed generators is not required with the preferred plan, and is probably not required with the alternative plan.

When the Centralia Unit 1 is out-of-service, the Raver-Paul pre-outage flow modeled is above 2000 MW. In practice, BPA would reduce the flow on the Raver-Paul 500 kV line, following DSO 307 for Level 4, so that the overloads would not happen if the outage were to occur. But running the outage at this high level illustrates the need for a Raver-Paul flow threshold that results in significant overloads if violated. From Table 3, with Centralia Unit 1 down, and following the breaker failure outage, loading on the Tacoma A-Centralia 230 kV line is at 104.8% of its rating when Frederickson CT's are on, but with the proposed generation at zero. When the proposed generators are at 270 MW, for the outage, loading on the Tacoma A-Centralia 230 kV line is at 107.5% of its rating. By tripping the full 270 MW, loading on this line reduces to 105.3%. In practice, when the Centralia Unit 1 is out-of-service, the flow level on the Raver-Paul would be reduced before any outages.

The percents of overload for the light summer cases are higher than the heavy summer cases. However, the increase is only 3 to 4%. During light load conditions, ambient temperatures are lower, and line ratings increase. For the lines that overload, a reduction in ambient air temperature from 35C to 20C results in a 10% increase in rating. During winter conditions the line loading on the Raver-Paul is relatively much lower.

The White River-Fern Hill 57.5 kV line overloads for the alternative plan with outages of the Raver-Paul line. A relay is installed at White River to detect when the line is being overloaded and the relay will sent a signal to automatically trip the line breaker at White River. All the power system simulations on the alternative plan were done with either the White River-Fern Hill line open, or with the relay modeled to open the line up if the flow level on the line is above its seasonal rating.

<u>Winter</u>

Some common mode outages do not achieve a solution for winter loading conditions. The Olympia 230 kV bus is divided between east and west segments with both 230-115 kV transformers on one bus segment, the east bus. Loss of the Olympia 230 east bus results in no solution. Loss of the Olympia 230 west bus results in depressed voltages and severe overloads. The depressed voltages may be remedied by inserting capacitors that are not in the case. The combination outage of the breaker failure loss of the Paul-Raver line and Centralia unit #2, when Centralia unit #1 is out-of-service fails to solve in the winter case. The voltage collapse is too severe to get a power flow solution. The conclusion is that during winter heavy loads, Centralia unit #1 must be running.

**COSTS**

Transmission costs for improvements to connect the proposed 270 MW of generation at Frederickson for the preferred and alternative plans include the following. This does not include the cost of 115 kV breakers at the proposed generator bus, or generator step-up transformers.

| **Preferred Plan** | | ($ x1000) |
|---|---|---|
| Cut over Fern Hill-St. Clair 55 kV line to 115 kV | | |
| Woodland-Fern Hill, rebuild 55 line to 115 with Bittern | 2,200 | |
| Fern Hill-South Gate Tap, uprate Bittern to 100C | 20 | |
| South Gate Tap-Gravelly Lake Drive, reconductor 2 miles to Bittern, and uprate existing Tern to 100C | 700 | |
| Gravelly Lake Drive-Holden Tap, reconductor 2.5 miles to Bittern | 900 | |
| Holden Tap-Dupont-St. Clair, uprate Bittern and Tern to 100C | 70 | |
| Woodland Substation, construct 115 kV bus with 3 breakers | 1,600 | |
| St. Clair Substation, install a 115 kV breaker | 400 | |
| Gravelly Lake Substation, install two 115 kV breakers | 700 | |
| Fern Hill & South Gate, construct distribution facilities | 1,000 | |
| | | 7,590 |
| Construct Woodland-Frederickson 115 kV line | | |
| Construct 0.5 and 1 mile sections of double circuit Bittern | 700 | |
| Reconductor 2 miles of Tern to Bittern | 260 | |
| Construct 4.7 miles of Bittern | 1410 | |
| Breakers at Woodland and Frederickson | 800 | |
| Additional right-of-way costs | 150 | |
| | | 3,320 |
| Frederickson-Proposed Generator 115 kV bus | | |
| Frederickson-Proposed Gen., construct 115 kV Lapwing ¼ mile | 90 | |
| Frederickson Substation, install 115 kV breaker | 450 | |
| | | 540 |
| Up-Rate several 115 kV lines to higher conductor temperature | | |
| Electron Heights-Boeing Puyallup-Frederickson, 17 miles to 100C | 340 | |
| Frederickson-Hemlock-Alderton, 12 miles Tern to 150C | 360 | |
| White River-Gardella-Alderton, 7.4 miles, Tern to 100C | 150 | |
| White River-Sumner-Pioneer, 4.7 miles, Tern to 100C | 100 | |
| Alderton-Stewart, reconductor 0.5 mile 4/0 to Bittern | 120 | |
| St. Clair-Johnson Hill, 5.7 miles, Tern to 100C | 120 | |
| St. Clair-Patterson, 2.7 miles, Tern to 100C | 60 | |
| | | 1250 |
| Total for preferred plan | | $ 12,700. |
| Total for preferred plan with 30% contingency buffer | | **$ 16,500.** |

| **<u>Alternative Plan</u>** | | ($ x1000) |
|---|---|---|
| Frederickson-St. Clair 115 kV line | | |
| Reconductor 29.7 miles to Lapwing (may require switch replacement) | | 7,430 |
| Electron Heights-Blumaer 115 kV line | | |
| Reconductor 4/0 copper is 23.5 miles to Tern | 5860 | |
| Up-rate Merlin conductor, 15.9 miles, to 125C | 320 | |
| | | 6,180 |
| Frederickson-Proposed Generation 115 kV bus | | |
| Frederickson-Proposed Gen., construct 115 kV Lapwing ¼ mile | 90 | |
| Frederickson Substation, install 115 kV breaker | 450 | |
| | | 540 |
| Up-Rate several 115 kV lines to higher conductor temperature | | |
| Electron Heights-Boeing Puyallup-Frederickson, 17 miles to 100C | 340 | |
| Frederickson-Hemlock-Alderton, 12 miles Tern to 150C | 360 | |
| Alderton-Stewart, reconductor 0.5 mile 4/0 to Bittern | 120 | |
| | | 820 |
| Total for second alternative | | $ 14,970. |
| Total for second alternative with 30% contingency buffer | | $ 19,460. |

## Table 1. Line flows on both Plans with Incremental levels of Proposed Generation

Page 1 / 2

| Seasonal case | Proposed Generation MW Level & Frederickson CT MW Level: 0 & 0 | 0 & 149 | 200 & 149 | 250 & 149 | 270 & 149 | 300 & 149 |
|---|---|---|---|---|---|---|
| ELEMENT OR PATH | Line loading in Mw ( Preferred Plan Cc / Alternative Plan Ec) | | | | | |
| **2002 Heavy Summer, West Side NI North to South** | | | | | | |
| West Side NI, Ingledow-Custer 1&2 | 2851 / 2850 | 2851 / 2850 | 2852 / 2851 | 2851 / 2851 | 2851 / 2850 | 2851 / 2851 |
| RAVER - PAUL 500 | 1787 / 1807 | 1800 / 1816 | 1816 / 1829 | 1820 / 1833 | 1822 / 1834 | 1825 / 1836 |
| OLYMPIA - TACOMA B 230 | 308 / 317 | 312 / 319 | 316 / 322 | 317 / 323 | 318 / 324 | 319 / 324 |
| TACOMA A - CENTR SS 230 | 292 / 296 | 297 / 300 | 303 / 306 | 305 / 307 | 306 / 308 | 307 / 309 |
| FREDRICK - BOE_PUY 115 | 3 / -1 | 27 / 34 | 60 / 82 | 68 / 94 | 71 / 99 | 76 / 106 |
| FREDRICK - SW28TIE 115 | -39 / -81 | 1 / -8 | 56 / 93 | 70 / 118 | 75 / 128 | 83 / 143 |
| FREDRICK - TILCM TP 115 | 64 / 77 | 90 / 116 | 124 / 167 | 132 / 179 | 135 / 184 | 140 / 192 |
| FREDRICK - WOODLND 115 | -34 | 24 | 102 | 122 | 130 | 141 |
| WOODLND-FERNHILL 115 | 79 | 90 | 105 | 108 | 109 | 111 |
| WOODLND-PIONEER 115 | -96 | -61 | -13 | -1 | 4 | 11 |
| WOODLND-FRUITLAND 115 | -23 | -12 | 4 | 8 | 9 | 11 |
| **2002 Light Summer, West Side NI North to South** | | | | | | |
| West Side NI, Ingledow-Custer 1&2 | 2851 / 2850 | 2851 / 2851 | 2851 / 2851 | 2851 / 2850 | 2851 / 2851 | 2850 / 2850 |
| RAVER - PAUL 500 | 1997 / 2019 | 2008 / 2026 | 2017 / 2034 | 2021 / 2035 | 2022 / 2036 | 2024 / 2038 |
| OLYMPIA - TACOMA B 230 | 334 / 344 | 338 / 346 | 343 / 350 | 345 / 351 | 345 / 351 | 346 / 352 |
| TACOMA A - CENTR SS 230 | 310 / 314 | 315 / 318 | 322 / 324 | 323 / 326 | 324 / 327 | 325 / 327 |
| FREDRICK - BOE_PUY 115 | 0 / -4 | 24 / 32 | 57 / 79 | 65 / 91 | 68 / 96 | 73 / 103 |
| FREDRICK - SW28TIE 115 | -42 / -87 | -1 / -13 | 54 / 88 | 67 / 113 | 73 / 123 | 81 / 139 |
| FREDRICK - TILCM TP 115 | 73 / 88 | 99 / 126 | 132 / 177 | 140 / 189 | 143 / 194 | 148 / 201 |
| FREDRICK - WOODLND 115 | -34 | 23 | 102 | 121 | 129 | 141 |
| WOODLND-FERNHILL 115 | 88 | 99 | 113 | 116 | 118 | 120 |
| WOODLND-PIONEER 115 | -93 | -58 | -9 | 3 | 8 | 15 |
| WOODLND-FRUITLAND 115 | -34 | -22 | -7 | -3 | -1 | 1 |
| **Dec. 2002 Heavy Winter, West Side NI North to South** | | | | | | |
| West Side NI, Ingledow-Custer 1&2 | 1450 / 1450 | 1451 / 1450 | 1450 / 1450 | 1451 / 1451 | 1451 / 1450 | 1451 / 1451 |
| RAVER - PAUL 500 | 1148 / 1161 | 1159 / 1170 | 1173 / 1180 | 1177 / 1183 | 1179 / 1184 | 1181 / 1186 |
| OLYMPIA - TACOMA B 230 | 185 / 191 | 189 / 193 | 193 / 196 | 194 / 197 | 195 / 197 | 195 / 198 |
| TACOMA A - CENTR SS 230 | 77 / 79 | 82 / 84 | 89 / 90 | 90 / 92 | 91 / 92 | 92 / 93 |
| FREDRICK - BOE_PUY 115 | 10 / 5 | 37 / 44 | 69 / 91 | 77 / 103 | 80 / 108 | 85 / 115 |
| FREDRICK - SW28TIE 115 | -29 / -66 | 15 / 16 | 70 / 117 | 84 / 143 | 89 / 153 | 97 / 168 |
| FREDRICK - TILCM TP 115 | 45 / 50 | 72 / 92 | 105 / 142 | 114 / 155 | 117 / 160 | 122 / 167 |
| FREDRICK - WOODLND 115 | -37 | 27 | 106 | 126 | 134 | 145 |
| WOODLND-FERNHILL 115 | 53 | 65 | 79 | 83 | 84 | 86 |
| WOODLND-PIONEER 115 | -105 | -66 | -17 | -5 | 0 | 7 |
| WOODLND-FRUITLAND 115 | -1 | 12 | 28 | 31 | 33 | 35 |

## Table 1. Line flows on both Plans with Incremental levels of Proposed Generation

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| Seasonal case | Proposed Generation MW Level & Frederickson CT MW Level | | | | | |
|---|---|---|---|---|---|---|
| | 0 & 0 | 0 & 149 | 200 & 149 | 250 & 149 | 270 & 149 | 300 & 149 |
| ELEMENT OR PATH | Line loading in Mw ( Preferred Plan Cc / Alternative Plan Ec) | | | | | |
| 2002 Heavy Summer, West Side NI South to North | | | | | | |
| West Side NI, Custer-Ingledow 1&2 | 1506 / 1506 | 1500 / 1500 | 1501 / 1501 | 1501 / 1501 | 1502 / 1501 | 1501 / 1501 |
| RAVER - PAUL 500 | 704 / 705 | 705 / 706 | 719 / 716 | 722 / 718 | 723 / 719 | 726 / 721 |
| OLYMPIA - TACOMA B 230 | 89 / 90 | 89 / 90 | 93 / 92 | 94 / 93 | 95 / 93 | 95 / 93 |
| TACOMA A - CENTR SS 230 | 86 / 86 | 86 / 86 | 92 / 92 | 94 / 93 | 94 / 93 | 95 / 94 |
| FREDRICK - BOE_PUY 115 | 27 / 36 | 27 / 36 | 59 / 84 | 67 / 96 | 71 / 101 | 75 / 108 |
| FREDRICK - SW28TIE 115 | 30 / 52 | 30 / 52 | 85 / 153 | 99 / 178 | 104 / 188 | 112 / 203 |
| FREDRICK - TILCM TP 115 | 39 / 54 | 39 / 54 | 72 / 105 | 80 / 118 | 83 / 123 | 88 / 130 |
| FREDRICK - WOODLND 115 | 47 | 47 | 125 | 145 | 153 | 165 |
| WOODLND-FERNHILL 115 | 30 | 30 | 44 | 47 | 49 | 51 |
| WOODLND-PIONEER 115 | -9 | -9 | 40 | 52 | 57 | 64 |
| WOODLND-FRUITLAND 115 | 19 | 19 | 35 | 39 | 40 | 43 |
| 2002 Light Summer, West Side NI South to North | | | | | | |
| West Side NI, Custer-Ingledow 1&2 | 1501 / 1501 | 1501 / 1501 | 1501 / 1501 | 1502 / 1501 | 1501 / 1501 | 1501 / 1501 |
| RAVER - PAUL 500 | 686 / 690 | 676 / 677 | 690 / 687 | 693 / 690 | 695 / 691 | 697 / 693 |
| OLYMPIA - TACOMA B 230 | 87 / 89 | 87 / 88 | 91 / 90 | 92 / 91 | 92 / 91 | 93 / 91 |
| TACOMA A - CENTR SS 230 | 94 / 95 | 95 / 95 | 101 / 101 | 103 / 102 | 103 / 103 | 104 / 103 |
| FREDRICK - BOE_PUY 115 | -1 / -2 | 23 / 33 | 55 / 80 | 63 / 92 | 66 / 97 | 71 / 104 |
| FREDRICK - SW28TIE 115 | -9 / -20 | 32 / 56 | 87 / 157 | 101 / 183 | 106 / 193 | 114 / 208 |
| FREDRICK - TILCM TP 115 | 16 / 19 | 39 / 56 | 72 / 106 | 80 / 118 | 84 / 123 | 89 / 131 |
| FREDRICK - WOODLND 115 | -9 | 50 | 129 | 149 | 157 | 168 |
| WOODLND-FERNHILL 115 | 20 | 30 | 43 | 47 | 48 | 50 |
| WOODLND-PIONEER 115 | -34 | 3 | 52 | 64 | 69 | 76 |
| WOODLND-FRUITLAND 115 | 1 | 13 | 29 | 33 | 35 | 37 |

# Table 2. Outages with Incremental levels of Proposed Generation and Fredrickson Generation

| Outage | Proposed Generation MW Level & Frederickson CT MW Level | | | | | |
|---|---|---|---|---|---|---|
| | 0 & 0 | 0 & 149 | 200 & 149 | 250 & 149 | 270 & 149 | 300 & 149 |
| Element at % of rating | Facility loading in % of rating | | | | | |
| **Preferred Plan (Convert Fern Hill-St. Clair 55 kV line)** | | | | | | |
| BUS WHITE RIVER SOUTH 230, 2002 Light Summer, North-to-South | | | | | | |
| COWLITZ - TACOMA B 230 | 111.6 / 2100 | 112.1 / 2070 | 113.3 / 2000 | 113.6 / 1980 | 113.7 / 1980 | 113.8 / 1970 |
| WHITE RV - TACOMA B 230, 2002 Light Summer, North-to-South | | | | | | |
| COWLITZ - TACOMA B 230 | 111.6 / 2090 | 112.3 / 2060 | 113.7 / 1970 | 114.0 / 1960 | 114.1 / 1950 | 114.2 / 1940 |
| COVINGTN - TACOMA A 230, 2002 Light Summer, North-to-South | | | | | | |
| COWLITZ - TACOMA A 230 | 107.5 / 2360 | 109.2 / 2250 | 111.7 / 2100 | 112.3 / 2060 | 112.6 / 2050 | 112.9 / 2030 |
| **Alternative Plan (Reconductor Frederickson-St. Clair 115 kV line)** | | | | | | |
| 2 LINE FREDRICK-SW28TIE & FREDRICK-TILCM TP 115, 2002 Light Summer, North-to-South | | | | | | |
| BLUMAER - OLY VAIL 115 | | | 96.8 | 107.9 | 112.3 | 119.1 |
| ELECTHTS - FRED TAP 115 | | | 160.1 | 185.2 | 195.4 | 210.9 |
| ELECTHTS - ORTING 115 | | | 143.8 | 173.3 | 185.3 | 203.6 |
| WHITE RV - BONNEYLK 115 | | | 95.7 | 119.9 | 129.8 | 144.8 |
| FRED TAP - BOE_PUY 115 | | | 121.4 | 140.5 | 148.2 | 159.9 |
| FREDRICK - BOE_PUY 115 | | | 126 | 145.1 | 152.9 | 164.7 |
| WR-KCTAP - BONNEYLK 115 | | | 100.8 | 125 | 134.9 | 150 |
| WR-KCTAP - RHODESLK 115 | | | 126.6 | 155.6 | 167.4 | 185.3 |
| ELECTHTS - WILKNSON57.5 | | | 101.4 | 117.7 | 124.4 | 134.5 |
| KAPOWSIN - YELM 115 | | | 111.5 | 122.7 | 127.2 | 134 |
| LONGMR T - OLY VAIL 115 | | | 97.8 | 108.7 | 113.1 | 119.9 |
| LONGMR T - YELM 115 | | | 104.4 | 115.5 | 120 | 126.8 |
| ORTING - RHODESLK 115 1 | | | 135.7 | 164.6 | 176.4 | 194.3 |
| BUS WHITE RIVER SOUTH 230, 2002 Light Summer, North-to-South | | | | | | |
| COWLITZ - TACOMA B 230 | 114.7 / 1930 | 114.9 / 1920 | 115.6 / 1880 | 116.0 / 1870 | 116.0 / 1860 | 116.1 / 1860 |
| WHITE RV - TACOMA B 230, 2002 Light Summer, North-to-South | | | | | | |
| COWLITZ - TACOMA B 230 | 116.0 / 1850 | 116.2 / 1840 | 117.0 / 1800 | 117.4 / 1780 | 117.5 / 1780 | 117.5 / 1780 |
| COVINGTN - TACOMA A 230, 2002 Light Summer, North-to-South | | | | | | |
| COWLITZ - TACOMA A 230 | 109.5 / 2240 | 111.0 / 2150 | 113.2 / 2020 | 113.8 / 1980 | 114.0 / 1970 | 114.4 / 1950 |

## Table 3. Raver-Paul 500 kV Related Outages - 2002 Heavy Summer

### Preferred Plan (Convert Fern Hill-St. Clair 55 kV line)

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% line loading at 2850 MW Northern Intertie / NI at 100% loading

| Proposed Generation Level / Outage | LONGMIR T - YELM 115 | LONGMIR T - OLY VAIL 115 | KAPOWSIN - YELM 115 | GRAVELLY - TILCM TP 115 | DUPONT - QUARRY 115 | DUPONT - GRAVELLY 115 | FREDRICK - TILCM TP 115 | ST CLAIR - QUARRY 115 | ELECTHTS - KAPOWSIN 115 | BLUMAER - OLY VAIL 115 | TACOMA A - CENTR SS 230 | OLYMPIA - TACOMA B 230 | CHEHALIS - CENTR SS 230 | Trip Proposed Generation | Trip Coulee gen 720 MW | Trip Chief Joseph gens 1100 MW | Trip Whitehorn & Fredonia 349 MW | Trip BC Hydro gens 1820 MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Existing Frederickson (149 MW) CT's off; Raver-Paul 500 kV line = 1787 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | | | | | | * | * | * |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | | 103.3 | 101.5 | 99.5 | | | * | * | * |
| | | | | | | | | | | | 2750 | 2830 | 2870 | | | | | |
| **With Proposed Generation 0 MW; Raver-Paul 500 kV line = 1800 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | | | | | | * | * | * |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | | 104.8 | 102.3 | 101.0 | | | * | * | * |
| | | | | | | | | | | | 2620 | 2820 | 2800 | | | | | |
| **With Proposed Generation 200 MW; Raver-Paul 500 kV line = 1816 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 97.0 | | | | | * | * | * |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 95.3 | | | * | | * | * | * |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 100.3 | 98.1 | 95.6 | | | | | | 99.1 | 96.6 | 106.8 | 103.8 | 103.0 | | | * | * | * |
| | 2840 | 2910 | | | | | | | 2880 | | 2530 | 2800 | 2710 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | | 105.1 | 102.7 | 101.3 | * | | * | * | * |
| | | | | | | | | | | | 2590 | 2820 | 2780 | | | | | |

# Table 3. Raver-Paul 500 kV Related Outages - 2002 Heavy Summer

## Preferred Plan (Convert Fern Hill-St. Clair 55 kV line)

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% line loading at 2850 MW Northern Intertie / NI at 100% loading

| Proposed Generation Level / Outage | LONGMR T - YELM 115 | LONGMR T - OLY VAIL 115 | KAPOWSIN - YELM 115 | GRAVELLY - TILCM TP 115 | DUPONT - QUARRY 115 | DUPONT - GRAVELLY 115 | FREDRICK - TILCM TP 115 | ST CLAIR - QUARRY 115 | ELECTHTS - KAPOWSIN 115 | BLUMAER - OLY VAIL 115 | TACOMA A - CENTR SS 230 | OLYMPIA - TACOMA B 230 | CHEHALIS - CENTR SS 230 | Trip Proposed Generation | Trip Coulee gen 720 MW | Trip Chief Joseph gens 1100 MW | Trip Whitehorn & Fredonia 349 MW | Trip BC Hydro gens 1820 MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **With Proposed Generation 250 MW: Raver-Paul 500 kV line = 1820 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 97.5 | | | | | * | * | * |
| | | | | | | | | | | | 3030 | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 95.4 | | | * | | * | * | * |
| BKF Raver-Paul & Ctr2 | 103.2 | 101.2 | 98.1 | 95.7 | | | 98.0 | | 101.7 | 99.7 | 107.3 | 104.1 | 103.5 | | | * | * | * |
| and Centralia 1 off line | 2760 | 2820 | 2920 | | | | 2960 | | 2790 | 2860 | 2500 | 2800 | 2680 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 105.2 | 102.8 | 101.4 | * | | * | * | * |
| and Centralia 1 off line | | | | | | | | | | | 2580 | 2810 | 2780 | | | | | |
| **With Proposed Generation 270 MW: Raver-Paul 500 kV line = 1822 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 97.7 | | | | | * | * | * |
| | | | | | | | | | | | 3020 | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 95.5 | | | * | | * | * | * |
| BKF Raver-Paul & Ctr2 | 104.4 | 102.4 | 99.1 | 97.3 | | 95.5 | 99.6 | | 102.7 | 101.0 | 107.5 | 104.3 | 103.7 | | | * | * | * |
| and Centralia 1 off line | 2720 | 2780 | 2880 | 2990 | | | 2870 | | 2760 | 2820 | 2490 | 2790 | 2670 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 105.3 | 102.8 | 101.5 | * | | * | * | * |
| and Centralia 1 off line | | | | | | | | | | | 2580 | 2810 | 2770 | | | | | |
| **With Proposed Generation 300 MW: Raver-Paul 500 kV line = 1825 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 98.0 | | | | | * | * | * |
| | | | | | | | | | | | 3000 | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 95.5 | | | * | | * | * | * |
| BKF Raver-Paul & Ctr2 | 106.1 | 104.3 | 100.6 | 99.8 | 96.4 | 97.9 | 102.1 | 95.4 | 104.1 | 102.8 | 107.8 | 104.4 | 104.0 | | | * | * | * |
| and Centralia 1 off line | 2670 | 2730 | 2830 | 2860 | | 2960 | 2740 | | 2710 | 2770 | 2480 | 2790 | 2660 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 105.3 | 102.9 | 101.5 | * | | * | * | * |
| and Centralia 1 off line | | | | | | | | | | | 2580 | 2810 | 2770 | | | | | |

## Table 4. Raver-Paul 500 kV Related Outages - 2002 Light Summer

**Preferred Plan (Convert Fern Hill-St. Clair 55 kV line)**

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% line loading at 2850 MW Northern Intertie / NI at 100% loading

| Proposed Generation Level / Outage | LONGMR T - YELM 115 | LONGMR T - OLY VAIL 115 | KAPOWSIN - YELM 115 | GRAVELLY - TILCM TP 115 | DUPONT - QUARRY 115 | DUPONT - GRAVELLY 115 | FREDRICK - TILCM TP 115 | ELECTHTS - KAPOWSIN 115 | BLUMAER - OLY VAIL 115 | TACOMA A - CENTR SS 230 | OLYMPIA - TACOMA B 230 | COWLITZ - TACOMA B 230 | CHEHALIS - CENTR SS 230 | Trip Proposed Generation | Trip Coulee gen 720 MW | Trip Chief Joseph gens 1100 MW | Trip Whitehorn & Fredonia 349 MW | Trip BC Hydro gens 1820 MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Existing Frederickson (149 MW) CT's off: Raver-Paul 500 kV line = 1997 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 95.7 | | 104.4<br>2640 | | | | * | * | * |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | 101.3<br>2780 | 95.7 | 115.3<br>2100 | 98.6<br>2930 | | | * | * | * |
| **With Proposed Generation 0 MW: Raver-Paul 500 kV line = 2008 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 97.2<br>3010 | | 102.7<br>2720 | | | | * | * | * |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | 102.7<br>2700 | 96.8 | 113.6<br>2180 | 100.1<br>2850 | | | * | * | * |
| **With Proposed Generation 200 MW: Raver-Paul 500 kV line = 2017 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 99.1<br>2900 | | 101.4<br>2780 | 96.5 | | | * | * | * |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 97.5<br>3000 | | 103.4<br>2690 | | * | | * | * | * |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 101.8<br>2740 | 103.5<br>2640 | | | | | | 95.4 | 102.5<br>2700 | 104.7<br>2580 | 98.0<br>2980 | 112.3<br>2250 | 102.1<br>2730 | | | * | * | * |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | 103.0<br>2680 | 97.1<br>3050 | 114.3<br>2150 | 100.4<br>2830 | * | | * | * | * |

## Table 4. Raver-Paul 500 kV Related Outages - 2002 Light Summer

**Preferred Plan (Convert Fern Hill-St. Clair 55 kV line)**

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% line loading at 2850 MW Northern Intertie / NI at 100% loading

| Proposed Generation Level / Outage | LONGMR T - YELM 115 | LONGMR T - OLY VAIL 115 | KAPOWSIN - YELM 115 | GRAVELLY - TILCM TP 115 | DUPONT - QUARRY 115 | DUPONT - GRAVELLY 115 | FREDRICK - TILCM TP 115 | ELECTHTS - KAPOWSIN 115 | BLUMAER - OLY VAIL 115 | TACOMA A - CENTR SS 230 | OLYMPIA - TACOMA B 230 | COWLITZ - TACOMA B 230 | CHEHALIS - CENTR SS 230 | Trip Proposed Generation | Trip Coulee gen 720 MW | Trip Chief Joseph gens 1100 MW | Trip Whitehorn & Fredonia 349 MW | Trip BC Hydro gens 1820 MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **With Proposed Generation 250 MW: Raver-Paul 500 kV line = 2021 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | 96.7 | 98.0 | | | | | | | 96.9 | 99.6 | | 101.1 | 97.0 | | | * | * | * |
| | | 2970 | | | | | | | | 2870 | | 2800 | 3020 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 97.6 | | 103.5 | | * | | * | * | * |
| | | | | | | | | | | 2990 | | 2680 | | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 104.7 | 106.6 | 95.8 | | | | | 97.9 | 105.6 | 105.2 | 98.3 | 111.9 | 102.6 | | | * | * | * |
| | 2550 | 2450 | | | | | | 3010 | 2510 | 2550 | 2960 | 2270 | 2700 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | 103.1 | 97.2 | 114.4 | 100.5 | * | | * | * | * |
| | | | | | | | | | | 2670 | 3040 | 2140 | 2820 | | | | | |
| **With Proposed Generation 270 MW: Raver-Paul 500 kV line = 2022 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | 97.8 | 99.2 | | | | | | | 98.2 | 99.8 | | 101.0 | 97.2 | | | * | * | * |
| | 2990 | 2900 | | | | | | | 2960 | 2860 | | 2800 | 3010 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 97.6 | | 103.5 | | * | | * | * | * |
| | | | | | | | | | | 2990 | | 2680 | | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 105.8 | 107.9 | 96.8 | | | | 96 | 98.9 | 106.8 | 105.4 | 98.5 | 111.8 | 102.8 | | | * | * | * |
| | 2480 | 2380 | | | | | | 2930 | 2440 | 2540 | 2950 | 2280 | 2690 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | 103.2 | 97.2 | 114.5 | 100.5 | * | | * | * | * |
| | | | | | | | | | | 2670 | 3040 | 2140 | 2820 | | | | | |
| **With Proposed Generation 300 MW: Raver-Paul 500 kV line = 2024 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | 99.5 | 101.0 | | | | | | | | 100.0 | 100.1 | 100.8 | 97.5 | | | * | * | * |
| | 2880 | 2790 | | | | | | | | 2850 | 2840 | 2810 | 2990 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 97.7 | | 103.6 | 95 | * | | * | * | * |
| | | | | | | | | | | 2980 | | 2670 | | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 107.5 | 109.7 | 98.3 | 97.1 | 95.0 | 95.9 | 98.4 | 100.4 | 108.7 | 105.7 | 98.7 | 111.6 | 103.1 | | | * | * | * |
| | 2370 | 2270 | 2980 | 3150 | | | 3010 | 2820 | 2330 | 2520 | 2940 | 2290 | 2670 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | 103.2 | 97.3 | 114.6 | 100.6 | * | | * | * | * |
| | | | | | | | | | | 2670 | 3030 | 2140 | 2820 | | | | | |

## Table 5. Raver-Paul 500 kV Related Outages - 2002 Heavy Summer
## Alternative Plan (Reconductor Frederickson-St. Clair 115 kV line)

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% line loading at 2850 MW Northern Intertie / NI at 100% loading

| Proposed Generation Level / Outage | LONGMR T - YELM 115 | LONGMR T - OLY VAIL 115 | KAPOWSIN - YELM 115 | GRAVELLY - TILCM TP 115 | DUPONT - QUARRY 115 | DUPONT - GRAVELLY 115 | FREDRICK - TILCM TP 115 | ST CLAIR - QUARRY 115 | ELECTHTS - KAPOWSIN 115 | BLUMAER - OLY VAIL 115 | TACOMA A - CENTR SS 230 | OLYMPIA - TACOMA B 230 | CHEHALIS - CENTR SS 230 | Trip Proposed Generation | Trip Coulee gen 720 MW | Trip Chief Joseph gens 1100 MW | Trip Whitehorn & Fredonia 349 MW | Trip BC Hydro gens 1820 MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Existing Frederickson (149 MW) CT's off; Raver-Paul 500 kV line = 1807 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 96.9 | | | | | * | * | * |
| | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 107.1 | 106.8 | 103.4 | | | * | * | * |
| and Centralia 1 off line | | | | | | | | | | | 2520 | 2760 | 2700 | | | | | |
| **With Proposed Generation 0 MW; Raver-Paul 500 kV line = 1816 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 98.1 | | | | | * | * | * |
| | | | | | | | | | | | 2980 | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 108.4 | 107.4 | 104.6 | | | * | * | * |
| and Centralia 1 off line | | | | | | | | | | | 2470 | 2760 | 2640 | | | | | |
| **With Proposed Generation 200 MW; Raver-Paul 500 kV line = 1829 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 99.9 | | 96.1 | | | * | * | * |
| | | | | | | | | | | | 2860 | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 98.5 | | | * | | * | * | * |
| | | | | | | | | | | | 2960 | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 110.1 | 108.3 | 106.4 | | | * | * | * |
| and Centralia 1 off line | | | | | | | | | | | 2400 | 2740 | 2560 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 108.7 | 107.7 | 104.9 | * | | * | * | * |
| and Centralia 1 off line | | | | | | | | | | | 2440 | 2750 | 2620 | | | | | |

## Table 5. Raver-Paul 500 kV Related Outages - 2002 Heavy Summer
## Alternative Plan (Reconductor Frederickson-St. Clair 115 kV line)

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% line loading at 2850 MW Northern Intertie / NI at 100% loading

| Proposed Generation Level / Outage | LONGMR T - YELM 115 | LONGMR T - OLY VAIL 115 | KAPOWSIN - YELM 115 | GRAVELLY - TILCM TP 115 | DUPONT - QUARRY 115 | DUPONT - GRAVELLY 115 | FREDRICK - TILCM TP 115 | ST CLAIR - QUARRY 115 | ELECTHTS - KAPOWSIN 115 | BLUMAER - OLY VAIL 115 | TACOMA A - CENTR SS 230 | OLYMPIA - TACOMA B 230 | CHEHALIS - CENTR SS 230 | Trip Proposed Generation | Trip Coulee gen 720 MW | Trip Chief Joseph gens 1100 MW | Trip Whitehorn & Fredonia 349 MW | Trip BC Hydro gens 1820 MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **With Proposed Generation 250 MW: Raver-Paul 500 kV line = 1833 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 100.3 | 95.2 | 96.5 | | | * | * | * |
| | | | | | | | | | | | 2830 | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 98.6 | | | * | | * | * | * |
| | | | | | | | | | | | 2950 | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | 96.7 | | | | | | | | 110.6 | 108.7 | 106.8 | | | * | * | * |
| and Centralia 1 off line | | | | | | | | | | | 2380 | 2740 | 2540 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 108.8 | 107.8 | 105.1 | * | | * | * | * |
| and Centralia 1 off line | | | | | | | | | | | 2430 | 2750 | 2610 | | | | | |
| **With Proposed Generation 270 MW: Raver-Paul 500 kV line = 1834 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 100.5 | 95.3 | 96.7 | | | * | * | * |
| | | | | | | | | | | | 2820 | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 98.7 | | | * | | * | * | * |
| | | | | | | | | | | | 2950 | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | 97.8 | | | | | | | | 110.8 | 108.9 | 107.0 | | | * | * | * |
| and Centralia 1 off line | | | 2930 | | | | | | | | 2370 | 2740 | 2540 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 108.9 | 107.9 | 105.1 | * | | * | * | * |
| and Centralia 1 off line | | | | | | | | | | | 2430 | 2750 | 2610 | | | | | |
| **With Proposed Generation 300 MW: Raver-Paul 500 kV line = 1836 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 100.7 | 95.4 | 97.0 | | | * | * | * |
| | | | | | | | | | | | 2800 | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 98.7 | | | * | | * | * | * |
| | | | | | | | | | | | 2950 | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | 99.4 | | | | | | | | 111.0 | 109.0 | 107.3 | | | * | * | * |
| and Centralia 1 off line | | | 2870 | | | | | | | | 2360 | 2740 | 2530 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 108.9 | 107.9 | 105.1 | * | | * | * | * |
| and Centralia 1 off line | | | | | | | | | | | 2420 | 2750 | 2600 | | | | | |

# Table 6. Raver-Paul 500 kV Related Outages - 2002 Light Summer

## Alternative Plan (Reconductor Frederickson-St. Clair 115 kV line)

Page 1 / 2

Proposed Generation Level

% line loading at 2850 MW Northern Intertie / NI at 100% loading

| Outage | LONGMIRT - YELM 115 | LONGMIRT - OLY VAIL 115 | KAPOWSIN - YELM 115 | GRAVELLY - TILCM TP 115 | DUPONT - QUARRY 115 | DUPONT - GRAVELLY 115 | FREDRICK - TILCM TP 115 | ELECTHTS - KAPOWSIN 115 | BLUMAER - OLY VAIL 115 | TACOMA A - CENTR SS 230 | OLYMPIA - TACOMA B 230 | COWLITZ - TACOMA B 230 | CHEHALIS - CENTR SS 230 | Trip Proposed Generation | Trip Coulee gen 720 MW | Trip Chief Joseph gens 1100 MW | Trip Whitehorn & Fredonia 349 MW | Trip BC Hydro gens 1820 MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Existing Frederickson (149 MW) CT's off; Raver-Paul 500 kV line = 2019 MW pre-outage | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 99 | | 108.6 | 96.4 | | | * | * | * |
| | | | | | | | | | | 2900 | | 2450 | | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | 104.9 | 100.8 | 119.9 | 102.2 | | | * | * | * |
| | | | | | | | | | | 2580 | 2800 | 1930 | 2730 | | | | | |
| With Proposed Generation 0 MW; Raver-Paul 500 kV line = 2026 MW pre-outage | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 100.2 | | 107.1 | 97.6 | | | * | * | * |
| | | | | | | | | | | 2840 | | 2520 | 2980 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | 106.0 | 101.3 | 118.4 | 103.4 | | | * | * | * |
| | | | | | | | | | | 2520 | 2770 | 2000 | 2660 | | | | | |
| With Proposed Generation 200 MW; Raver-Paul 500 kV line = 2034 MW pre-outage | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 102 | | 105.4 | 99.4 | | | * | * | * |
| | | | | | | | | | | 2740 | | 2600 | 2890 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 100.6 | | 107.6 | 98 | * | | * | * | * |
| | | | | | | | | | | 2820 | | 2500 | 2960 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | 107.8 | 102.3 | 116.6 | 105.2 | | | * | * | * |
| | | | | | | | | | | 2430 | 2710 | 2090 | 2570 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | 106.4 | 101.8 | 118.9 | 103.8 | * | | * | * | * |
| | | | | | | | | | | 2500 | 2740 | 1980 | 2640 | | | | | |

## Table 6. Raver-Paul 500 kV Related Outages - 2002 Light Summer

**Alternative Plan (Reconductor Frederickson-St. Clair 115 kV line)**

Page 2 / 2

% line loading at 2850 MW Northern Intertie / NI at 100% loading

| Proposed Generation Level / Outage | LONGMR T - YELM 115 | LONGMR T - OLY VAIL 115 | KAPOWSIN - YELM 115 | GRAVELLY - TILCM TP 115 | DUPONT - QUARRY 116 | DUPONT - GRAVELLY 115 | FREDRICK - TILCM TP 115 | ELECTHTS - KAPOWSIN 115 | BLUMAER - OLY VAIL 115 | TACOMA A - CENTR SS 230 | OLYMPIA - TACOMA B 230 | COWLITZ - TACOMA B 230 | CHEHALIS - CENTR SS 230 | Trip Proposed Generation | Trip Coulee gen 720 MW | Trip Chief Joseph gens 1100 MW | Trip Whitehorn & Fredonia 349 MW | Trip BC Hydro gens 1820 MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **With Proposed Generation 250 MW: Raver-Paul 500 kV line = 2035 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 102.4 | | 105.0 | 99.8 | | | * | * | * |
| | | | | | | | | | | 2720 | | 2620 | 2860 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 100.7 | | 107.8 | 98.0 | * | | * | * | * |
| | | | | | | | | | | 2810 | | 2490 | 2960 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 108.3 | 102.6 | 116.3 | 105.6 | | | * | * | * |
| and Centralia 1 off line | | | | | | | | | | 2400 | 2690 | 2110 | 2540 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 106.5 | 101.9 | 119.1 | 103.8 | * | | * | * | * |
| and Centralia 1 off line | | | | | | | | | | 2500 | 2730 | 1970 | 2640 | | | | | |
| **With Proposed Generation 270 MW: Raver-Paul 500 kV line = 2036 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 102.6 | | 104.9 | 100.0 | | | * | * | * |
| | | | | | | | | | | 2710 | | 2630 | 2850 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 100.7 | | 107.9 | 98.1 | * | | * | * | * |
| | | | | | | | | | | 2810 | | 2490 | 2960 | | | | | |
| BKF Raver-Paul & Ctr2 | | | 95.5 | | | | | | | 108.5 | 102.7 | 116.1 | 105.8 | | | * | * | * |
| and Centralia 1 off line | | | | | | | | | | 2390 | 2680 | 2110 | 2530 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 106.5 | 102.0 | 119.2 | 103.9 | * | | * | * | * |
| and Centralia 1 off line | | | | | | | | | | 2490 | 2730 | 1970 | 2640 | | | | | |
| **With Proposed Generation 300 MW: Raver-Paul 500 kV line = 2038 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 95.1 | 102.9 | 104.7 | 100.2 | | | * | * | * |
| | | | | | | | | | | | 2690 | 2640 | 2840 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 100.8 | | 107.9 | 98.1 | * | | * | * | * |
| | | | | | | | | | | 2810 | | 2480 | 2950 | | | | | |
| BKF Raver-Paul & Ctr2 | | | 97.1 | | | | | | | 108.7 | 102.9 | 115.9 | 106.1 | | | * | * | * |
| and Centralia 1 off line | | | 3060 | | | | | | | 2380 | 2670 | 2130 | 2520 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | 106.6 | 102.0 | 119.3 | 103.9 | * | | * | * | * |
| and Centralia 1 off line | | | | | | | | | | 2490 | 2730 | 1960 | 2630 | | | | | |

# FREDERICKSON

# 50/100/150 MW

Fredrickson -
50/100/150 MW

PUGET SOUND ENERGY

July 17, 2000

Puget Sound Energy, Inc.
411 108th NE
Bellevue, WA 98004-5515
Attn: Douglas K. Faulkner, Manager Energy Contracts

**Re: Requests for Transmission Service – Frederickson
OASIS Assignment Reference No. 117855
Preliminary Study Results**

Dear Doug:

This is in response to your letter to me dated June 16, 2000 in which you requested an additional study pursuant to your OASIS Request No. 117855. Specifically, you asked us to first study the effects of adding 50 MW, 100 MW, and 150 MW at the Frederickson site, before studying the remainder of your request. The preliminary study is enclosed.

For the System Impact Study Agreement for the Frederickson OASIS Assignment Reference No. 117855, please see the attached preliminary study, "Frederickson Steam Generator Addition." This study explores the transmission capacity that would be needed to reliably interconnect a steam turbine at the PSE Frederickson Generation Station. Steam turbine sizes studied included 50, 100, 150, and 200 MW.

The results of studies showed that with minor improvements the existing Pierce and Thurston County transmission system can reliably interconnect a steam turbine with up to 150 MW output on the Frederickson Substation 115 kV bus. Above that level, several lines exceed their limits, and costs to increase ratings and build additional lines would be high. If this project is chosen additional studies will be needed using data that must be obtained specifically for the generator selected. Because generator tripping is required for a BPA outage, BPA must also be involved, and agree to it being added to their trip scheme.

Before finalizing the study, we would like to meet with you at your earliest convenience. In the meantime, we will proceed with studying the remainder of your request for 270 MW or 600 MW at Frederickson, and lastly 50 MW at Tenaska.

Sincerely,

**Puget Sound Energy, Inc.**

By: George Marshall
George Marshall
Its: Manager Transmission Contracts
and OASIS Trading

Enclosure

# FREDERICKSON STEAM GENERATOR ADDITION

Scoping Study
PSE Electric Transmission

## INTRODUCTION

PSE Electric Transmission has been asked to assess the affect to the transmission system of additional generation at the existing Frederickson combustion turbine site in Pierce County. This report is a scoping document that summarizes studies done to find threshold levels where new generation could be added with large impacts to the existing transmission system. The added generation would be a steam unit with possible sizes being 50, 100, or 150 MW (200 MW was included to explore sensitivities).

## CONCLUSION

If a new generator is installed at Frederickson Generating Station and connected to the existing 115 kV bus, and if the size is 150 MW or smaller, then impacts to the existing transmission system are expected to be minimal. A requirement for this addition is that during conditions of high north to south flow on the Raver-Paul 500 kV line, an equivalent amount of generation at Frederickson should be tripped automatically if an outage of the Raver-Paul 500 kV line were to occur. The generation could be tripped by an electronic signal supplied by BPA, but BPA must agree to this. The only line requiring conductor temperature upgrade is the Electron Heights-Boeing Puyallup-Frederickson 115 kV line. Also, at the highest generation level, a Remedial Action Scheme should be employed to trip or ramp generation at Frederickson in the event that two of the three 115 kV lines to Frederickson becomes out-of-service. An estimate of the cost for transmission interconnection facilities and improvements is $800,000.

## STUDY ASSUMPTIONS

Summer and winter seasons were studied, with a focus on high Raver-Paul loading and high north to south flows on lines going through Pierce County. Load sensitivity was performed for the summer season. The lines through Pierce County are:

Raver-Paul 500 kV line
White River-Cowlitz-Olympia 230 kV line
Covington-Cowlitz-Chehalis 230 kV line
Frederickson-St. Clair 115 kV line
Electron Heights-Blumaer 115 kV line
White River-Fern Hill 57.5 kV line

The time frame was 2001 with the following improvements assumed to be completed:

Chief Joe-Monroe #4 line re-converted to 345 kV operation.
Bothell-Snoking #2 and Snoking-Maple Valley #2 230 kV lines energized.
Schultz-Raver #2 500 kV line rerouted from Raver to Echo Lake.
Bothell #2 and #3 230-115 kV transformers replaced with 300 MVA transformers.

Reactive power margin and voltage stability was not determined, it is anticipated that addition of generation with full reactive capability at Frederickson will improve voltage regulation in the area. This can be confirmed with reactive margin studies. Transient stability was not confirmed, and would be done when stability models, and machine specific parameters are provided.

The proposed Westcoast generator was studied as a sensitivity, to understand the combined impacts of the Frederickson steam turbine generator and the Westcoast generator. The total MW output of the Westcoast generators was modeled as 270 MW.

**OUTAGE ASSUMPTIONS**

Outages taken included single contingency (N-1) outages and common mode outages. The single contingency outages are taken automatically, and include all lines in southern King, Pierce and Thurston Counties. The common mode outages are:

White River north 230 bus, south 230 bus, north115 bus, and south 115 bus
Krain Corner 115 bus, Alderton 115 bus, Frederickson 115 bus
Electron Heights 115 bus, Saint Clair 115bus, Blumaer 115 bus
West Olympia 115 bus, Plum Street 57.5 bus
PSE Olympia north 115 bus, and south 115 bus, Tono phase shifter
BPA Olympia east 230 bus, west 230 bus, and 115 bus

The following use governor load-flow following WSCC guidelines.

Raver-Paul 500 line; Trip BC Hydro
Raver-Paul 500 line; Trip BC Hydro, FGStm, WC
Raver-Paul-Centralia G2 500 BKF; Trip BC Hydro
Raver-Paul-Centralia G2 500 BKF; Trip BC Hydro, FGStm, WC
Raver-Paul-Centralia G2 500 BKF & Centralia G1; Trip BC Hydro
Raver-Paul-Centralia G2 500 BKF & Centralia G1; Trip BC Hydro, FGStm, WC
Paul-Allston 1&2 500 lines on common right-of-way; Trip BC Hydro

The formula for tripping BC Hydro generation is:

Trip generation = 1.3 x (Westside NI north-to-south – 1450 MW)

FGStm stands for tripping the proposed Frederickson steam turbine and gen.
WC stands for tripping the proposed Westcoast generator.
BKF stands for breaker failure.

**FINDINGS**

The transmission through flow can be seen in Table 1, which shows line flows before outages are taken for heavy summer, lighter summer, and heavy winter. Line flows on the Raver-Paul 500 kV line, as an example are 1800 to 1900 MW in the summer, and decrease to 1200 MW in the winter. In these seasons, the West Side Northern Intertie (WSNI) is 2850 MW in the summer cases, and is 1450 MW in the winter cases. If the winter import OTC goes above 1450 MW, then transmission through flow will increase in the winter. Load sensitivity that was performed for the summer season was to reduce the area load by 1000 MW, from 5758 to 4758 MW, an 18% reduction. The results indicated that for lines at or near overload, the overloads increased slightly as loads were scaled down by 1000 MW. This is a favorable result because as loads go down in the summer, ambient air temperatures also cool, as in night-time conditions, and line ratings go up.

<u>Summer</u>

During the summer season loading on lines can be closer to line ratings than during other seasons because of transmission through flow, and because the line ratings are significantly lower in the summer on lines having a lower conductor temperature rating.

The results of outage simulations are given in Table 2, for single contingency outages (N-1), and common mode outages, except that the Raver-Paul 500 kV outage results are given in Tables 3-6, and are discussed later. The outage results for other than Raver-Paul 500 kV show that line loadings remain within their ratings up to an addition of

150 MW of generation. An exception is the double line loss of the Alderton-Frederickson and Frederickson-St. Clair 115 kV lines. This outage is an N-1 outage if one of the other two lines to Frederickson is already out for some reason. The temperature rating of the Electron Heights-Boeing Puyallup-Frederickson 115 kV line should be raised to significantly increase the threshold levels at which generation can safely generate during conditions such as line maintenance, unplanned outages, and the double line outage. The 1272 kcm Narcissus conductor portions should be uprated to 75C conductor rating, and the 795 kcm Tern portions to 100C conductor rating.

Raver-Paul 500 kV Outage

The most severe outage is the Raver-Paul 500 kV outage, and combination outages, which include the Raver-Paul 500 kV line. The combination outages studied are a breaker failure at Paul that trips both the Raver-Paul line and the Centralia #1 generator, and the same breaker failure when the Centralia #2 generator is also out of service. Results are given in Tables 3-6, and include summer heavy load, summer light load, without and with a proposed Westcoast IPP connected to BPA South Tacoma Switch. The tables show when PSE lines will overload without tripping the Frederickson steam generator, or an equivalent amount in MW at Frederickson.

BPA arms a RAS when there are high north to south flows on the Raver-Paul 500 kV line. The RAS sends trip signals to selected generators north of this line when the RAS detects that the line is tripped out of service. The generators that are armed are determined according to the flow level on the Raver-Paul line, and other factors, as described in BPA Dispatcher Standing Order (DSO) 307. In the power system simulations, for high flow levels on the Raver-Paul line, the generators that were tripped included Whitehorn, Fredonia, 1024 MW at Chief Joseph, and units in Canada following the formula:

$$MWtoTrip = 1.3(IngledowCusterflow - 1450MW)$$

The results indicate that for light summer loads, or for Frederickson steam generator sizes above 100 MW, PSE lines overload for the breaker failure outage of the Raver-Paul 500 kV line and Centralia generator unit 2, unless the Frederickson steam generator is tripped. If the Westcoast generator is installed at about 270 MW, and if it is tripped for the same outage, then the above holds true for Frederickson steam generator sizes above 50 MW. The Frederickson steam generator, or one of the combustion turbine generators will need to be tripped during summer load and temperature conditions when the Raver-Paul 500 kV line loading is high. Tripping will not be needed during winter conditions because the Raver-Paul line loading is low.

The Tables 3-6 show overloads for the breaker failure outage and when the other Centralia generator unit 1 is off line. The Raver-Paul pre-outage flow is above 2000 MW. In practice, BPA would reduce the flow on the Raver-Paul 500 kV line, following DSO 307 for Level 4, so that the overloads would not happen if the outage were to occur. But running the outage at this high level illustrates the need for a Raver-Paul flow threshold that results in significant overloads if violated.

The White River-Fern Hill 57.5 kV line overloads with outages of the Raver-Paul line. A relay is being installed at White River to detect when the line is being overloaded and the relay will sent a signal to automatically trip the line breaker at White River. All the power system simulations were done with either the White River-Fern Hill line open, or with the relay modeled to open the line up if the flow level on the line is above its seasonal rating.

Winter

Some common mode outages do not achieve a solution for winter loading conditions. The Olympia 230 kV bus is divided between east and west segments with both 230-115 kV transformers on one bus segment, the east bus. Loss of the Olympia 230 west bus results in no solution.

## COSTS

Transmission costs to install up to 150 MW of new generation at Frederickson are expected to include the following:

| | |
|---|---|
| RAS for Frederickson generator tripping for Raver-Paul outage, and for loss of two lines | $50,000 |
| Breaker and line bay at Frederickson for generator, 115 kV | $300,000 |
| Conductor temperature upgrade of Electron Heights-Boeing Puyallup-Frederickson 115 kV line | $400,000 |

## POWER FLOW DRAWINGS

Schematic type power flow drawings of selected conditions are given following the tables. The drawings provided are a few that represent the thousands of unique combinations of conditions that could be shown. For each season, hundreds of outages were simulated for each level of proposed steam generation at Frederickson, without and with the proposed Westcoast project. The drawings include summer No Outage cases without and with Frederickson steam generator at 150 MW, and without and with the proposed Westcoast project.

They are given in the following order:

| Figure | Condition | Season | Frederick-son Steam | West-coast |
|---|---|---|---|---|
| 1 | No Outage | HS | 0 | 0 |
| 2 | No Outage | HS | 150 | 0 |
| 3 | No Outage | HS | 0 | 270 |
| 4 | No Outage | HS | 150 | 270 |
| 5 | No Outage | HW | 0 | 0 |
| 6 | No Outage | HW | 150 | 0 |
| 7 | No Outage | HW | 0 | 270 |
| 8 | No Outage | HW | 150 | 270 |
| 9 | BPA Olympia 115 kV Bus | HW | 0 | 0 |
| 10 | BPA Olympia 115 kV Bus | HW | 150 | 0 |
| 11 | Freder-SW 28 Tie & Freder-Tillicum Tap | HS | 150 | 0 |
| 12 | White River-Cowlitz-Olympia B 230 kV | HS | 0 | 0 |
| 13 | Bkf Raver-Paul & Centr G2 | HS | 0 | 0 |
| 14 | White River-Cowlitz-Olympia B 230 kV | HS | 150 | 0 |
| 15 | Bkf Raver-Paul & Centr G2 | HS | 150 | 0 |
| 16 | Bkf Raver-Paul & Centr G2, trip F.Steam | HS | 150 | 0 |
| 17 | White River-Cowlitz-Olympia B 230 kV | HS -1000 | 0 | 0 |
| 18 | Bkf Raver-Paul & Centr G2 | HS -1000 | 0 | 0 |
| 19 | White River-Cowlitz-Olympia B 230 kV | HS -1000 | 150 | 0 |
| 20 | Bkf Raver-Paul & Centr G2 | HS -1000 | 150 | 0 |
| 21 | Bkf Raver-Paul & Centr G2, trip F.Steam | HS -1000 | 150 | 0 |

## Table 1. Line flows with Incremental levels of Frederickson Steam Generation

| Seasonal case | Facility loading in MVA | | | | |
|---|---|---|---|---|---|
| | Frederickson Steam Level (without / with Westcoast) | | | | |
| Element or path | 0 MW | 50 MW | 100 MW | 150 MW | 200 MW |
| 2002 Heavy Summer | | | | | |
| West Side NI, Ingledow-Custer 1&2 | 2850 / 2850 | 2850 / 2850 | 2851 / 2850 | 2851 / 2851 | 2851 / 2851 |
| RAVER - PAUL 500 | 1827 / 1867 | 1830 / 1871 | 1833 / 1874 | 1837 / 1877 | 1841 / 1882 |
| OLYMPIA - TACOMA B 230 | 325 / 374 | 326 / 375 | 327 / 376 | 328 / 377 | 329 / 378 |
| TACOMA A - CENTR SS 230 | 303 / 321 | 304 / 322 | 306 / 324 | 307 / 325 | 309 / 327 |
| FREDRICK - BOE_PUY 115 | 34 / 34 | 45 / 45 | 57 / 57 | 69 / 70 | 82 / 82 |
| FREDRICK - SW28TIE 115 | 30 / 30 | 31 / 29 | 49 / 46 | 71 / 68 | 95 / 92 |
| FREDRICK - TILCM TP 115 | 117 / 120 | 130 / 133 | 142 / 145 | 155 / 158 | 167 / 170 |
| 2002 Heavy Summer, lighter load case | | | | | |
| West Side NI, Ingledow-Custer 1&2 | 2850 / 2851 | 2849 / 2850 | 2850 / 2851 | 2851 / 2852 | 2851 / 2851 |
| RAVER - PAUL 500 | 1920 / 1957 | 1922 / 1960 | 1924 / 1963 | 1928 / 1966 | 1932 / 1970 |
| OLYMPIA - TACOMA B 230 | 341 / 390 | 342 / 391 | 343 / 392 | 344 / 393 | 345 / 394 |
| TACOMA A - CENTR SS 230 | 326 / 344 | 327 / 346 | 329 / 347 | 330 / 349 | 332 / 350 |
| FREDRICK - BOE_PUY 115 | 31 / 32 | 43 / 43 | 56 / 56 | 68 / 68 | 80 / 80 |
| FREDRICK - SW28TIE 115 | 29 / 30 | 28 / 27 | 45 / 42 | 68 / 65 | 92 / 88 |
| FREDRICK - TILCM TP 115 | 123 / 126 | 135 / 138 | 147 / 151 | 160 / 163 | 172 / 175 |
| Dec. 2002 Heavy Winter | | | | | |
| West Side NI, Ingledow-Custer 1&2 | 1450 / 1449 | 1451 / 1450 | 1451 / 1451 | 1451/ 1450 | 1451 / 1450 |
| RAVER - PAUL 500 | 1174 / 1210 | 1177 / 1213 | 1179 / 1216 | 1182 / 1219 | 1185 / 1222 |
| OLYMPIA - TACOMA B 230 | 198 / 246 | 198 / 246 | 199 / 247 | 200 / 247 | 200 / 248 |
| TACOMA A - CENTR SS 230 | 87 104 | 88 / 106 | 90 / 107 | 91 / 108 | 92 / 110 |
| FREDRICK - BOE_PUY 115 | 44 / 44 | 56 / 56 | 68 / 68 | 81 / 81 | 93 / 93 |
| FREDRICK - SW28TIE 115 | 24 / 20 | 45 / 42 | 69 / 66 | 94 / 91 | 119 / 116 |
| FREDRICK - TILCM TP 115 | 90 / 93 | 103 / 106 | 115 / 118 | 128 / 130 | 140 / 143 |

## Table 2. Outages with Incremental levels of Fredrickson Steam Generation

| Outage<br>Element at % of rating | Facility loading in % of rating<br>Fredrickson Steam Level (without / with Westcoast)<br>0 MW | 50 MW | 100 MW | 150 MW | 200 MW | Notes |
|---|---|---|---|---|---|---|
| **ST CLAIR - QUARRY 115, 2002 Heavy Summer** | | | | | | |
| ELECTHTS - FRED TAP 115 | | | | 96.6 / 97.7 | 111.5 / 112.6 | |
| same line with lighter summer load | | | | | 114.4 / 115.5 | |
| **FREDRICK - TILCM TP 115, 2002 Heavy Summer** | | | | | | |
| ELECTHTS - FRED TAP 115 | | | | 100.8 / 101.8 | 115.7 / 116.7 | |
| same line with lighter summer load | | | | | 117.8 / 118.9 | |
| **GRAVELLY - TILCM TP 115, 2002 Heavy Summer** | | | | | | |
| ELECTHTS - FRED TAP 115 | | | | 99.4 / 100.4 | 114.3 / 115.3 | |
| same line with lighter summer load | | | | | 116.6 / 117.7 | |
| **FREDRICK - HEMLOCK 115, 2002 Heavy Summer** | | | | | | |
| ELECTHTS - FRED TAP 115 | | | | | 106.6 / 105.3 | |
| same line with lighter summer load | | | | | 105.7 / 104.3 | |
| FREDRICK - TILCM TP 115 | | | | | 101.0 / 101.7 | |
| same line with lighter summer load | | | | | 102.9 / 103.7 | |
| **BUS SAINT CLAIR 115, 2002 Heavy Summer** | | | | | | |
| ELECTHTS - FRED TAP 115 | | | | | 105.7 / 106.8 | |
| **BUS ALDERTON 115, 2002 Heavy Summer** | | | | | | |
| ELECTHTS - FRED TAP 115 | | | | | 102.5 / 101.1 | |
| **BUS OLYMPIA 230 EAST, 2002 Heavy Summer - lighter load case** | | | | | | |
| TACOMA A - CENTR SS 230 | / 96.3 | / 96.6 | / 97.1 | / 97.4 | / 97.9 | |
| FREDRICK - TILCM TP 115 | | | | / 96.0 | 99.2 / 102.1 | |
| **FREDRICK-SW28TIE & FREDRICK-TILCM TP 115, 2002 Heavy Summer** | | | | | | |
| ELECTHTS - FRED TAP 115 | 115.3 | 159.2 | 203.1 | 247.3 | Not Run | |
| FREDRICK - FRED TAP 115 | | 130.5 | 164.4 | 198.5 | • • | |
| **WHITE RV 115 - WHITE RV57.5, Dec. 2002 Heavy Winter** | | | | | | |
| KRAINCOR 115-57.5 XFMR | 102.4 / 103.2 | 100.9 / 101.7 | 99.4 / 100.3 | 98.0 / 98.8 | 96.6 / 97.4 | |
| **BUS WHITE RIVER SOUTH 115, Dec. 2002 Heavy Winter** | | | | | | |
| KRAINCOR 115-57.5 XFMR | 104.6 / 105.4 | 102.6 / 103.5 | 100.7 / 101.6 | 98.8 / 99.7 | 97.0 / 97.9 | |
| **STEVNSON - KRAINCOR 57.5, Dec. 2002 Heavy Winter** | | | | | | |
| ELECTHTS - WILKNSON 57.5 | 105.3 / 105.2 | 105.2 / 105.1 | 105.1 / 105.0 | 105.1 / 105.0 | 105.1 / 105.0 | # |
| **CRW PAUL - ALLSTON 500 1&2, Dec. 2002 Heavy Winter** | | | | | | |
| ABERDEEN - COSMOPLS 115 | 111.5 / 113.9 | 111.9 / 114.3 | 112.3 / 114.7 | 112.7 / 115.1 | 113.1 / 115.5 | |

Notes: # - Line loading is insensitive to proposed generation.

## Table 3.a. Raver-Paul 500 kV Related Outages - Fredrickson Steam Generation

% line loading at 2850 MW Northern Intertie / NI at 100% loading

| Fredrickson Steam Generation Level / Outage | LONGMR T - YELM 115 | LONGMR T - OLY VAIL 115 | KAPOWSIN - YELM 115 | GRAVELLY - TILCM TP 115 | DUPONT - QUARRY 115 | DUPONT - GRAVELLY 115 | FREDRICK - TILCM TP 115 | ST CLAIR - QUARRY 115 | ELECTHTS - KAPOWSIN 115 | BLUMAER - OLY VAIL 115 | TACOMA A - CENTR SS 230 | OLYMPIA - TACOMA B 230 | CHEHALIS - CENTR SS 230 | Trip Fredrickson steam unit | Trip Coulee gen 720 MW | Trip Chief Joseph gens 1100 MW | Trip Whitehorn & Fredonia 349 MW | Trip BC Hydro gens 1820 MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **With existing Fredrickson 2 CT's, 149MW total; Raver-Paul 500 kV line = 1820 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| Raver-Paul 500 outage | | | | | | | | | | | | | | | | * | * | * |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | | | | | | * | * | * |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 103.5 | 101.6 | 98.3 | 95.1 | | | 97.4 | | 101.9 | 100.2 | 109.0 | 108.2 | 105.2 | | | * | * | * |
| | 2760 | 2810 | | | | | | | 2790 | 2850 | 2450 | 2750 | 2620 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | | | | | | * | * | * | * |
| **With Frederickson 50MW Steam unit added, 199MW total; Raver-Paul 500 kV line = 1824 MW pre-outage** | | | | | | | | | | | | | | | | | | |
| Raver-Paul 500 outage | | | | | | | | | | | | | | | | * | * | * |
| Raver-Paul 500 outage | | | | | | | | | | | | | | * | | * | * | * |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 99.1 | | 95.3 | | | * | * | * |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 98.7 | | | * | | * | * | * |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 107.5 | 105.9 | 101.8 | 101.4 | 98.0 | 99.5 | 103.7 | 97.0 | 105.4 | 104.5 | 109.4 | 108.4 | 105.6 | | | * | * | * |
| | 2650 | 2700 | 2790 | 2790 | | | 2690 | | 2680 | 2740 | 2430 | 2740 | 2600 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 103.0 | 101.0 | 98.0 | 95.0 | | | 97.0 | | 102.0 | 100.0 | 109.0 | 108.0 | 105.0 | * | | * | * | * |
| | 2740 | 2800 | | | | | | | 2780 | 2840 | 2440 | 2740 | 2610 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | | | | | * | * | * | * | * |

## Table 3.b. Raver-Paul 500 kV Related Outages - Fredrickson Steam Generation

% line loading at 2850 MW Northern Intertie / NI at 100% loading

| Fredrickson Steam Generation Level<br>Outage | LONGMR T - YELM 115 | LONGMR T - OLY VAIL 115 | KAPOWSIN - YELM 115 | GRAVELLY - TILCM TP 115 | DUPONT - QUARRY 115 | DUPONT - GRAVELLY 115 | FREDRICK - TILCM TP 115 | ST CLAIR - QUARRY 115 | ELECTHTS - KAPOWSIN 115 | BLUMAER - OLY VAIL 115 | TACOMA A - CENTR SS 230 | OLYMPIA - TACOMA B 230 | CHEHALIS - CENTR SS 230 | Trip Fredrickson steam unit | Trip Coulee gen 720 MW | Trip Chief Joseph gens 1100 MW | Trip Whitehorn & Fredonia 349 MW | Trip BC Hydro gens 1820 MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| With Fredrickson 100MW Steam unit added, 249MW total; Raver-Paul 500 kV line = 1827MW pre-outage | | | | | | | | | | | | | | | | | | |
| Raver-Paul 500 outage | | | | | | | | | | | | | | | | * | * | * |
| Raver-Paul 500 outage | | | | | | | | | | | | | | * | | * | * | * |
| BKF Raver-Paul & Ctr2 | 96.4 | | | 97.5 | | 95.6 | 99.8 | | 95.8 | | 99.5 | 95.2 | 95.7 | | | * | * | * |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 98.8 | | 95 | * | | * | * | * |
| BKF Raver-Paul & Ctr2 | 111.5 | 110.2 | 105.2 | 107.7 | 104.3 | 105.7 | 110.0 | 103.2 | 108.8 | 108.8 | 109.9 | 108.8 | 106.1 | | | * | * | * |
| and Centralia 1 off line | 2540 | 2600 | 2690 | 2520 | 2670 | 2600 | 2420 | 2710 | 2580 | 2630 | 2410 | 2740 | 2580 | | | | | |
| BKF Raver-Paul & Ctr2 | 103.7 | 101.9 | 98.5 | 95.3 | | | 97.6 | | 102.1 | 100.5 | 109.1 | 108.3 | 105.4 | * | | * | * | * |
| and Centralia 1 off line | 2730 | 2790 | | | | | | | 2770 | 2840 | 2430 | 2740 | 2600 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | | | | * | * | * | * | * |
| and Centralia 1 off line | | | | | | | | | | | | | | | | | | |
| With Fredrickson 150MW Steam unit added, 299MW total; Raver-Paul 500 kV line = 1830MW pre-outage | | | | | | | | | | | | | | | | | | |
| Raver-Paul 500 outage | | | | | | | 96.2 | | | | | | | | | * | * | * |
| Raver-Paul 500 outage | | | | | | | | | | | | | | * | | * | * | * |
| BKF Raver-Paul & Ctr2 | 100.3 | 98.0 | 95.7 | 103.7 | 100.3 | 101.8 | 106.0 | 99.3 | 99.2 | 96.9 | 99.9 | 95.4 | 96.2 | | | * | * | * |
| | 2840 | | | 2620 | 2830 | 2740 | 2480 | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 98.9 | | 95.1 | * | | * | * | * |
| BKF Raver-Paul & Ctr2 | 115.5 | 114.5 | 108.7 | 113.9 | 110.5 | 112.0 | 116.2 | 109.5 | 112.2 | 113.1 | 110.3 | 109.1 | 106.5 | | | * | * | * |
| and Centralia 1 off line | 2440 | 2490 | 2580 | 2260 | 2400 | 2340 | 2160 | 2450 | 2470 | 2520 | 2390 | 2740 | 2560 | | | | | |
| BKF Raver-Paul & Ctr2 | 103.8 | 102.0 | 98.6 | 95.4 | | | 97.7 | | 102.2 | 100.6 | 109.2 | 108.4 | 105.4 | * | | * | * | * |
| and Centralia 1 off line | 2720 | 2790 | | | | | | | 2760 | 2830 | 2430 | 2740 | 2600 | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | | | | * | * | * | * | * |
| and Centralia 1 off line | | | | | | | | | | | | | | | | | | |

# Table 4.a. Raver-Paul 500 kV Related Outages - Fredrickson Steam, and Light Load

% line loading at 2850 MW Northern Intertie / NI at 100% loading

| Fredrickson Steam Generation Level / Outage | LONGMR T - YELM 115 | LONGMR T - OLY-VAIL 115 | KAPOWSIN - YELM 115 | GRAVELLY - TILCM TP 115 | DUPONT - QUARRY 115 | DUPONT - GRAVELLY 115 | FREDRICK - TILCM TP 115 | ST CLAIR - QUARRY 115 | ELECTHTS - KAPOWSIN 115 | BLUMAER - OLY VAIL 115 | TACOMA A - CENTR SS 230 | OLYMPIA - TACOMA B 230 | CHEHALIS - CENTR SS 230 | Trip Fredrickson steam unit | Trip Coulee gen 720 MW | Trip Chief Joseph gens 1100 MW | Trip Whitehorn & Fredonia 349 MW | Trip BC Hydro gens 1820 MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| With existing Fredrickson 2 CT's, 149MW total; Raver-Paul 500 kV line = 19MW pre-outage | | | | | | | | | | | | | | | | | | |
| Raver-Paul 500 outage | | | | | | | | | | | 96.4 | | | | | * | * | * |
| BKF Raver-Paul & Ctr2 | 98.0 | 97.3 | | | | | | | 95.0 | 96.3 | 106.5 | 100.1 | 102.8 | | | * | * | * |
| | | | | | | | | | | | 2460 | 2860 | 2690 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 113.1 | 113.7 | 105.1 | 100.1 | 97.3 | 98.5 | 102.0 | 96.4 | 108.0 | 112.4 | 116.9 | 113.8 | 113.1 | | | * | * | * |
| | 2520 | 2530 | 2710 | 2860 | | | 2780 | | 2620 | 2560 | 2150 | 2690 | 2310 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | | | | | | * | * | * | * |
| With Frederickson 50MW Steam unit added, 199MW total; Raver-Paul 500 kV line = 1916MW pre-outage | | | | | | | | | | | | | | | | | | |
| Raver-Paul 500 outage | | | | | | | | | | | 96.9 | | | | | * | * | * |
| Raver-Paul 500 outage | | | | | | | | | | | 96.5 | | | * | | * | * | * |
| BKF Raver-Paul & Ctr2 | 102.0 | 101.6 | 95.5 | 96.2 | | | 98.1 | | 98.4 | 100.6 | 107.0 | 100.4 | 103.2 | | | * | * | * |
| | 2790 | 2810 | | | | | | | | 2840 | 2430 | 2850 | 2660 | | | | | |
| BKF Raver-Paul & Ctr2 | 98.1 | 97.4 | | | | | | | 95.1 | 96.4 | 106.6 | 100.2 | 102.9 | * | | * | * | * |
| | | | | | | | | | | | 2450 | 2860 | 2680 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 117.1 | 118.0 | 108.6 | 106.4 | 103.5 | 104.8 | 108.3 | 102.7 | 111.5 | 116.7 | 117.3 | 114.1 | 113.6 | | | * | * | * |
| | 2420 | 2430 | 2600 | 2600 | 2710 | 2660 | 2520 | 2750 | 2520 | 2460 | 2130 | 2690 | 2290 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 113.2 | 113.9 | 105.2 | 100.2 | 97.4 | 98.6 | 102.1 | 96.5 | 108.1 | 112.6 | 117.0 | 113.9 | 113.2 | * | | * | * | * |
| | 2490 | 2500 | 2690 | 2850 | | | 2750 | | 2600 | 2530 | 2140 | 2690 | 2300 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | | | | | * | * | * | * | * |

## Table 4.b. Raver-Paul 500 kV Related Outages - Fredrickson Steam, and Light Load

% line loading at 2850 MW Northern Intertie / NI at 100% loading

| Fredrickson Steam Generation Level / Outage | LONGMR T - YELM 115 | LONGMR T - OLY VAIL 115 | KAPOWSIN - YELM 115 | GRAVELLY - TILCM TP 115 | DUPONT - QUARRY 115 | DUPONT - GRAVELLY 115 | FREDRICK - TILCM TP 115 | ST CLAIR - QUARRY 115 | ELECTHTS - KAPOWSIN 115 | BLUMAER - OLY VAIL 115 | TACOMA A - CENTR SS 230 | OLYMPIA - TACOMA B 230 | CHEHALIS - CENTR SS 230 | Trip Fredericksson steam unit | Trip Coulee gen 720 MW | Trip Chief Joseph gens 1100 MW | Trip Whitehorn & Fredonia 349 MW | Trip BC Hydro gens 1820 MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **With Fredericksson 100MW Steam unit added, 249MW total; Raver-Paul 500 kV line = 1919MW pre-outage** | | | | | | | | | | | | | | | | | | |
| Raver-Paul 500 outage | | | | | | | | | | | 97.3 | | | | | * | * | * |
| | | | | | | | | | | | | | | | | | | |
| Raver-Paul 500 outage | | | | | | | | | | | 96.6 | | | * | | * | * | * |
| | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | 105.9 | 105.8 | 98.9 | 102.4 | 99.6 | 100.8 | 104.3 | 98.7 | 101.8 | 104.8 | 107.4 | 100.6 | 103.7 | | | * | * | * |
| | 2650 | 2670 | 2900 | 2720 | 2880 | 2810 | 2610 | 2930 | 2780 | 2700 | 2410 | 2850 | 2630 | | | | | |
| BKF Raver-Paul & Ctr2 | 98.2 | 97.6 | | | | | | | 95.2 | 96.6 | 106.7 | 100.3 | 102.9 | * | | * | * | * |
| | | | | | | | | | | | 2440 | 2850 | 2670 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 121.1 | 122.3 | 112.0 | 112.6 | 109.8 | 111.0 | 114.5 | 108.9 | 114.9 | 121.0 | 117.8 | 114.3 | 114.0 | | | * | * | * |
| | 2320 | 2330 | 2500 | 2340 | 2460 | 2410 | 2270 | 2490 | 2420 | 2360 | 2120 | 2690 | 2270 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 113.4 | 114.0 | 105.3 | 100.3 | 97.5 | 98.7 | 102.2 | 96.6 | 108.3 | 112.7 | 117.1 | 114.0 | 113.3 | * | | * | * | * |
| | 2460 | 2470 | 2670 | 2840 | | | 2720 | | 2570 | 2500 | 2130 | 2690 | 2290 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | | | | | * | * | * | * | * |
| | | | | | | | | | | | | | | | | | | |
| **With Fredericksson 150MW Steam unit added, 299MW total; Raver-Paul 500 kV line = 1922MW pre-outage** | | | | | | | | | | | | | | | | | | |
| Raver-Paul 500 outage | 95.2 | | | 98.7 | 95.9 | 97.1 | 100.7 | 95.1 | | | 97.8 | | | | | * | * | * |
| | | | | | | | 2790 | | | | | | | | | | | |
| Raver-Paul 500 outage | | | | | | | | | | | 96.7 | | | * | | * | * | * |
| | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | 109.9 | 110.1 | 102.3 | 108.6 | 105.8 | 107.0 | 110.5 | 104.9 | 105.2 | 109.1 | 107.9 | 100.9 | 104.1 | | | * | * | * |
| | 2510 | 2530 | 2760 | 2360 | 2520 | 2450 | 2250 | 2570 | 2640 | 2560 | 2380 | 2850 | 2610 | | | | | |
| BKF Raver-Paul & Ctr2 | 98.4 | 97.7 | | | | | | | 95.3 | 96.7 | 106.8 | 100.4 | 103.0 | * | | * | * | * |
| | | | | | | | | | | | 2430 | 2850 | 2670 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 125.1 | 126.6 | 115.5 | 118.9 | 116.1 | 117.3 | 120.8 | 115.2 | 118.4 | 125.3 | 118.3 | 114.6 | 114.5 | | | * | * | * |
| | 2220 | 2230 | 2400 | 2090 | 2210 | 2160 | 2020 | 2240 | 2320 | 2260 | 2100 | 2680 | 2250 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 113.5 | 114.2 | 105.4 | 100.4 | 97.6 | 98.8 | 102.3 | 96.7 | 108.4 | 112.9 | 117.2 | 114.1 | 113.4 | * | | * | * | * |
| | 2420 | 2430 | 2660 | 2820 | | | 2650 | | 2540 | 2470 | 2120 | 2690 | 2280 | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | | | | | * | * | * | * | * |
| | | | | | | | | | | | | | | | | | | |

## Table 5.a. Raver-Paul 500 kV Related Outages - Fredrickson Steam, with Westcoast 270MW

% line loading at 2850 MW Northern Intertie / NI at 100% loading

| Fredrickson Steam Generation Level / Outage | LONGMR T - YELM 115 | LONGMR T - OLY VAIL 115 | KAPOWSIN - YELM 115 | GRAVELLY - TILCM TP 115 | DUPONT - QUARRY 115 | DUPONT - GRAVELLY 115 | FREDRICK - TILCM TP 115 | ST CLAIR - QUARRY 115 | ELECTHTS - KAPOWSIN 115 | BLUMAER - OLY VAIL 115 | TACOMA A - CENTR SS 230 | OLYMPIA - TACOMA B 230 | CHEHALIS - CENTR SS 230 | | Trip Fredrickson steam unit | Trip Coulee gen 720 MW | Trip Chief Joseph gens 1100 MW | Trip Whitehorn & Fredonia 349 MW | Trip BC Hydro gens 1820 MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| With existing Fredrickson 2 CT's, 149MW total; Raver-Paul 500 kV line = 1860MW pre-outage | | | | | | | | | | | | | | | | | | | |
| Raver-Paul 500 outage | | | | | | | | | | | | | | | | | * | * | * |
| Raver-Paul 500 outage | | | | | | | | | | | | | | * | | | * | * | * |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 104.0<br>2640 | 103.9<br>2800 | 100.2<br>2840 | | | | * | * | * |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | | | | * | | | * | * | * |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 107.1<br>2670 | 105.5<br>2720 | 101.5<br>2810 | 97.5 | | 95.6 | 99.8 | | 105.1<br>2700 | 104.1<br>2750 | 114.4<br>2300 | 117.6<br>2640 | 110.6<br>2440 | | | | * | * | * |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | | | | | * | | | * | * | * |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | | | | | * | | * | * | * | * |
| With Fredrickson 50MW Steam unit added, 199MW total; Raver-Paul 500 kV line = 1863MW pre-outage | | | | | | | | | | | | | | | | | | | |
| Raver-Paul 500 outage | | | | | | | | | | | | | | | | | * | * | * |
| Raver-Paul 500 outage | | | | | | | | | | | | | | * | * | | * | * | * |
| BKF Raver-Paul & Ctr2 | | | | | | | | 96.1 | 96.0 | 95.6 | 104.4<br>2610 | 104.2<br>2790 | 100.6<br>2820 | | | | * | * | * |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 99.4 | 95.3 | 95.6 | * | * | | * | * | * |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 111.2<br>2570 | 109.8<br>2620 | 105.0<br>2700 | 103.8<br>2700 | 100.4<br>2830 | 101.9<br>2770 | 106.1<br>2600 | 99.4<br>2880 | 108.5<br>2600 | 108.4<br>2650 | 114.8<br>2280 | 117.9<br>2640 | 111.0<br>2430 | | | | * | * | * |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 104.3<br>2730 | 102.6<br>2780 | 99.1 | 95.7 | | | 98.0 | | 102.6<br>2760 | 101.2<br>2820 | 109.7<br>2420 | 108.9<br>2740 | 105.9<br>2580 | * | * | | * | * | * |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | | | | | * | * | * | * | * | * |

## Table 5.b. Raver-Paul 500 kV Related Outages - Fredrickson Steam, with Westcoast 270MW

% line loading at 2850 MW Northern Intertie / NI at 100% loading

| Fredrickson Steam Generation Level / Outage | LONGMR T - YELM 115 | LONGMR T - OLY VAIL 115 | KAPOWSIN - YELM 115 | GRAVELLY - TILCM TP 115 | DUPONT - QUARRY 115 | DUPONT - GRAVELLY 115 | FREDRICK - TILCM TP 115 | ST CLAIR - QUARRY 115 | ELECTHTS - KAPOWSIN 115 | BLUMAER - OLY VAIL 115 | TACOMA A - CENTR SS 230 | OLYMPIA - TACOMA B 230 | CHEHALIS - CENTR SS 230 | | Trip Fredrickson steam unit | Trip Coulee gen 720 MW | Trip Chief Joseph gens 1100 MW | Trip Whitehorn & Fredonia 349 MW | Trip BC Hydro gens 1820 MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| With Fredrickson 100MW Steam unit added, 249MW total; Raver-Paul 500 kV line = 1867MW pre-outage | | | | | | | | | | | | | | | | | | | |
| Raver-Paul 500 outage | | | | | | | | | | | | | | | | | * | * | * |
| Raver-Paul 500 outage | | | | | | | | | | | | | | * | * | | * | * | * |
| BKF Raver-Paul & Ctr2 | 100.1 | 97.8 | 95.5 | 100.0 | 96.6 | 98.1 | 102.3 | 95.5 | 99.0 | 96.6 | 104.8 | 104.4 | 101.1 | | | | * | * | * |
| | 2850 | | | 2850 | | 2960 | 2720 | | | | 2590 | 2790 | 2790 | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 99.5 | 95.4 | 95.7 | * | * | | * | * | * |
| BKF Raver-Paul & Ctr2 | 115.2 | 114.1 | 108.4 | 110.1 | 106.7 | 108.2 | 112.4 | 105.6 | 112.0 | 112.7 | 115.2 | 118.1 | 111.5 | | | | * | * | * |
| and Centralia 1 off line | 2470 | 2520 | 2600 | 2450 | 2580 | 2520 | 2350 | 2620 | 2500 | 2550 | 2270 | 2640 | 2410 | | | | | | |
| BKF Raver-Paul & Ctr2 | 104.4 | 102.7 | 99.2 | 95.8 | | | 98.1 | | 102.7 | 101.3 | 109.8 | 109.0 | 106.0 | * | * | | * | * | * |
| and Centralia 1 off line | 2710 | 2770 | | | | | | | 2750 | 2810 | 2410 | 2740 | 2580 | | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | | | | | * | * | * | * | * | * |
| With Fredrickson 150MW Steam unit added, 299MW total; Raver-Paul 500 kV line = 1870MW pre-outage | | | | | | | | | | | | | | | | | | | |
| Raver-Paul 500 outage | | | | 96.3 | | | 98.6 | | | | 95.1 | | | | | | * | * | * |
| Raver-Paul 500 outage | | | | | | | | | | | | | | * | * | | * | * | * |
| BKF Raver-Paul & Ctr2 | 104.1 | 102.0 | 98.9 | 106.2 | 102.8 | 104.3 | 108.5 | 101.7 | 102.4 | 100.9 | 105.3 | 104.7 | 101.5 | | | | * | * | * |
| | 2710 | 2790 | 2900 | 2500 | 2690 | 2610 | 2370 | 2750 | 2750 | 2820 | 2570 | 2790 | 2770 | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | | | 99.5 | 95.5 | 95.8 | * | * | | * | * | * |
| BKF Raver-Paul & Ctr2 | 104.6 | 102.9 | 99.3 | 95.9 | | | 98.2 | | 102.8 | 101.4 | 109.9 | 109.1 | 106.1 | | | | * | * | * |
| and Centralia 1 off line | 2700 | 2760 | | | | | | | 2740 | 2810 | 2400 | 2740 | 2570 | | | | | | |
| BKF Raver-Paul & Ctr2 | 119.2 | 118.4 | 111.9 | 116.3 | 112.9 | 114.4 | 118.6 | 111.9 | 115.4 | 117.0 | 115.7 | 118.4 | 111.9 | * | * | | * | * | * |
| and Centralia 1 off line | 2370 | 2420 | 2510 | 2200 | 2340 | 2280 | 2110 | 2380 | 2400 | 2450 | 2250 | 2640 | 2400 | | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | | | | | | | | | | | | | | * | * | * | * | * | * |

## Table 6.a. Raver-Paul 500 kV Related Outages - Frederickson Steam, with Westcoast 270MW, and Light Load

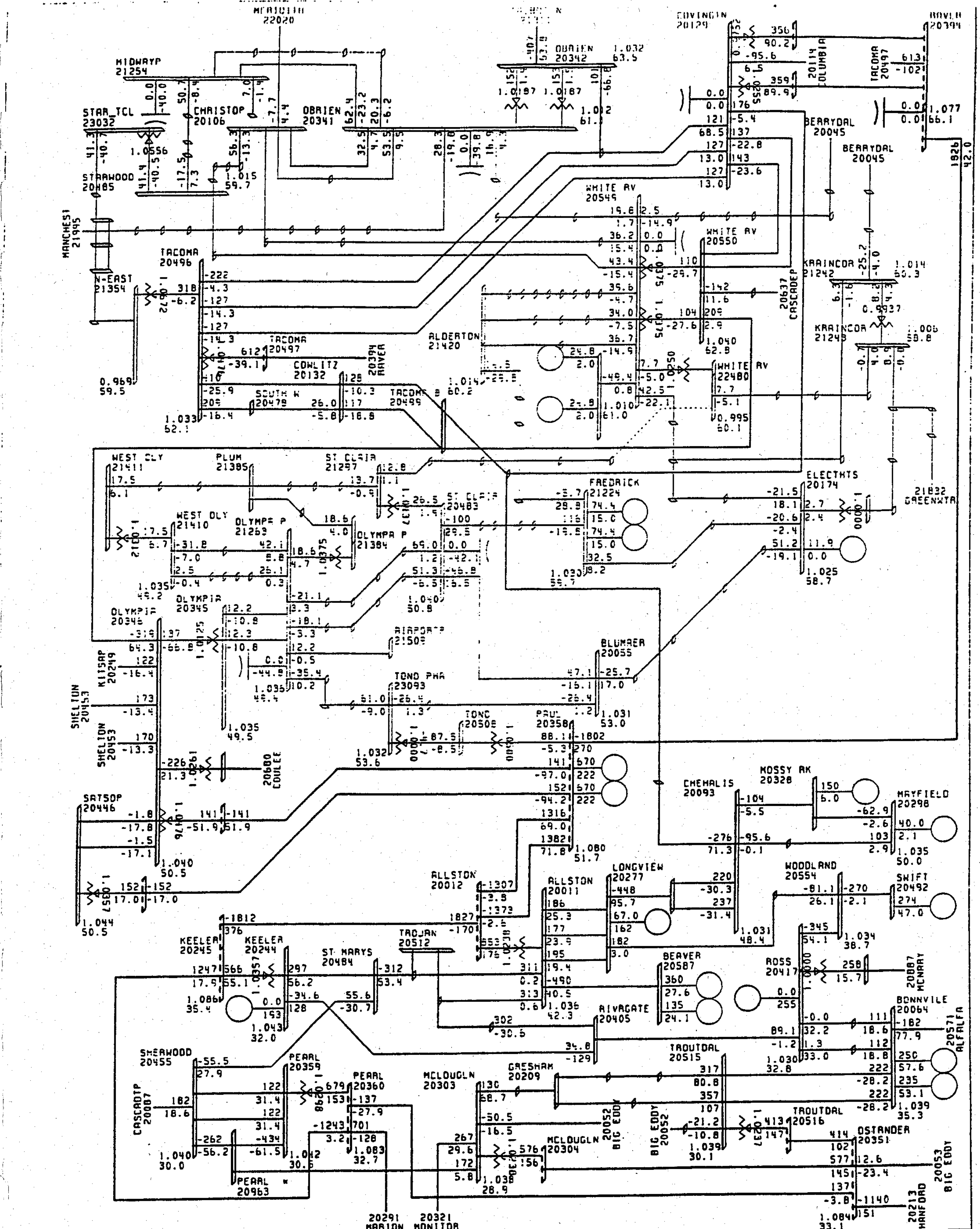
% line loading at 2850 MW Northern Intertie / NI at 100% loading

| Frederickson Steam Generation Level / Outage | LONGMR T - YELM 115 | LONGMR T - OLY VAIL 115 | KAPOWSIN - YELM 115 | GRAVELLY - TILCM TP 115 | DUPONT - QUARRY 115 | DUPONT - GRAVELLY 115 | FREDRICK - TILCM TP 115 | ST CLAIR - QUARRY 115 | ELECTHTS - KAPOWSIN 115 | BLUMAER - OLY VAIL 115 | TACOMA A - CENTR SS 230 | OLYMPIA - TACOMA B 230 | CHEHALIS - CENTR SS 230 | | Trip Frederickson steam unit | Trip Coulee gen 720 MW | Trip Chief Joseph gens 1100 MW | Trip Whitehorn & Fredonia 349 MW | Trip BC Hydro gens 1820 MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| With existing Frederickson 2 CT's, 149MW total; Raver-Paul 500 kV line = 1949MW pre-outage | | | | | | | | | | | | | | | | | | | |
| Raver-Paul 500 outage | | | | | | | | | | | 101.8 | 96.1 | 98.1 | | | | * | * | * |
| | | | | | | | | | | | 2710 | | | | | | | | |
| Raver-Paul 500 outage | | | | | | | | | | | 97.2 | | | * | | | * | * | * |
| | | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | 101.8 | 101.4 | 95.4 | | | | | | 98.3 | 100.4 | 111.9 | 109.4 | 108.2 | | | | * | * | * |
| | 2790 | 2810 | | | | | | | | 2840 | 2260 | 2730 | 2440 | | | | | | |
| BKF Raver-Paul & Ctr2 | 98.8 | 98.2 | | | | | | | 95.7 | 97.2 | 107.3 | 100.8 | 103.5 | * | | | * | * | * |
| | | | | | | | | | | | 2420 | 2840 | 2640 | | | | | | |
| BKF Raver-Paul & Ctr2 | 116.9 | 117.8 | 108.4 | 102.6 | 99.8 | 101.0 | 104.5 | 98.9 | 111.3 | 116.5 | 122.4 | 123.2 | 118.6 | | | | * | * | * |
| and Centralia 1 off line | 2440 | 2450 | 2620 | 2750 | 2860 | 2810 | 2680 | 2890 | 2530 | 2480 | 2040 | 2590 | 2180 | | | | | | |
| BKF Raver-Paul & Ctr2 | 114.0 | 114.7 | 105.8 | 100.7 | 97.9 | 99.1 | 102.7 | 97.0 | 108.8 | 113.4 | 117.6 | 114.4 | 113.9 | * | | | * | * | * |
| and Centralia 1 off line | 2500 | 2510 | 2680 | 2820 | 2940 | 2890 | 2740 | 2970 | 2590 | 2530 | 2120 | 2680 | 2280 | | | | | | |
| BKF Raver-Paul & Ctr2 | 108.2 | 108.5 | 100.8 | 96.7 | | 95.1 | 98.7 | | 103.8 | 107.3 | 110.9 | 108.6 | 107.1 | * | | * | * | * | * |
| and Centralia 1 off line | 2610 | 2610 | 2820 | | | | | | 2720 | 2650 | 2380 | 2590 | 2540 | | | | | | |
| With Frederickson 50MW Steam unit added, 199MW total; Raver-Paul 500 kV line = 1952MW pre-outage | | | | | | | | | | | | | | | | | | | |
| Raver-Paul 500 outage | | | | | | | | | | | 102.2 | 96.4 | 98.5 | | | | * | * | * |
| | | | | | | | | | | | 2680 | | | | | | | | |
| Raver-Paul 500 outage | | | | | | | | | | | 97.3 | | | * | * | | * | * | * |
| | | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | 105.8 | 105.7 | 98.8 | 98.7 | 95.9 | 97.1 | 100.6 | 95.1 | 101.7 | 104.7 | 112.4 | 109.7 | 108.6 | | | | * | * | * |
| | 2660 | 2680 | | | | | 2820 | | 2780 | 2710 | 2240 | 2730 | 2420 | | | | | | |
| BKF Raver-Paul & Ctr2 | 99.0 | 98.4 | | | | | | | 95.8 | 97.4 | 107.4 | 100.9 | 103.6 | * | * | | * | * | * |
| | | | | | | | | | | | 2410 | 2840 | 2630 | | | | | | |
| BKF Raver-Paul & Ctr2 | 120.9 | 122.1 | 111.9 | 108.9 | 106.1 | 107.3 | 110.8 | 105.2 | 114.8 | 120.8 | 122.8 | 123.5 | 119.1 | | | | * | * | * |
| and Centralia 1 off line | 2350 | 2360 | 2520 | 2510 | 2620 | 2570 | 2440 | 2650 | 2440 | 2380 | 2030 | 2590 | 2160 | | | | | | |
| BKF Raver-Paul & Ctr2 | 114.1 | 114.9 | 106.0 | 100.8 | 98.0 | 99.2 | 102.8 | 97.1 | 108.9 | 113.6 | 117.7 | 114.5 | 114.0 | * | * | | * | * | * |
| and Centralia 1 off line | 2470 | 2480 | 2660 | 2810 | | | 2710 | | 2570 | 2510 | 2110 | 2680 | 2270 | | | | | | |
| BKF Raver-Paul & Ctr2 | 108.3 | 108.7 | 100.9 | 96.9 | | 95.3 | 98.8 | | 103.9 | 107.4 | 110.9 | 108.7 | 107.2 | * | * | * | * | * | * |
| and Centralia 1 off line | 2600 | 2610 | 2820 | | | | | | 2720 | 2640 | 2370 | 2590 | 2540 | | | | | | |

## Table 6.b. Raver-Paul 500 kV Related Outages - Frederickson Steam, with Westcoast 270MW, and Light Load

% line loading at 2850 MW Northern Intertie / NI at 100% loading

| Frederickson Steam Generation Level / Outage | LONGMR T - YELM 115 | LONGMR T - OLY VAIL 115 | KAPOWSIN - YELM 115 | GRAVELLY - TILCM TP 115 | DUPONT - QUARRY 115 | DUPONT - GRAVELLY 115 | FREDRICK - TILCM TP 115 | ST CLAIR - QUARRY 115 | ELECTHTS - KAPOWSIN 115 | BLUMAER - OLY VAIL 115 | TACOMA A - CENTR SS 230 | OLYMPIA - TACOMA B 230 | CHEHALIS - CENTR SS 230 | | Trip Frederickson steam unit | Trip Coulee gen 720 MW | Trip Chief Joseph gens 1100 MW | Trip Whitehorn & Fredonia 349 MW | Trip BC Hydro gens 1820 MW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **With Frederickson 100MW Steam unit added, 249MW total; Raver-Paul 500 kV line = 1955MW pre-outage** | | | | | | | | | | | | | | | | | | | |
| Raver-Paul 500 outage | 95.1 | | | 95.1 | | | 97.0 | | | | 102.7 | 96.7 | 99.0 | | | | * | * | * |
| | | | | | | | | | | | 2640 | | | | | | | | |
| Raver-Paul 500 outage | | | | | | | | | | | 97.4 | | | * | * | | * | * | * |
| | | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | 109.8 | 110.0 | 102.3 | 105.0 | 102.2 | 103.4 | 106.9 | 101.3 | 105.2 | 109.0 | 112.9 | 110.0 | 109.1 | | | | * | * | * |
| | 2530 | 2550 | 2770 | 2590 | 2740 | 2670 | 2490 | 2780 | 2660 | 2580 | 2220 | 2730 | 2400 | | | | | | |
| BKF Raver-Paul & Ctr2 | 99.1 | 98.6 | | | | | | | 96.0 | 97.5 | 107.5 | 101.0 | 103.7 | * | * | | * | * | * |
| | | | | | | | | | | | 2390 | 2840 | 2620 | | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 125.0 | 126.4 | 115.3 | 115.2 | 112.4 | 113.6 | 117.1 | 111.5 | 118.3 | 125.2 | 123.3 | 123.8 | 119.5 | | | | * | * | * |
| | 2260 | 2270 | 2430 | 2270 | 2380 | 2330 | 2200 | 2410 | 2340 | 2290 | 2010 | 2580 | 2150 | | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 114.3 | 115.1 | 106.1 | 101.0 | 98.1 | 99.4 | 102.9 | 97.3 | 109.0 | 113.8 | 117.8 | 114.7 | 114.1 | * | * | | * | * | * |
| | 2430 | 2440 | 2640 | 2790 | 2970 | 2890 | 2670 | 3020 | 2540 | 2480 | 2100 | 2670 | 2260 | | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 108.5 | 108.6 | 101.1 | 97.0 | | 95.4 | 99.0 | | 104.0 | 107.6 | 111.0 | 108.8 | 107.3 | * | * | * | * | * | * |
| | 2600 | 2610 | 2810 | | | | | | 2710 | 2640 | 2370 | 2590 | 2530 | | | | | | |
| **With Frederickson 150MW Steam unit added, 299MW total; Raver-Paul 500 kV line = 1958MW pre-outage** | | | | | | | | | | | | | | | | | | | |
| Raver-Paul 500 outage | 99.0 | 98.4 | | 101.2 | 98.4 | 99.6 | 103.1 | 97.5 | 95.8 | 97.4 | 103.2 | 96.9 | 99.4 | | | | * | * | * |
| | | | | 2750 | | | 2590 | | | | 2610 | | | | | | | | |
| Raver-Paul 500 outage | | | | | | | | | | | 97.4 | | | * | * | | * | * | * |
| | | | | | | | | | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | 113.7 | 114.2 | 105.7 | 111.1 | 108.3 | 109.6 | 113.0 | 107.4 | 108.6 | 113.2 | 113.3 | 110.3 | 109.6 | | | | * | * | * |
| | 2410 | 2430 | 2640 | 2270 | 2410 | 2350 | 2160 | 2460 | 2530 | 2460 | 2200 | 2720 | 2380 | | | | | | |
| BKF Raver-Paul & Ctr2 | 99.3 | 98.7 | | | | | | | 96.1 | 97.7 | 107.6 | 101.2 | 103.8 | * | * | | * | * | * |
| | | | | | | | | | | | 2380 | 2840 | 2610 | | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 129.0 | 130.7 | 118.8 | 121.4 | 118.6 | 119.8 | 123.4 | 117.7 | 121.7 | 129.4 | 123.8 | 124.1 | 120.0 | | | | * | * | * |
| | 2160 | 2170 | 2330 | 2040 | 2150 | 2100 | 1970 | 2180 | 2250 | 2200 | 2000 | 2580 | 2130 | | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 114.4 | 115.2 | 106.2 | 101.1 | 98.2 | 99.5 | 103.0 | 97.4 | 109.2 | 113.9 | 117.9 | 114.8 | 114.2 | * | * | | * | * | * |
| | 2390 | 2410 | 2620 | 2760 | 3000 | 2900 | 2600 | 3080 | 2510 | 2440 | 2100 | 2670 | 2250 | | | | | | |
| BKF Raver-Paul & Ctr2 and Centralia 1 off line | 108.6 | 108.8 | 101.2 | 97.1 | | 95.5 | 99.1 | | 104.1 | 107.8 | 111.1 | 109.0 | 107.4 | * | * | * | * | * | * |
| | 2600 | 2610 | 2810 | | | | | | 2710 | 2640 | 2370 | 2580 | 2530 | | | | | | |

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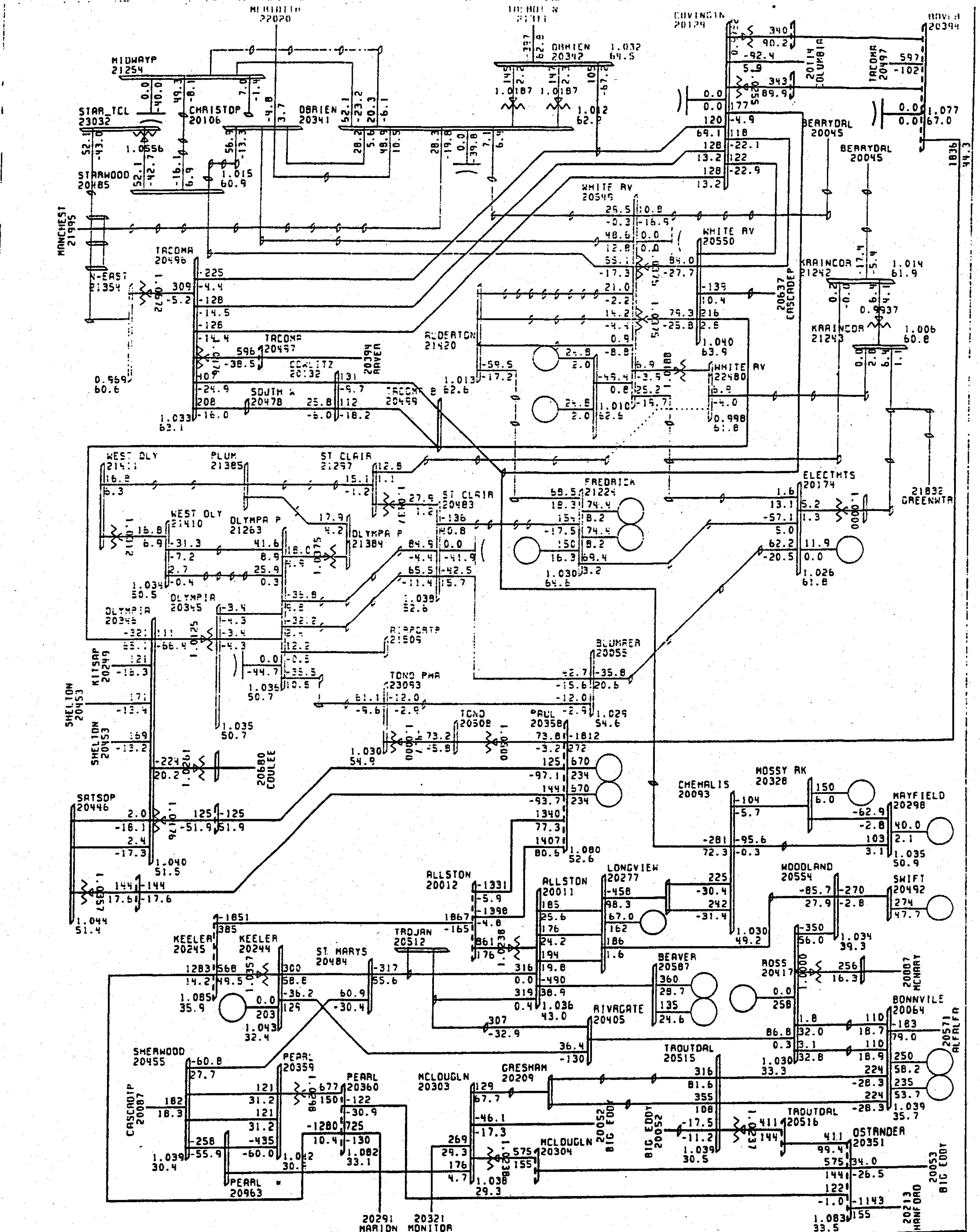
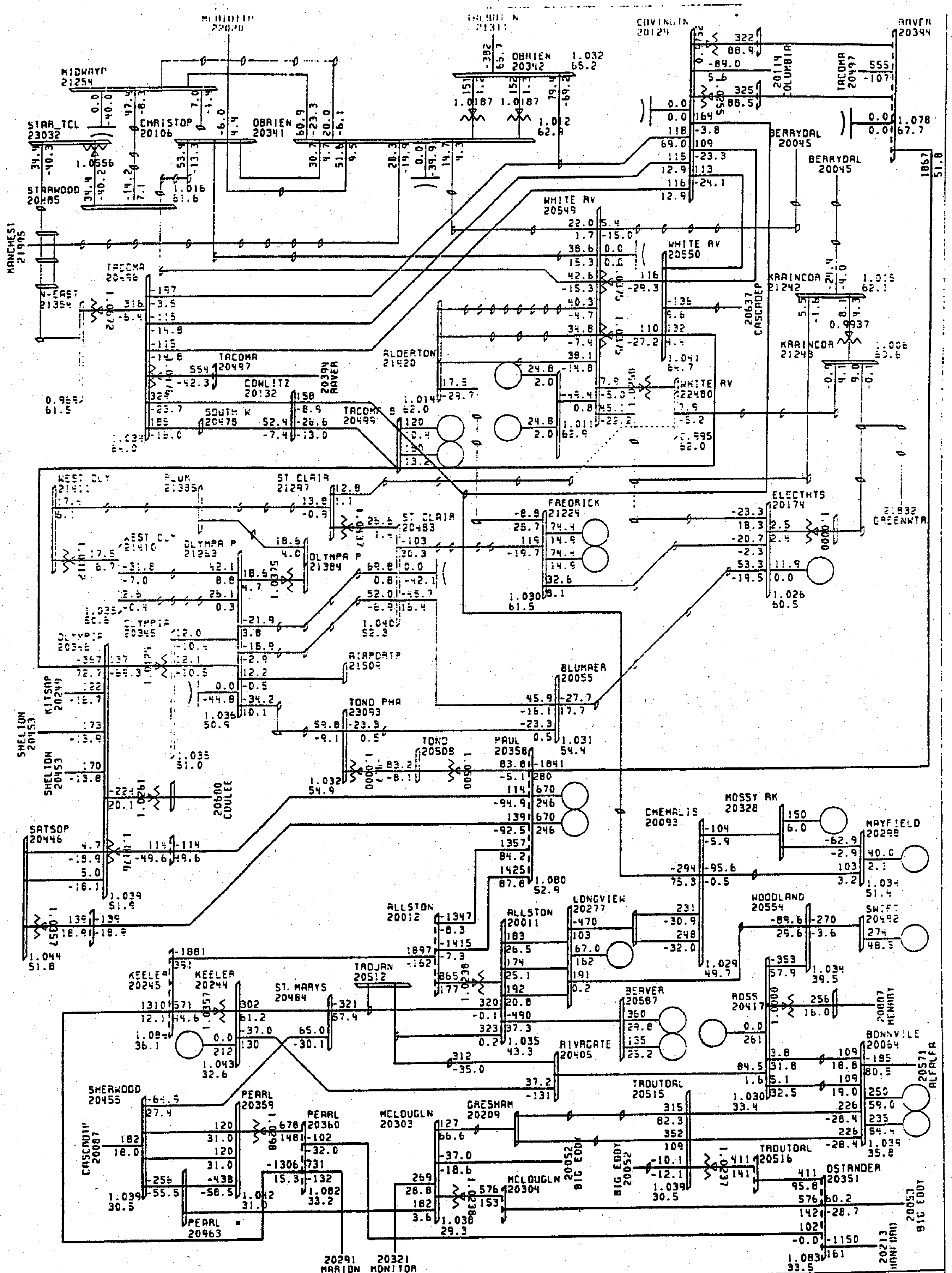
NO OUTAGES

100% RATEA
0.950UV 1.050OV




99HSNS04 BCH=2850/300 WASK=1123.SCL=650, FRED=299
NO OUTAGES

100% RATEA
0.950UV 1.050OV
KV: <115 <230 <345




99HSNS04 BCH=2850/300 WASK=1123,SCL=650, WCG=270
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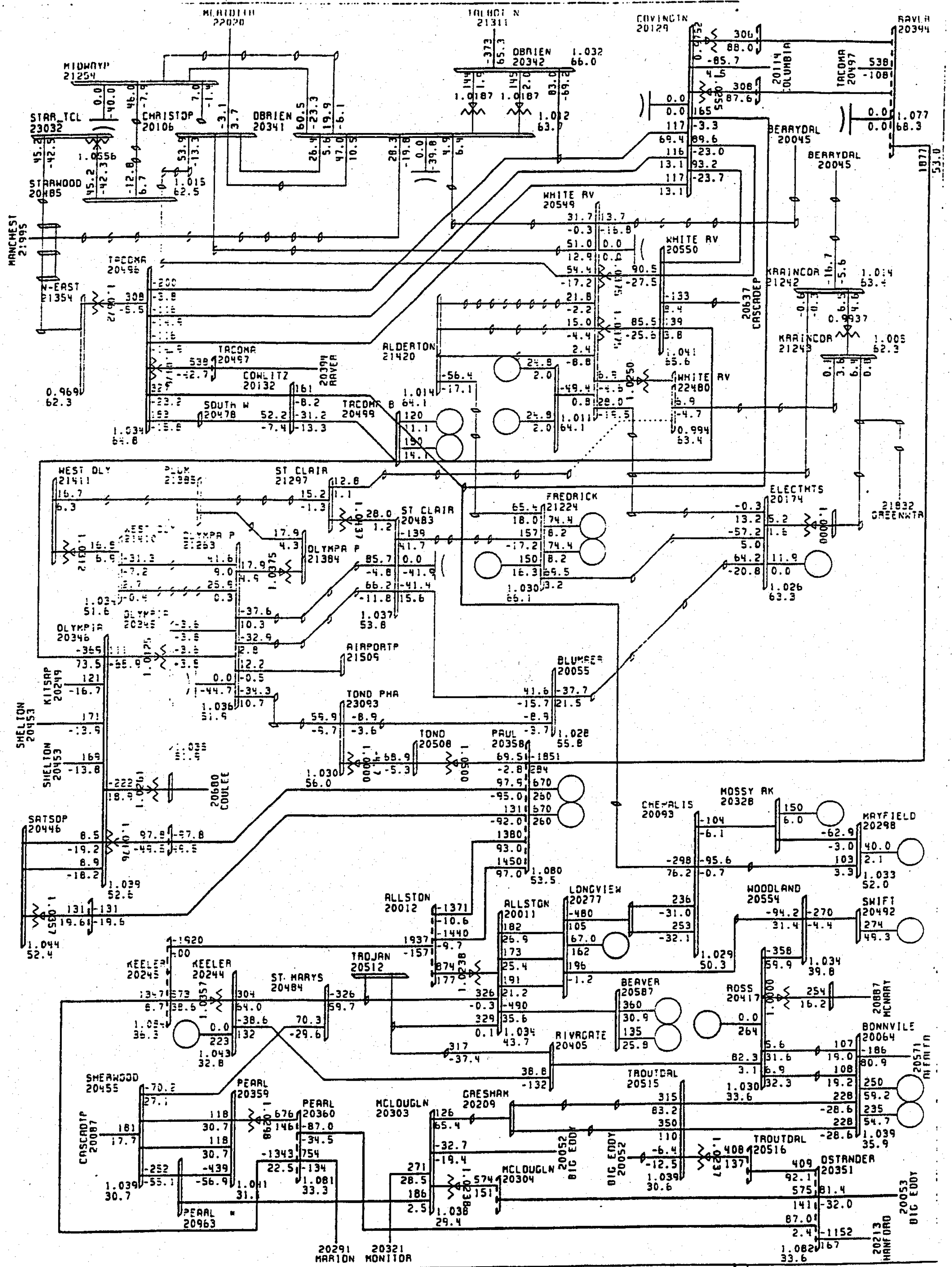
100% RATEA
0.950UV 1.050OV
KV: <115 <230 <345

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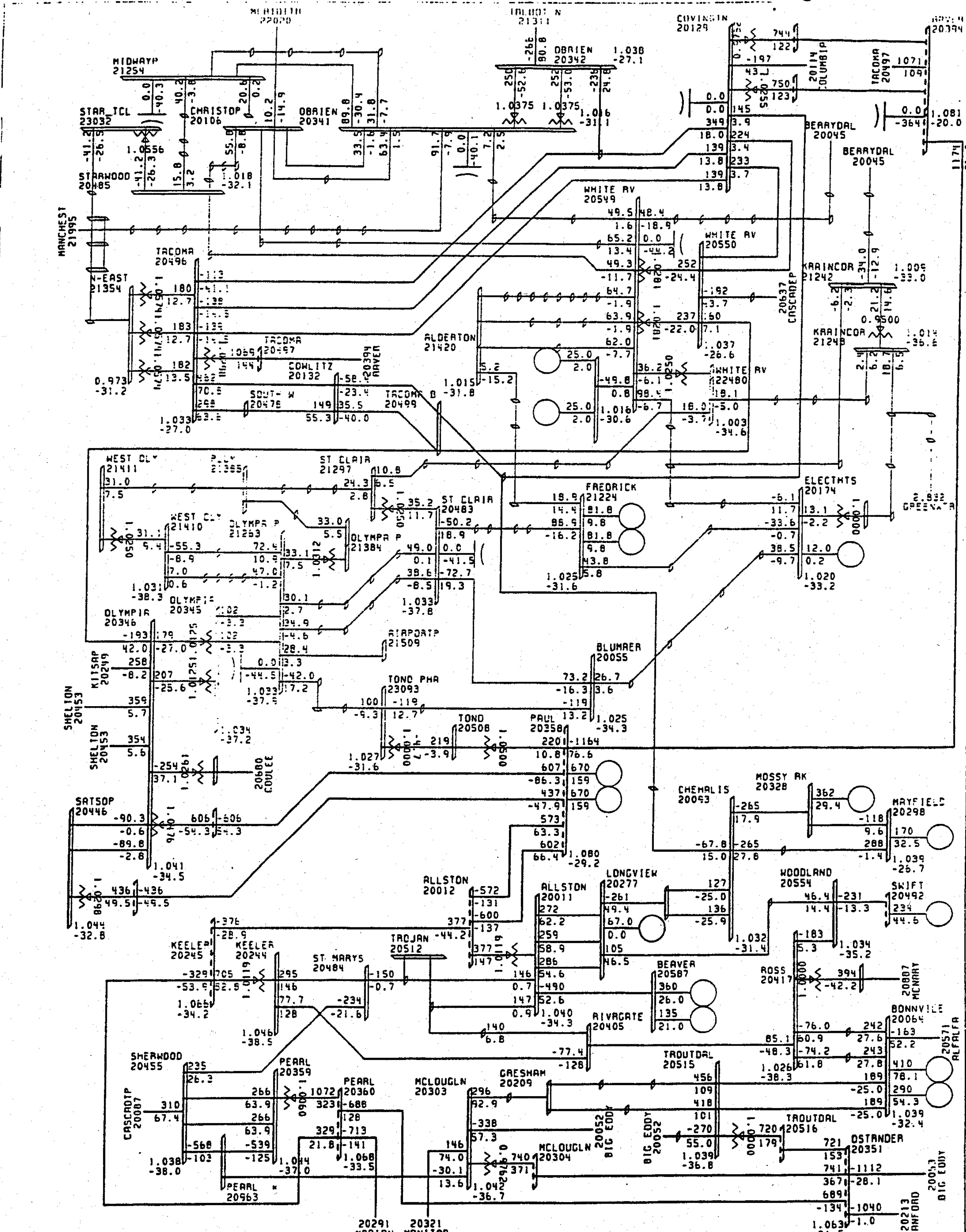
NO OUTAGES

100% RATEA
0.950UV 1.050OV

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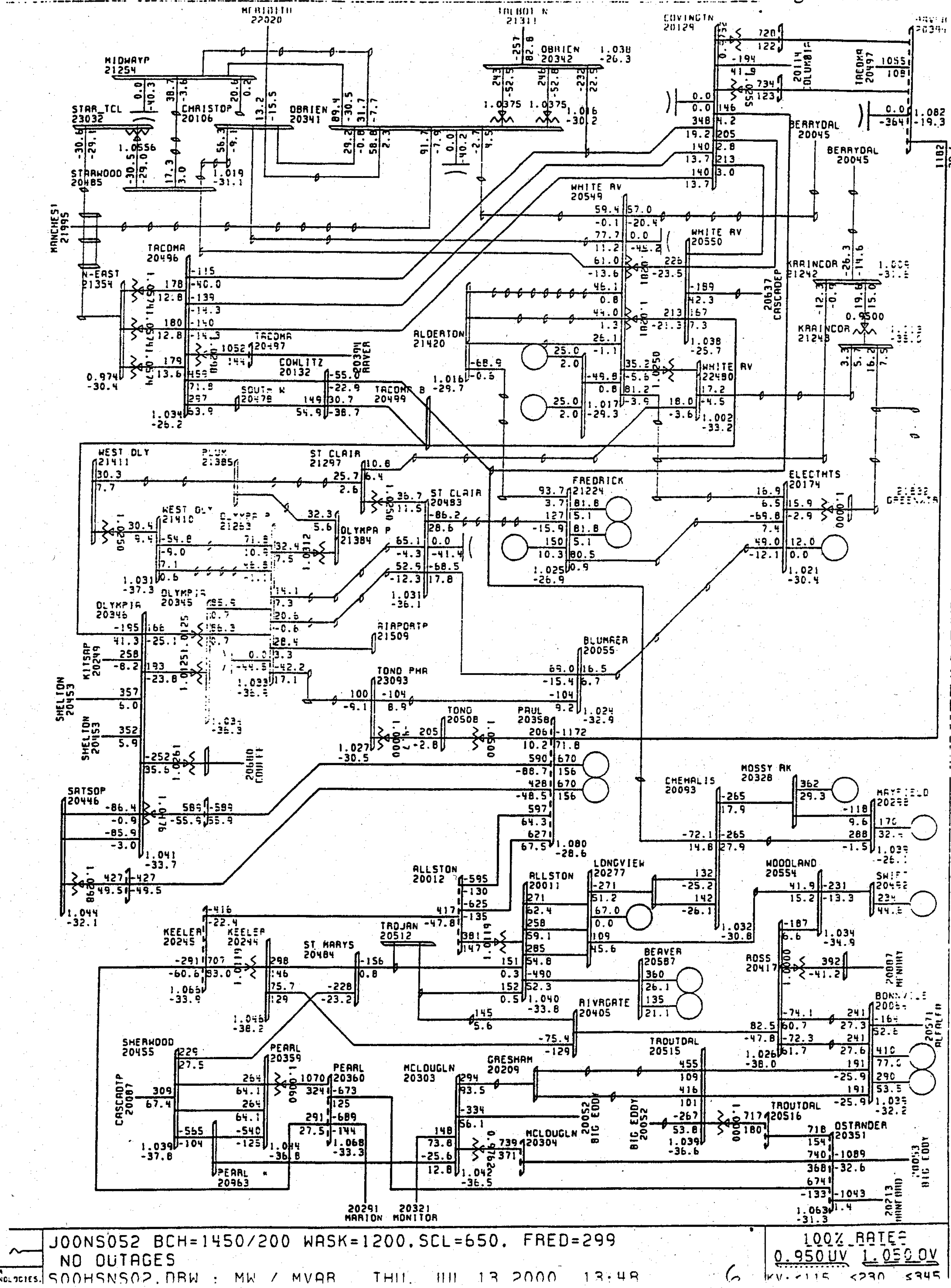
5

100% RATEA
0.950UV 1.050OV
KV: <115 <230 <345

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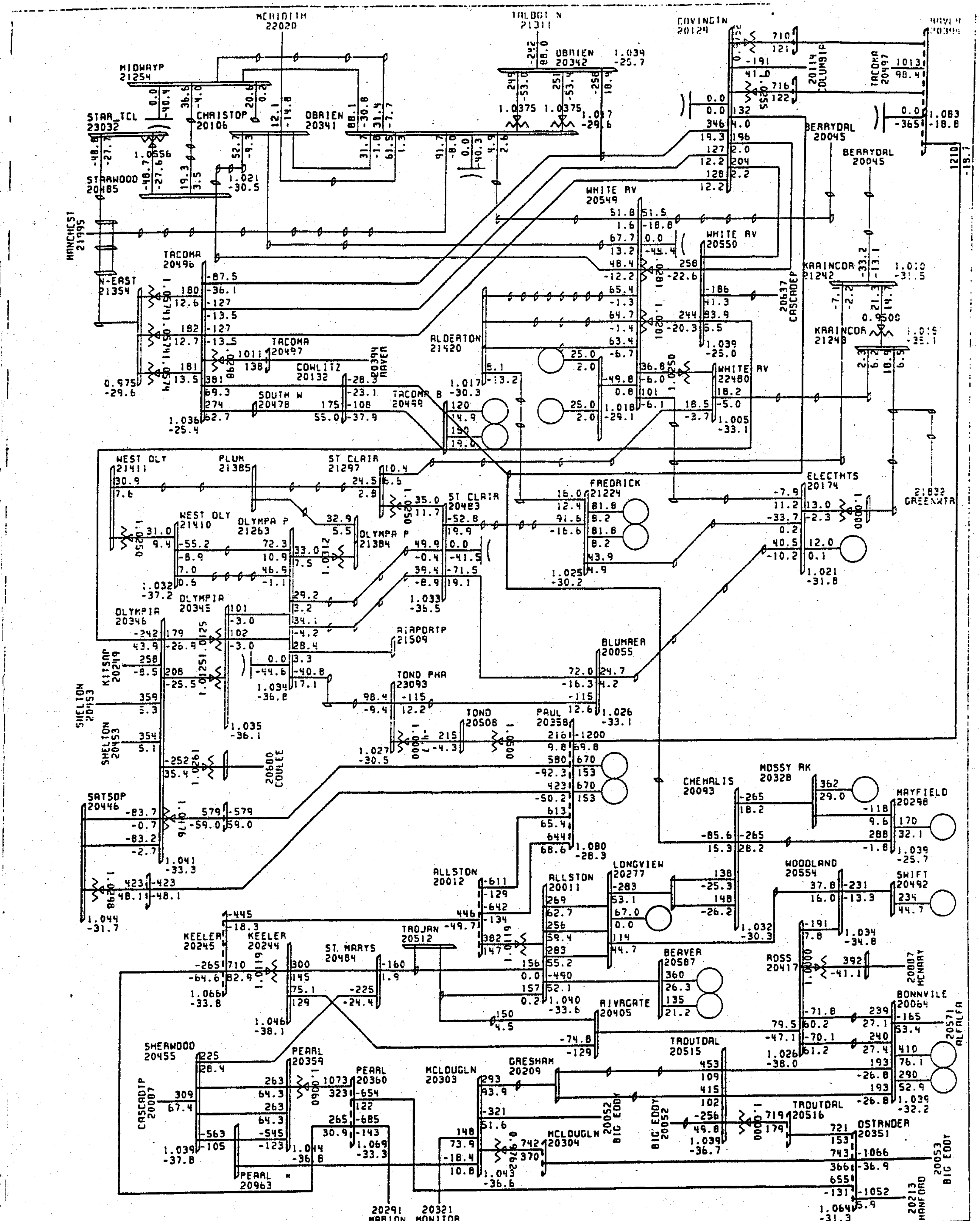
100% RATE?
0.950UV 1.050OV
KV:<115 <230 <345

6

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NO OUTAGES
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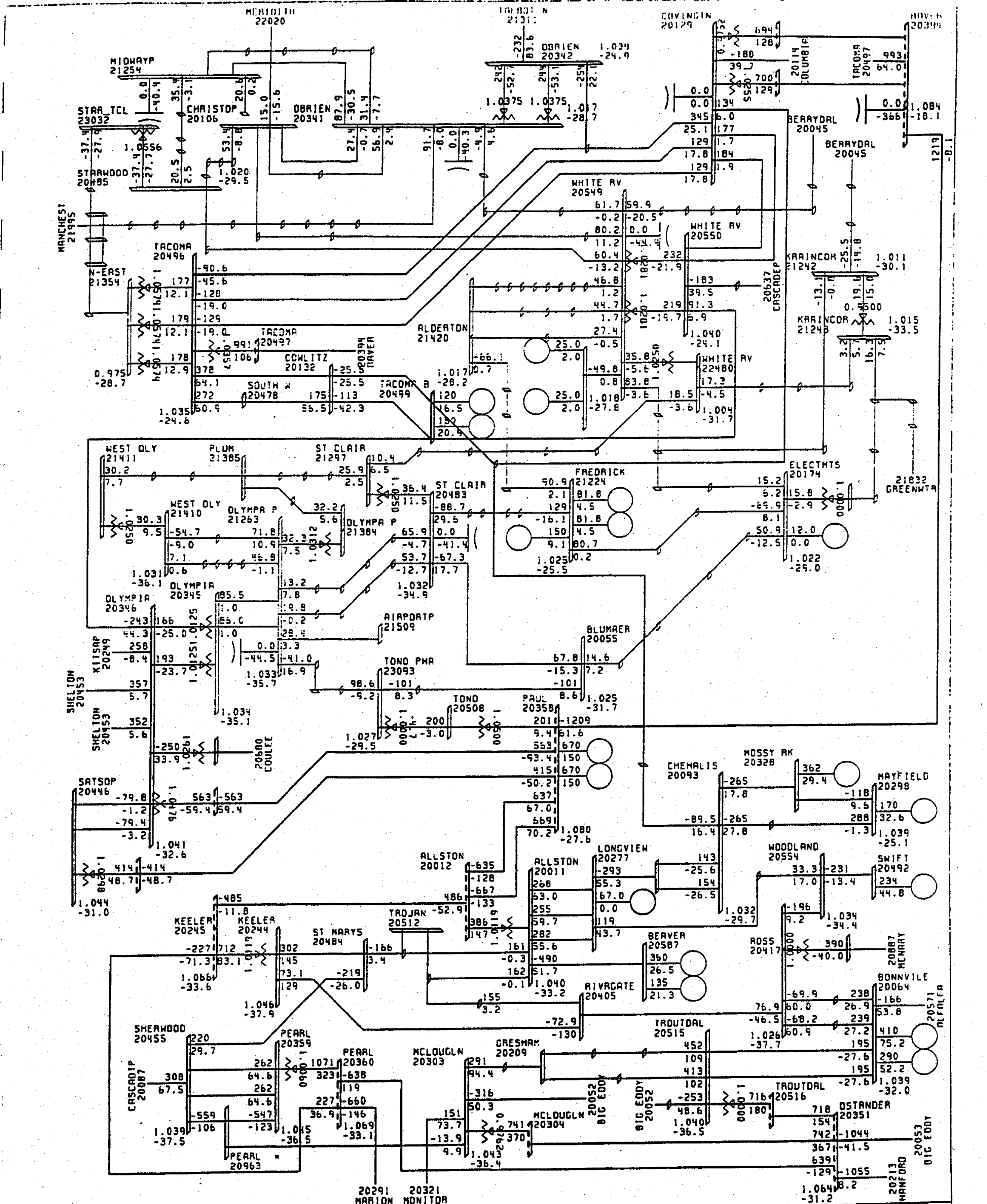
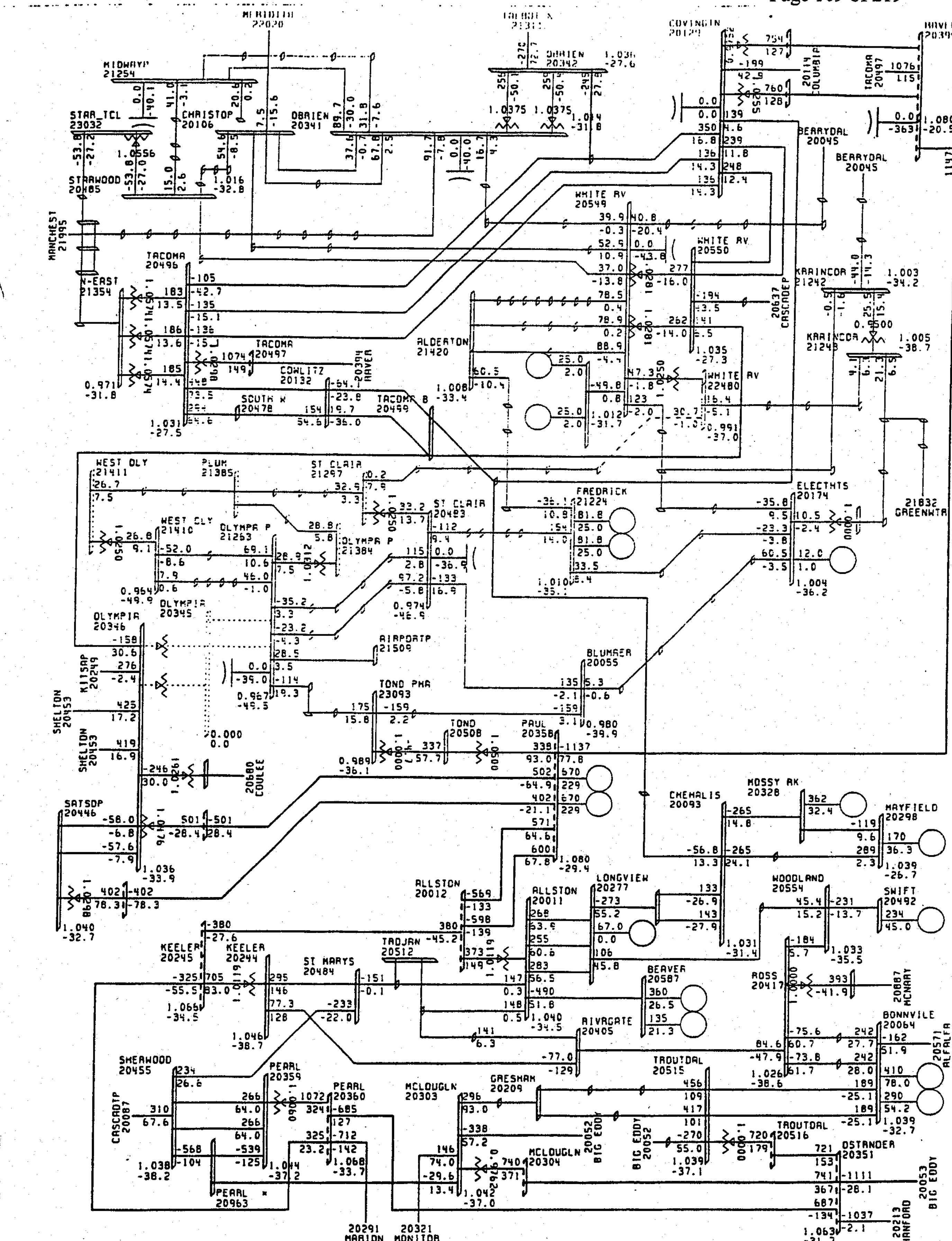
100% RATEA
0.950UV 1.050OV
KV: <115 <230 <345

7




J00NS052 BCH=1450/200 WASK=1200.SCL=650. FRED=299. WCG=270
NO OUTAGES

100% RATEA
0.950UV 1.050OV

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BUS OLYMPIA 115 BUS
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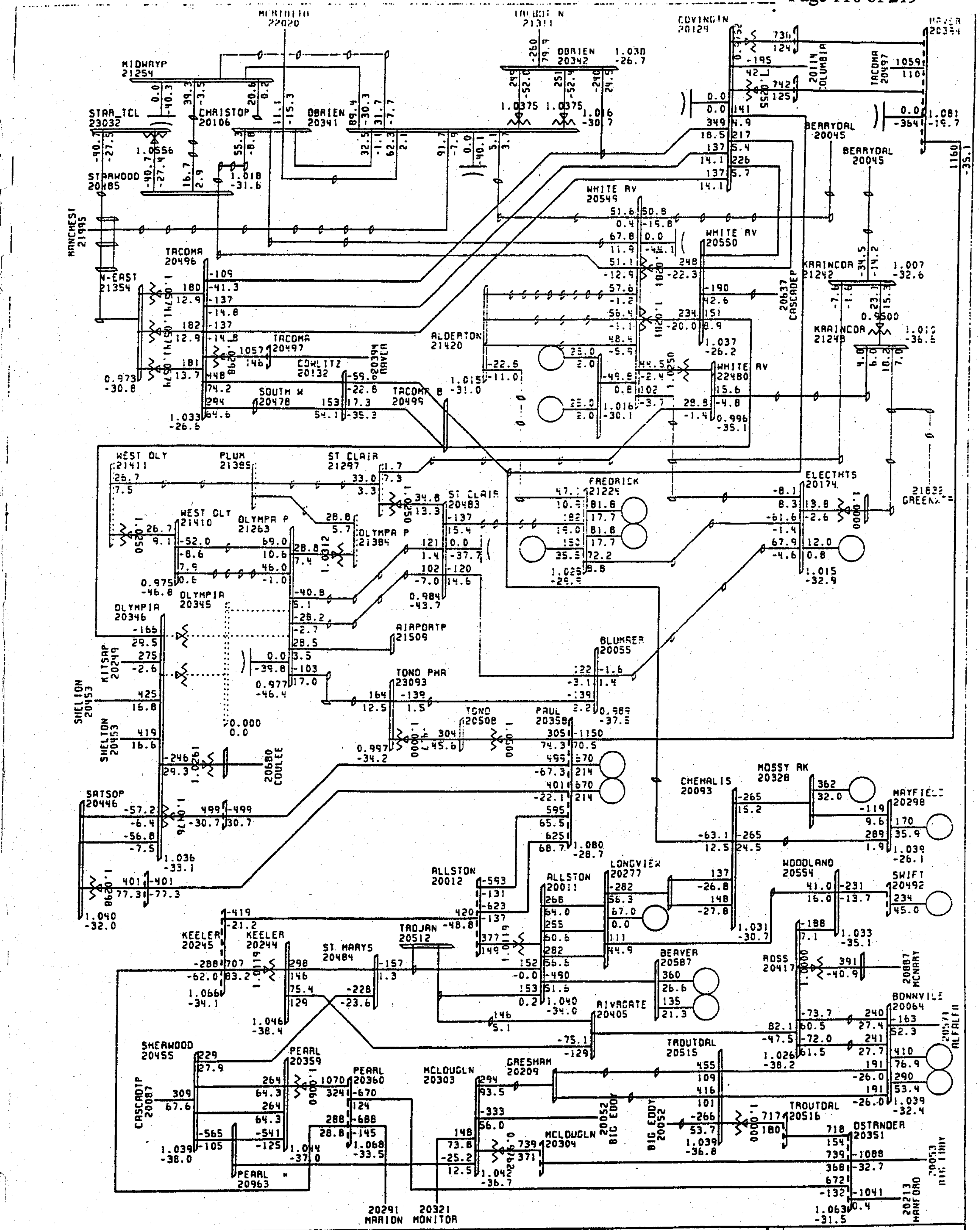
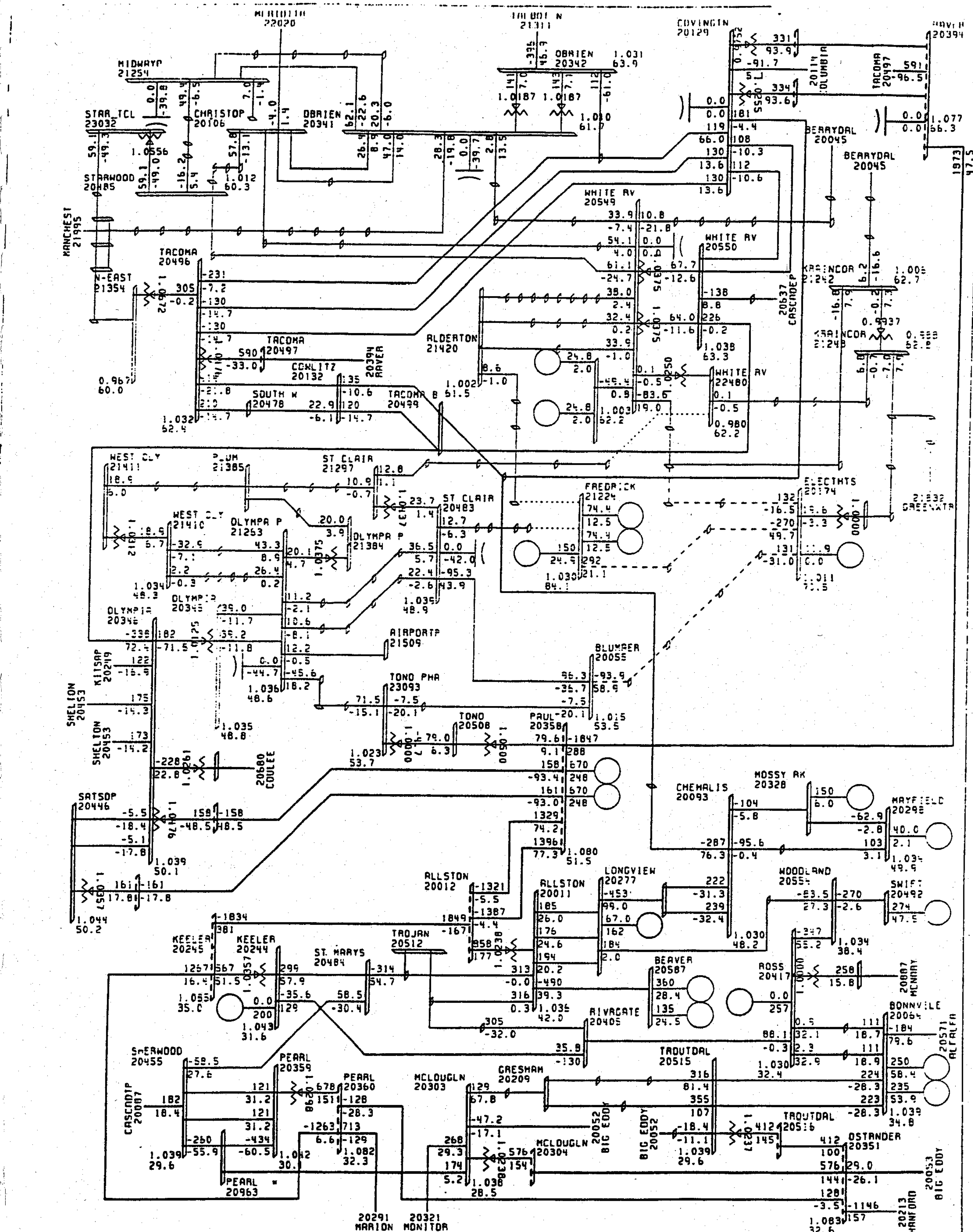
100% RATEA
0.950UV 1.050OV




J00NS052 BCH=1450/200 WASK=1200,SCL=650, FRED=299
BUS OLYMPIA 115 BUS

100% RATEA
0.950UV 1.050OV

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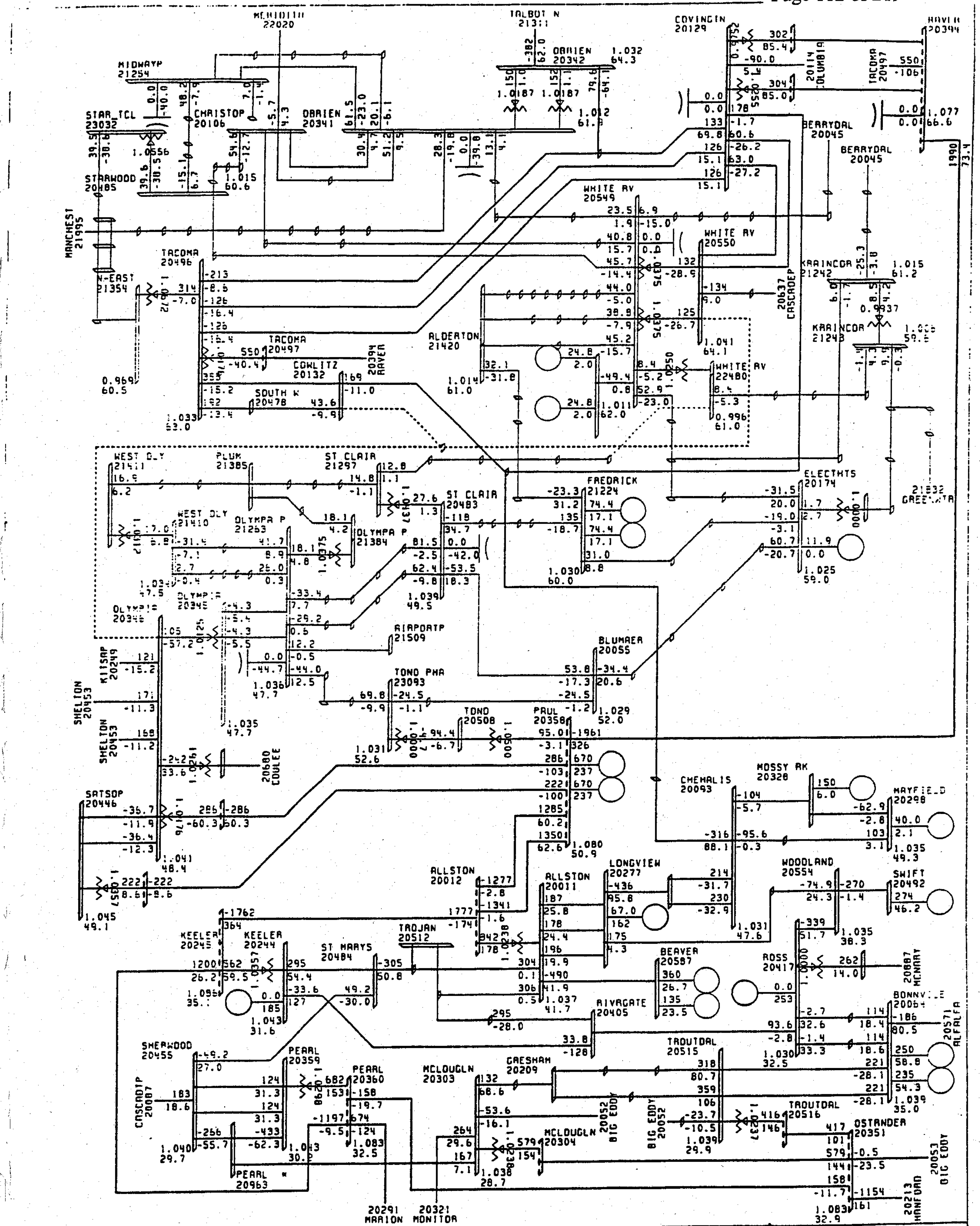
2 LINE FREDRICK-SW28TIE & FREDRICK-TILCM TP 115

100% RATEA
0.950UV 1.050OV

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SL WHITE R-COWLITZ-OLYMPIA B 230

100% RATEA
0.950UV 1.050OV

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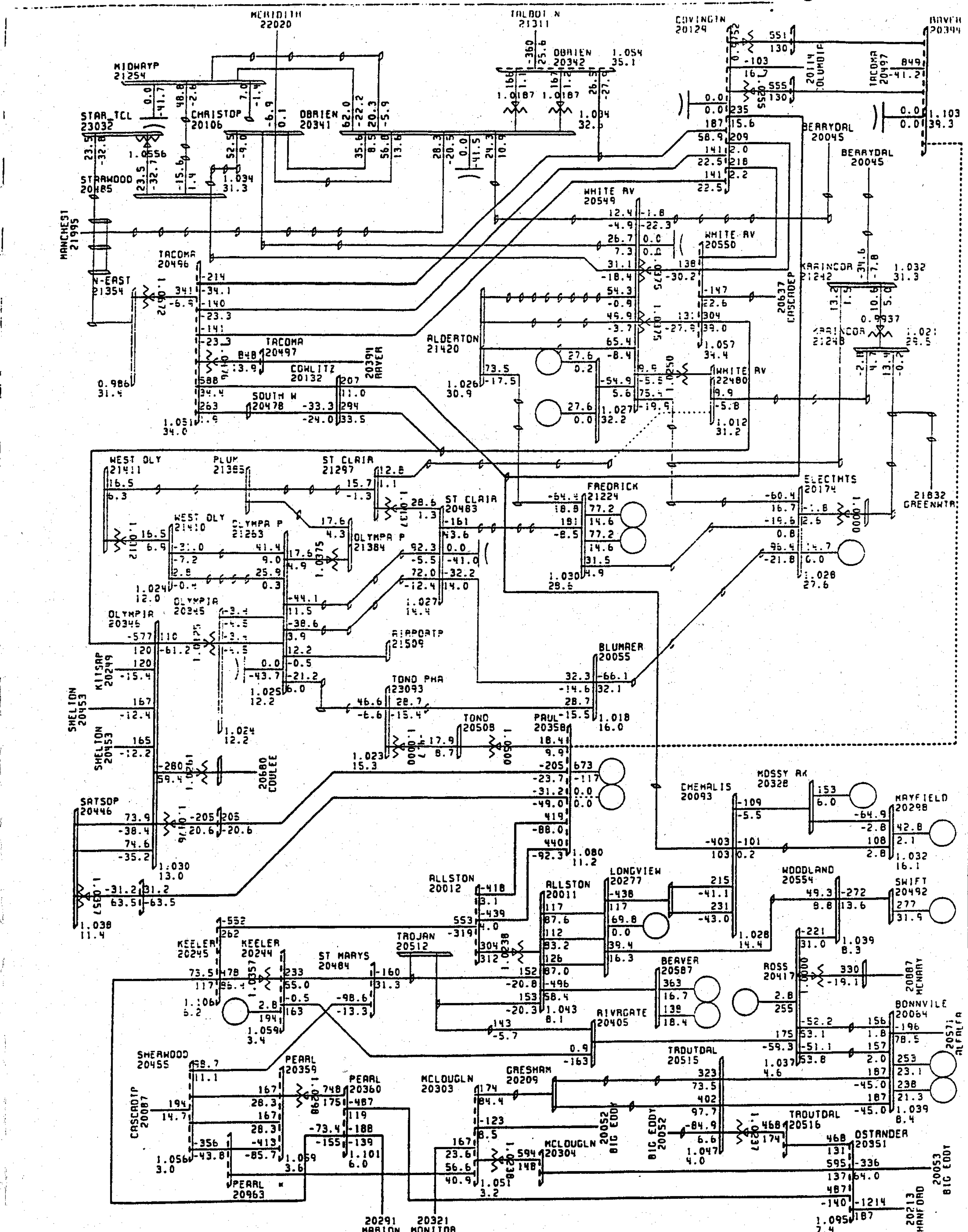
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TALBOT N 21311
COVINGTN 20129
RAVER 20399
MIDWAYP 21254
OBRIEN 20342
STAR_TCL 23032
CHRISTOP 20106
OBRIEN 20341
STRAWDOD 20485
BERRYDAL 20045
MANCHEST 21995
WHITE RV 20549
WHITE RV 20550
TACOMA 20496
N-EAST 21354
KARINCOR 21242
TACOMA 20497
COWLITZ 20132
ALDERTON 21420
WHITE RV 22480
SOUTH W 20478
CASCADEP 20637
WEST OLY 21411
PLUM 21365
ST CLAIR 21297
ST CLAIR 20483
FREDRICK 21224
ELECTHTS 20174
21832 GREENWTR
WEST OLY 21410
OLYMPA P 21263
OLYMPA P 21384
OLYMPIA 20346
OLYMPIA 20345
AIRPORTP 21509
KITSAP 20299
SHELTON 20453
BLUMAER 20055
TONO PHA 23093
TONO 20508
PAUL 20358
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SATSOP 20446
CHEHALIS 20093
MOSSY RK 20328
MAYFIELD 20298
ALLSTON 20012
ALLSTON 20011
LONGVIEW 20277
WOODLAND 20554
SWIFT 20492
KEELER 20245
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ST MARYS 20484
TROJAN 20512
BEAVER 20587
ROSS 20417
20887 MCNARY
BONNVILE 20064
RIVRGATE 20405
20571 ALFALFA
SHERWOOD 20455
PEARL 20359
PEARL 20360
MCLOUGLN 20303
GRESHAM 20209
TROUTDAL 20515
CASCADTP 20087
20052 BIG EDDY
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PEARL 20963
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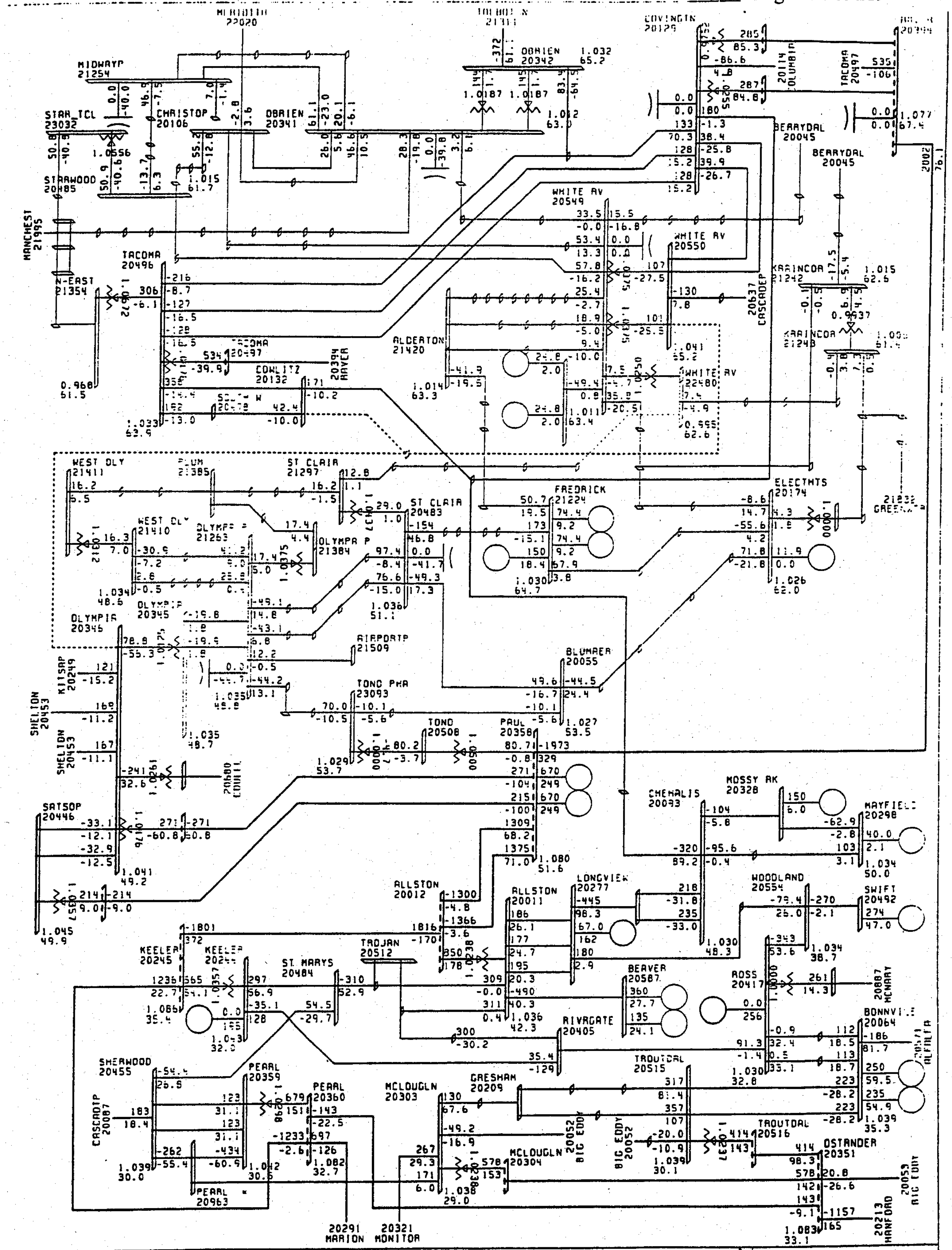
20213 HANFORD
20291 MARION
20321 MONITOR

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SL WHITE R-COWLITZ-OLYMPIA B 230
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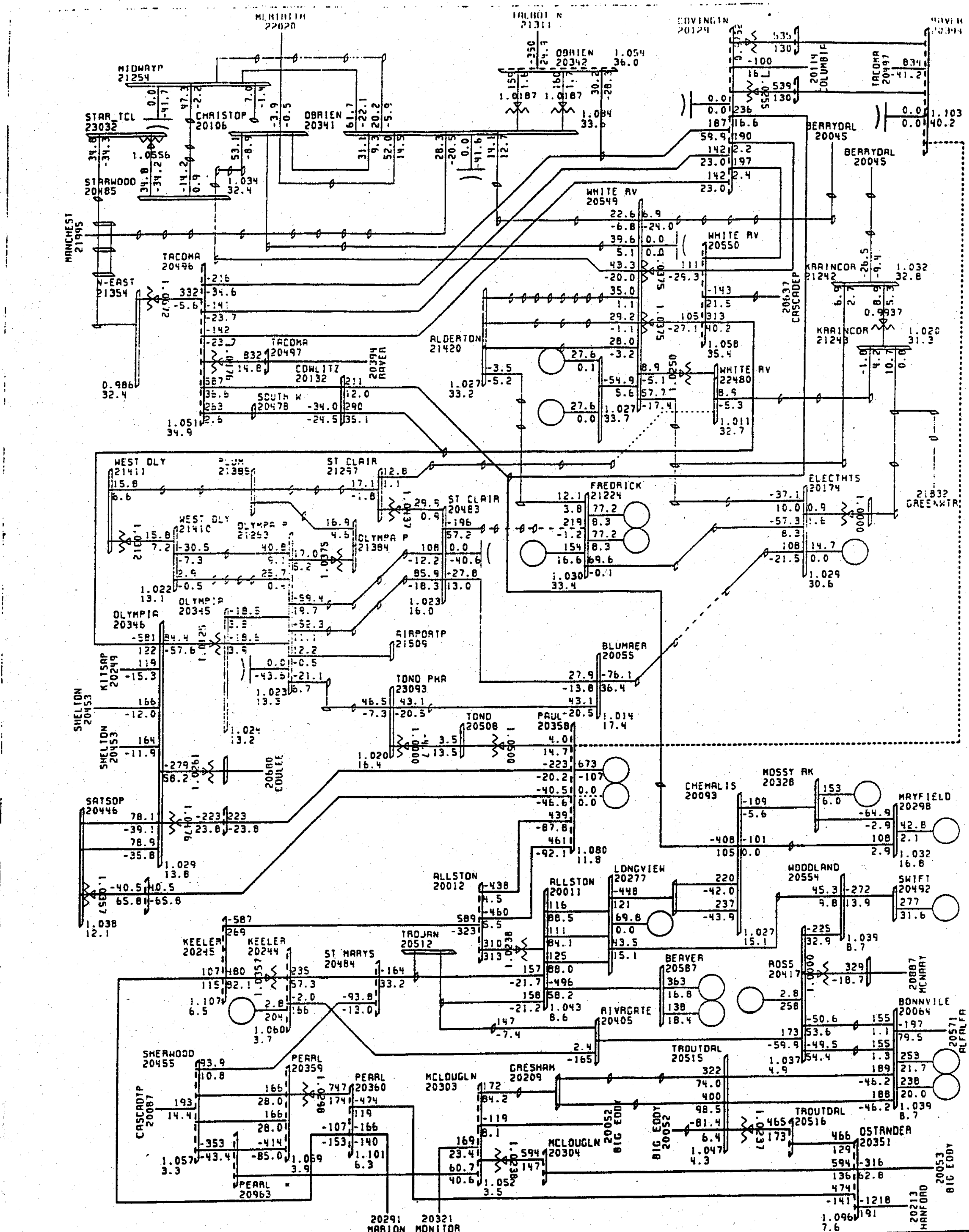
14

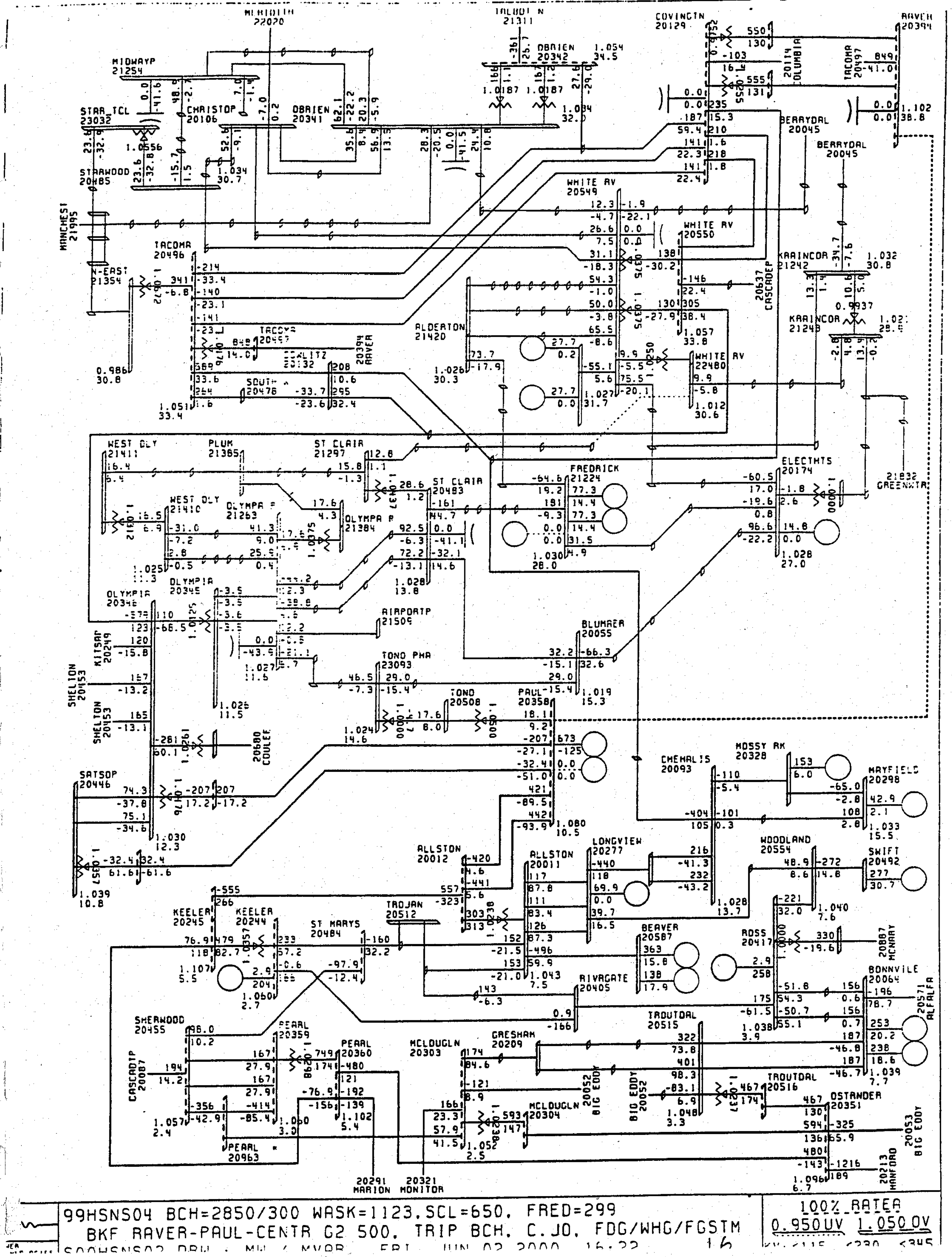
100% RATEA
0.950UV 1.050OV
KV:<115 <230 <345




99HSNS04 BCH=2850/300 WASK=1123, SCL=650, FRED=299
BKF RAVER-PAUL-CENTR G2 500, TRIP BCH, C.JO, FDG/WHG
S00HSNS02.DRW : MW / MVAR FRI, JUN 02 2000 16:21

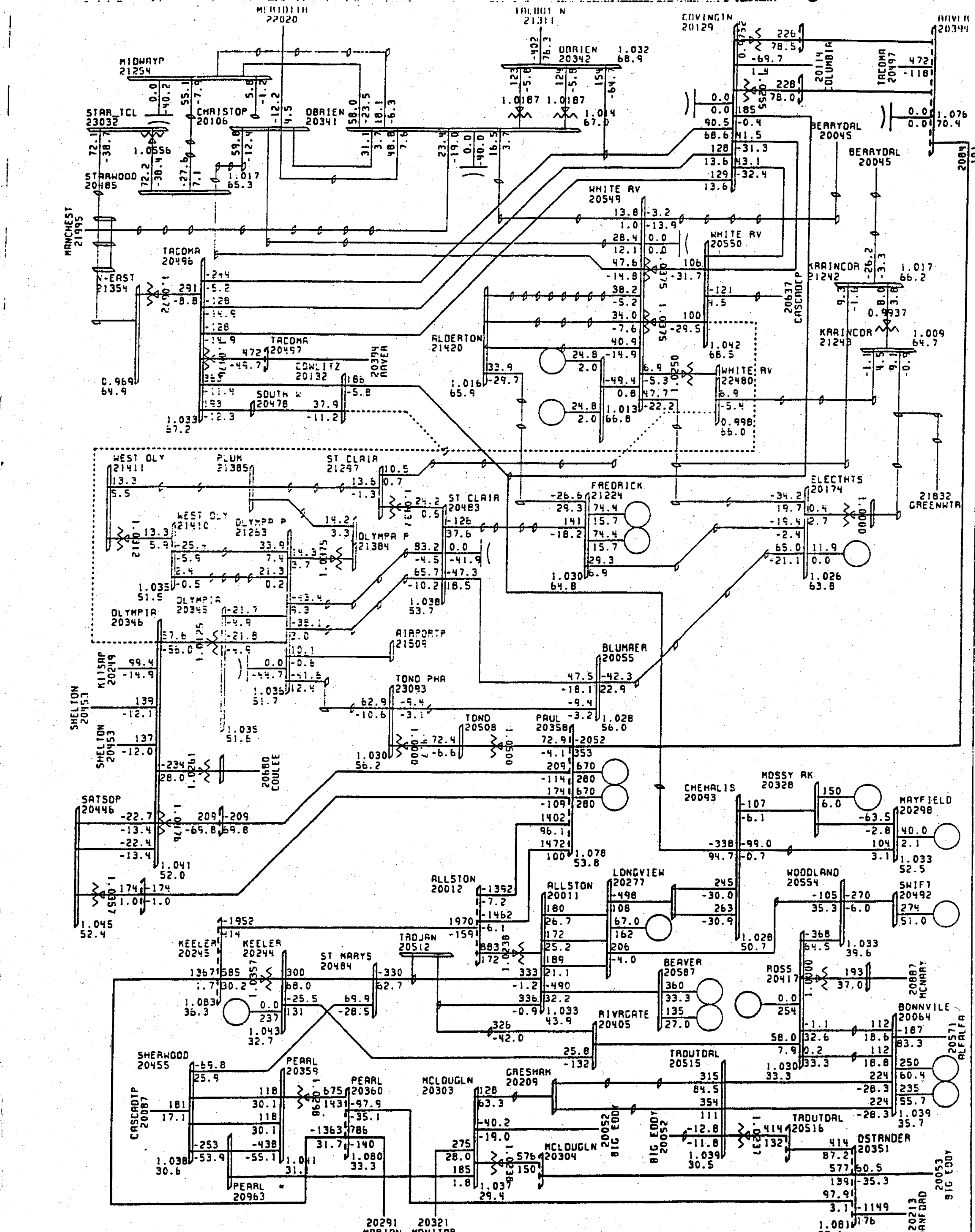
15

100% RATED
0.950UV 1.050OV
KV: ≤115 ≤230 ≤345




99HSNS04 BCH=2850/300 WASK=1123, SCL=650, FRED=299
BKF RAVER-PAUL-CENTR G2 500, TRIP BCH, C.JO, FDG/WHG/FGSTM
S99HSNS02.DRW ; MW / MVAR FRI JUN 02 2000 16:22

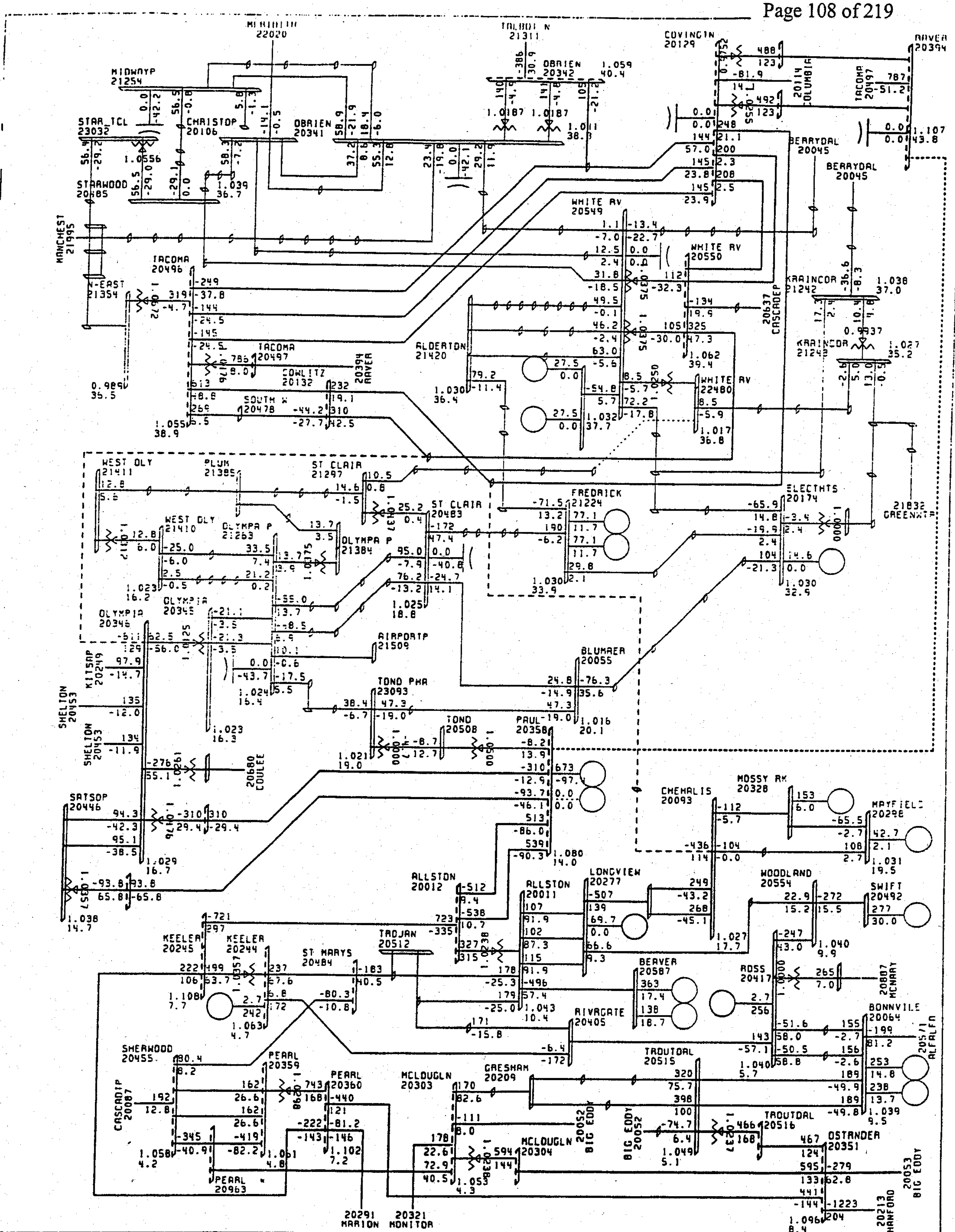
100% RATEA
0.950UV 1.050OV
KV: <115 <230 <345




99HSNS04 BCH=2850/300 WASK=1123.SCL=650. LOAD-1000
SL WHITE R-COWLITZ-OLYMPIA B 230
S00HSNS02 DRW . MW / MVAR FRI JUN 02 2000 16:24

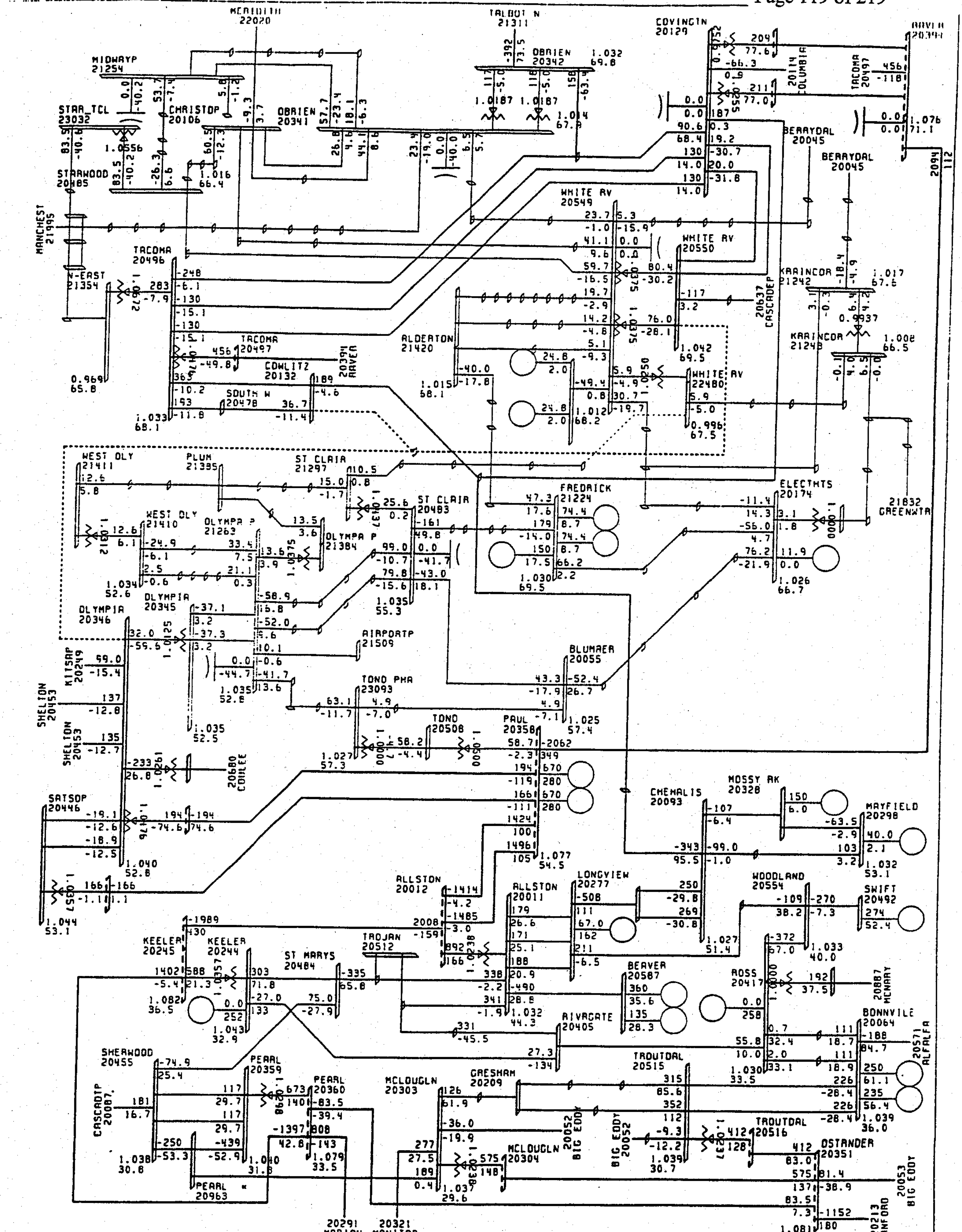
17

100% RATE A
0.950UV 1.050OV
KV: <115 <230 <345



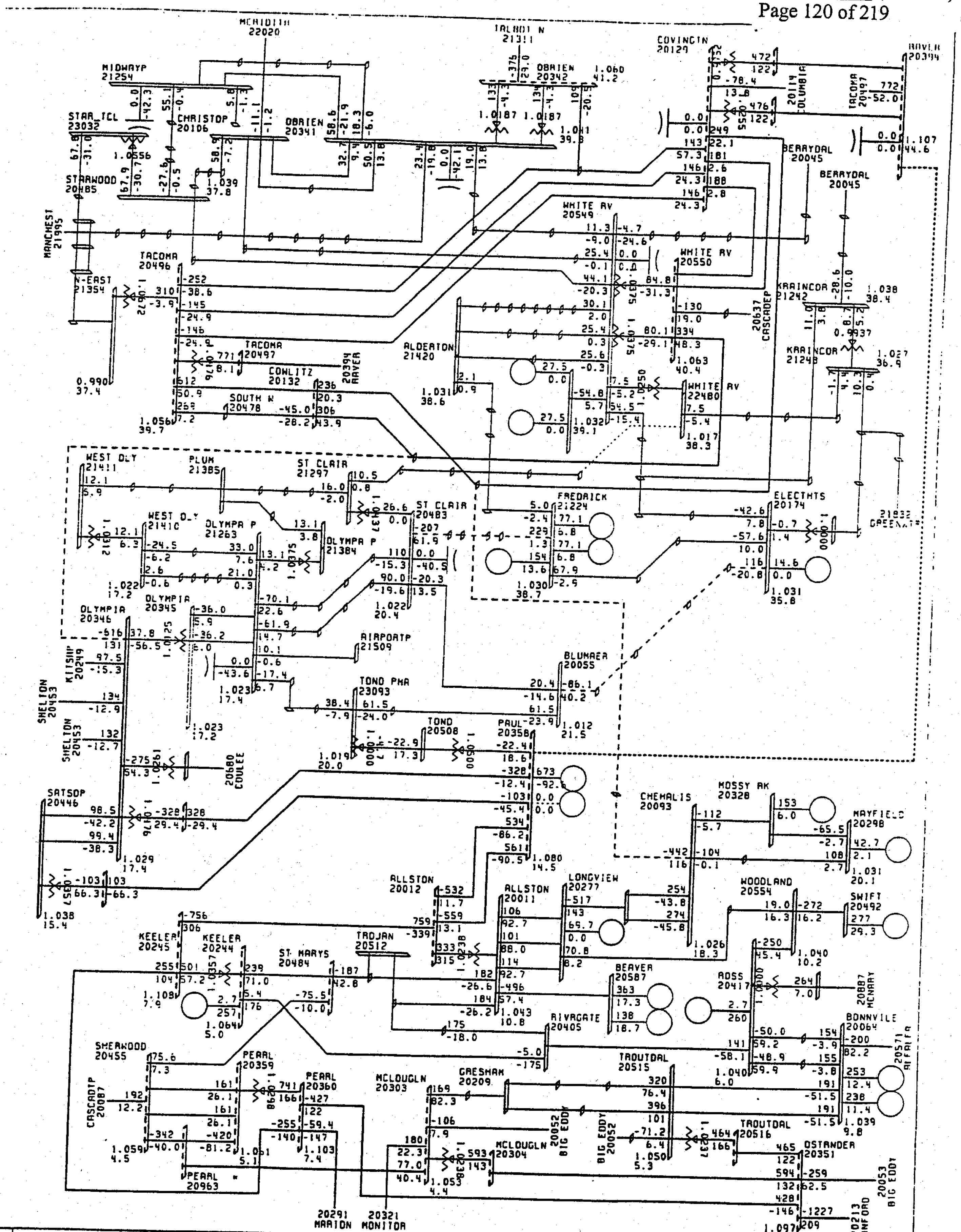

99HSNS04 BCH=2850/300 WASK=1123.SCL=650. LOAD-1000
BKF RAVER-PAUL-CENTR G2 500. TRIP BCH. C.JD. FDG/WHG
S00HSNS02.DRW : MW / MVAR FRI. JUN 02 2000 16:16

100% RATEA
0.950UV 1.050OV



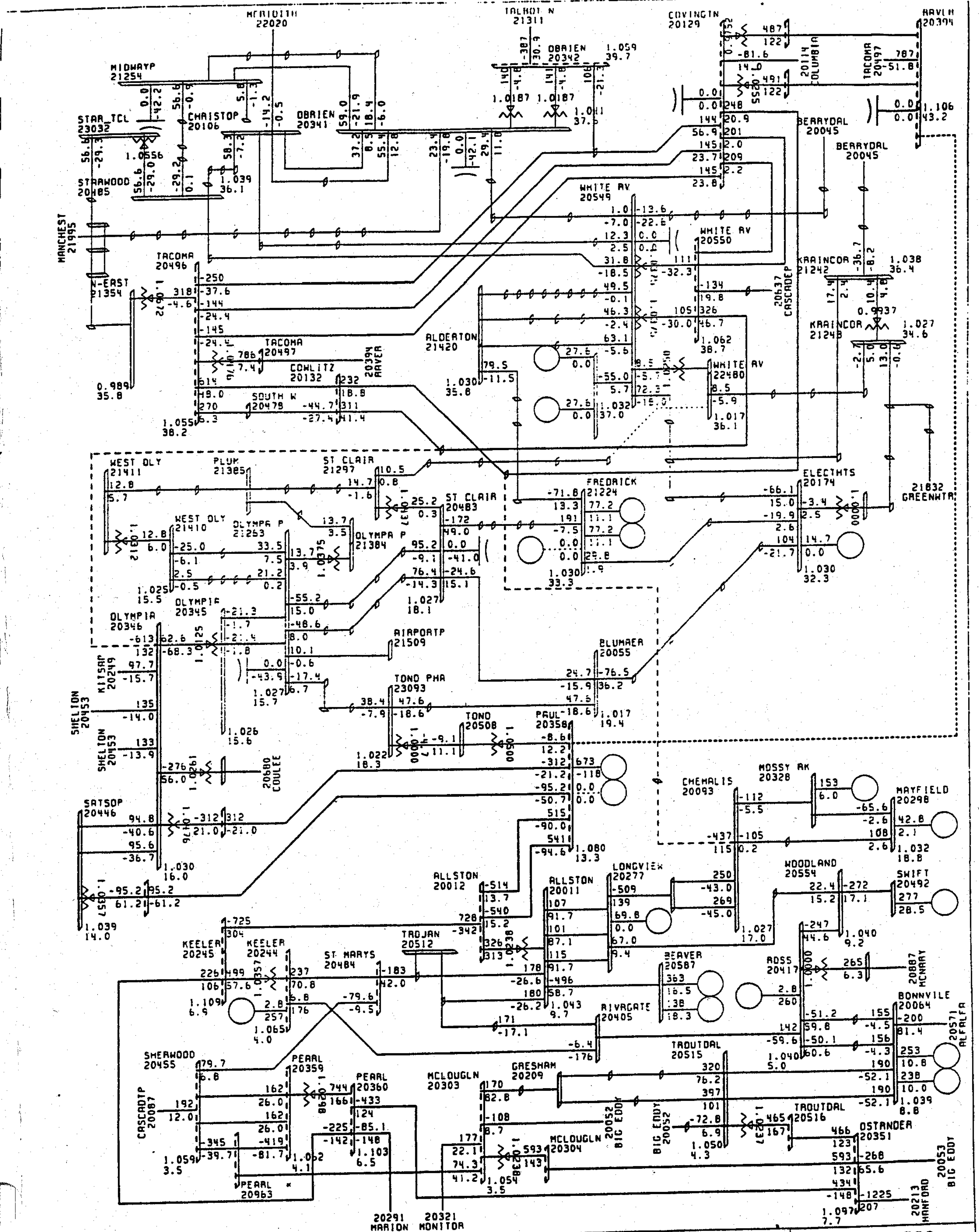

99HSNS04 BCH=2850/300 WASK=1123.SCL=650. FRED=299. LOAD-1000
SL WHITE R-COWLITZ-OLYMPIA B 230

100% RATEA
0.950UV 1.050OV




99HSNS04 BCH=2850/300 WASK=1123. SCL=650. FRED=299. LOAD-1000
BKF RAVER-PAUL-CENTR G2 500. TRIP BCH. C.JO. FDG/WHG
S00HSNS02 DRW . MW / MVAR FRI JUN 02 2000 16:17

100% RATEA
0.950UV 1.050OV




99HSNS04 BCH=2850/300 WASK=1123.SCL=650. FRED=299. LOAD-1000
BKF RAVER-PAUL-CENTR G2 500. TRIP BCH. C.JO. FDG/WHG/FGSTM
500HSNS02 DRW . MW / MVAR FRI JUN 02 2000 16:17

100% RATEA
0.950UV 1.050OV

# FREDERICKSON

# 25 MW

Frederickson - 25 MW

# SYSTEM IMPACT STUDY
# OASIS Reference No. 133622
# 25 MW GENERATION ADDITION TO FREDERICKSON 115 kV BUS

May 21, 2001
PSE Electric Transmission

## INTRODUCTION

This study is in response to OASIS Reference No. 133622 and the System Impact Study Agreement executed by PSE's merchant function on April 24, 2001 requesting 25 MW of Firm Point-to-Point Transmission Service by Electricity Capital (E.C.) for proposed new generation located near PSE's 115 kV Frederickson Substation located in Pierce County, Washington. The generation would consist of several reciprocating engine powered generators, each producing approximately 1.9 MW. This study summarizes the results of analyses done to evaluate transmission requirements to integrate this proposed generation at or near Frederickson. This 25 MW proposed generation is in addition to the 149 MW (summer) existing PSE generation, and the planned 154 MW generation owned by MEGA.

## CONCLUSION

If 25 MW of generator is tapped to the Frederickson-Boeing Puyallup 115 kV line, then impacts to the existing transmission system are expected to be minimal. A requirement for this addition is that during conditions of high north to south flow on the Raver-Paul 500 kV line, the generation may need to be tripped automatically if an outage of the Raver-Paul 500 kV line were to occur. The only line requiring conductor temperature upgrade as a result of the 25 MW addition is the PSE Dieringer-Boeing Auburn 115 kV line. This assumes that the Electron Heights-Boeing Puyallup-Frederickson 115 kV line is upgraded for the MEGA project to 100C conductor temperature rating.

Also, a Remedial Action Scheme (RAS) should be employed to trip or ramp generation at MEGA and E.C. in the event that two of the three 115 kV lines to Frederickson go out-of-service, or for loss of the Raver-Paul 500 kV line at high Raver-Paul path flows. For redundancy, the RAS will use both overload monitoring relays on three lines out of Frederickson, and the Boeing Puyallup-Electron Heights line, and a trip signal from BPA in the event the Raver-Paul line is forced out of service. The cost estimate for transmission interconnection and facilities improvements is $300,000 - $500,000. E.C. will need to acquire electrical equipment including a generator step-up 115-13 kV transformer and a 115 kV breaker to interconnect with PSE Frederickson-Boeing Puyallup 115 kV line.

## STUDY ASSUMPTIONS

The results of a prior study were used along with additional study work. The prior study is on PSE's OASIS site (oasis.puget.com), and it is attached as an appendix to this document. That work explored summer and winter seasons, with Northern Intertie flows in a north to south direction. The prior study covered a range of generation at Frederickson that included the existing generators at 149 MW, plus levels of 50, 100, 150, and 200 additional MW. The total generation addition including the proposed 25 MW in this study and MEGA's planned 154 MW, is between 150 and 200 MW additional generation at Frederickson. The totals become:

Table 1. Total Frederickson Generation Output

| Generating facility | MW per facility | Total MW |
|---|---|---|
| Existing PSE CT's | 149 | 149 |
| Addition in prior study | 50 | 199 |
| " " " | 100 | 249 |
| " " " | 150 | 299 |
| " " " | 200 | 349 |
| MEGA | 154 | 303 |
| Electricity Capital | 25 | 328 |

For the additional studies, only the heavy summer season was studied because the prior study had shown the summer had the most critical loading conditions. The through-flow conditions studied included both high Raver-Paul north to south loading, and high Northern Intertie south to north loading. The lines in the Raver-Paul path through Pierce County are:

Raver-Paul 500 kV line
White River-Cowlitz-Olympia 230 kV line
Covington-Cowlitz-Chehalis 230 kV line
Frederickson-St. Clair 115 kV line
Electron Heights-Blumaer 115 kV line
White River-Fern Hill 57.5 kV line

The total MW output of the E.C. generators was modeled as 25 MW. Each generator consists of a natural gas reciprocating engine and generator producing approximately 1.9 MW. The generators are assumed to have capability to produce at least 0.9 power factor lagging (VARS supplied to PSE's system by E.C. generators), and 0.95 power factor leading, at full rated power. The generators are assumed to be operating in automatic voltage control mode according to the PSE Interconnection Standard.

The time frame was 2002 and 2003. The planned West Coast generators were modeled as in-service, generating 270 MW, and connected to the BPA South Tacoma Switch B 230 kV bus. This bus has three 230 kV lines connected to it from White River, Cowlitz, and BPA Olympia.

Reactive power margin and voltage stability were not determined because it is anticipated that addition of generation with full reactive capability at Frederickson will improve voltage regulation in the area. This can be confirmed with reactive margin studies. Transient stability was not confirmed, but it can be done when stability models and machine specific parameters are provided.

**OUTAGE ASSUMPTIONS**

Outages taken included single contingency (N-1) outages and common mode outages. The outage conditions used are to meet PSE's reliability criteria, the NERC Planning Standards and the WSCC Reliability Criteria. The single contingency outages are taken automatically, and include all lines in southern King, Pierce and Thurston Counties. The common mode outages are:

For south to north – Talbot 230 & 115 bus segments,
O'Brien 230 & 115 bus segments, Asbury 115 bus, Midway 115 bus
Christopher 115 bus, Starwood 115 bus, Berrydale 115 kV bus
Monroe 230 bus & breaker failures, Monroe 500 breaker failures
Snohomish 230 bus segments, Snoking 230 bus segments

Bothell 230 bus segments, SCL 230 and 115 kV double lines
Maple Valley 230 bus segments, Covington 230 bus segments
Echo Lake 500 breaker failures, Raver 500 breaker failures
Raver-Paul-Centralia G2 500 BKF

For both south to north and north to south –
White River north 230 bus, south 230 bus, north115 bus, and south 115 bus
Krain Corner 115 bus, Alderton 115 bus, Frederickson 115 bus
Electron Heights 115 bus, Saint Clair 115bus, Blumaer 115 bus
West Olympia 115 bus, Plum Street 57.5 bus
PSE Olympia north 115 bus, and south 115 bus, Tono phase shifter
BPA Olympia east 230 bus, west 230 bus, and 115 bus

For north to south – governor load-flow is used, following WSCC guidelines.
Raver-Paul 500 line; Trip BC Hydro
Raver-Paul 500 line; Trip BC Hydro, MEGA, WC
Raver-Paul-Centralia G2 500 BKF; Trip BC Hydro
Raver-Paul-Centralia G2 500 BKF; Trip BC Hydro, MEGA, WC
Raver-Paul-Centralia G2 500 BKF & Centralia G1; Trip BC Hydro
Raver-Paul-Centralia G2 500 BKF & Centralia G1; Trip BC Hydro, MEGA, WC
Paul-Allston 1&2 500 lines on common right-of-way; Trip BC Hydro

The formula for tripping BC Hydro generation is:
Trip generation = 1.3 x (Westside NI north-to-south – 1450 MW)
MEGA stands for tripping the proposed MEGA generators at Frederickson.
WC stands for tripping the proposed West Coast generator.
BKF stands for breaker failure.

## FINDINGS

### Summer

Loading on lines in the Raver-Paul path are closer to their ratings during the summer season than during other seasons because of transmission through-flow, and because the ratings are significantly lower in the summer than the winter on most lines. Flows on selected paths are given in Table 2 for the heavy summer case with high Northern Intertie flows in north to south.

Table 2. Line flows with Frederickson Total Generation

| 2002 Heavy Summer (N to S) | Frederickson total (includes MEGA & E.C.) | | |
|---|---|---|---|
| | 149 MW | 303 MW | 328 MW |
| Element or Path | Facility loading in MVA | | |
| West Side NI, Ingledow-Custer 1&2 | 2850 | 2850 | 2850 |
| Raver-Paul 500 | 1867 | 1877 | 1880 |
| Olympia-Tacoma B 230 | 374 | 377 | 378 |
| Tacoma A-Centralia SS 230 | 321 | 325 | 326 |
| Frederickson-Boeing Puyallup 115 | 34 | 70 | 78 |
| Frederickson-Alderton 115 | 30 | 68 | 84 |
| Frederickson-St. Clair 115 | 120 | 158 | 162 |

The results of the prior Frederickson study indicate that the Frederickson-St. Clair 115 kV line exceeds its maximum load capability for an outage of the Frederickson-Alderton 115 kV line if the combined generation at Frederickson is 349 MW. For the same outage at a combined generation of 328 MW, loading on the Frederickson-St. Clair 115 kV line is 97%.

If the Frederickson-Boeing Puyallup-Electron Heights line were not upgraded, it would overload to 111% at the 328 MW generation level for an outage of the Frederickson-St. Clair 115 kV line. It would overload to 102% at the 303 MW level for the same outage. The double line loss of the Alderton-Frederickson and Frederickson-St. Clair 115 kV lines overloads the Frederickson-Boeing Puyallup-Electron Heights line to 250% of its existing rating at 303 MW generation level. This outage is an N-1 outage if one of the other two lines to Frederickson is already out for some reason. This line is being up-rated, increasing the threshold levels of allowable generation during conditions such as line maintenance, unplanned outages, and the double line outage.

A RAS is being deployed with the MEGA project that will monitor line flows on the three 115 kV lines out of Frederickson Substation. When the flows on any one line are high enough to cause the computed conductor temperature rating of that line to be exceeded, then the RAS will trip or fast ramp MEGA generation to 0 MW. The RAS scheme trip signal should be sent to the E.C. generation also. The line monitoring point for the Frederickson-Boeing Puyallup-Electron Heights line should be at Boeing Puyallup Substation on the Boeing Puyallup-Electron Heights line, and not at the Frederickson bus. The RAS will also receive a trip signal for Raver-Paul 500 kV line outages, discussed later under Raver-Paul 500 kV Outage.

The results of heavy summer conditions with high south to north flows on the Northern Intertie is that the Dieringer-Boeing Auburn 115 kV line overloads and must be up-rated to avoid curtailing Frederickson generation during those conditions. The level of overload is 103%, and at a Westside Northern Intertie south-to-north export level of 1700 MW. The 795 kcmil Tern conductor in this line should be up-rated from 55C to a minimum 75C conductor rating. The White River-Dieringer 115 kV line has already been up-rated to 100C.

Raver-Paul 500 kV Outage

The following discussion is based on prior studies and reconfirmed with current simulations. The most severe outage is the Raver-Paul 500 kV outage, and combination outages that include the Raver-Paul 500 kV line. The combination outages studied are a breaker failure at Paul that trips both the Raver-Paul line and the Centralia #2 generator, and the same breaker failure when the Centralia #1 generator is also out of service. Results are given in Table 3, and include the planned West Coast IPP connected to BPA South Tacoma Switch. The table shows when PSE lines will overload without tripping MEGA and E.C. generation, or an equivalent amount in MW at Frederickson.

BPA arms a RAS when there are high north to south flows on the Raver-Paul 500 kV line. The RAS sends trip signals to selected generators north of this line when the RAS detects that the line is tripped out of service. The generators that are armed are determined according to the flow level on the Raver-Paul line, and other factors, as described in BPA Dispatcher Standing Order (DSO) 307. In the power system simulations, for high flow levels on the Raver-Paul line, the generators that were tripped included Whitehorn, Fredonia, 1024 MW at Chief Joseph, and units in Canada following the formula:

$$MWtoTrip = 1.3(IngledowCusterflow - 1450MW)$$

The results indicate that for the Raver-Paul 500 kV line outage, assuming the West Coast generation is armed to trip, one PSE line is at 100% of its thermal rating. That line is the Frederickson-St. Clair 115 kV line. It will be protected by a thermal overload relay that will trip MEGA and E.C. generation if it does exceed its rating, and by a trip signal from BPA that will trip MEGA and E.C. generation. No PSE lines overload after the MEGA and E.C. generation is tripped. The RAS is redundant in that either the overload relays can trip generation, or the BPA trip signal can trip generation. The RAS will normally be armed to trip generation on line overloads. It will be armed to trip generation from the BPA trip signal only when BPA and PSE determine that flows on the Raver-Paul line are sufficiently high. The trip signal from BPA will be received only for outages that include the Raver-Paul 500 kV line outage.

Table 3. Raver-Paul 500 kV Related Outages, 2850 MW Northern Intertie

| Fredrickson tot. gen 328 MW | Electhts-Kapow 115 ↓ | Yelm-Longmr T 115 ↓ | Longmr T-OlyVail115↓ | Fredrick-Tilcm T 115 ↓ | Tilcm T-Gravelly 115↓ | Gravelly-Dupont 115 ↓ | Dupont-Quarry 115 ↓ | Quarry-St. Clair 115 ↓ | Tacoma B-Oly 230 ↓ | Tacoma A-Centr 230 ↓ | Centr-Chehalis 230 ↓ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Outages | % line loading on above lines, Without tripping Westcoast, MEGA & E.C. | | | | | | | | | | |
| Raver-Paul 500 kV | | | | 102.1 | 99.8 | 97.9 | 96.4 | 95.4 | 95.4 | | |
| BKF Raver-Paul & Ctr2 | 104.4 | 106.4 | 104.5 | 112.1 | 109.8 | 107.9 | 106.4 | 105.3 | 104.9 | 105.6 | 101.8 |
| BKF Raver-Paul & Ctr2 with Centralia 1 off line | 117.4 | 121.5 | 120.9 | 122.3 | 120.0 | 118.0 | 116.6 | 115.5 | 118.6 | 116.0 | 112.2 |
| | % line loading on above lines, With tripping Westcoast, but not MEGA & E.C. | | | | | | | | | | |
| Raver-Paul 500 kV | | | | 100.3 | 98.0 | 96.1 | | | | | |
| BKF Raver-Paul & Ctr2 | 101.8 | 103.4 | 101.3 | 110.2 | 107.9 | 106.0 | 104.5 | 103.4 | 96.2 | 100.9 | 97.1 |
| BKF Raver-Paul & Ctr2 with Centralia 1 off line | 114.9 | 118.6 | 117.8 | 120.4 | 118.1 | 116.2 | 114.7 | 113.7 | 109.7 | 111.3 | 107.5 |
| | % line loading on above lines, With tripping Westcoast, MEGA & E.C. | | | | | | | | | | |
| Raver-Paul 500 kV | | | | | | | | | | | |
| BKF Raver-Paul & Ctr2 | | | | | | | | | 95.6 | 99.6 | 95.9 |
| BKF Raver-Paul & Ctr2 with Centralia 1 off line | 102.9 | 104.7 | 102.9 | 98.3 | 95.9 | | | | 109.1 | 110.0 | 106.7 |

For the breaker failure outage of both the Raver-Paul 500 kV line, and the Centralia generator unit #2, PSE lines overload. The Frederickson-St. Clair 115 kV line overloads the highest at 110% of its rating. After tripping MEGA and E.C. generation, there are no more PSE overloads remaining.

For the condition where the Centralia generator unit #1 is already out of service, and the breaker failure occurs, the simulation showed an overload of 120% on the Frederickson-St. Clair 115 kV line. After tripping MEGA and E.C. generation, there would be overloads remaining on the Electron Heights-Blumaer 115 kV line. The highest PSE overload then is 105%, that is half of the highest BPA overload at 110%. In this simulation, the Raver-Paul pre-outage loading is at 2080 MW, that is higher than allowed by the previous and current BPA DSO 307. In practice, BPA would reduce the flow on the Raver-Paul 500 kV line, following DSO 307 for Level 4, so that the overloads would not happen if the outage were to occur. By reducing the pre-outage flow down to a level studied for the other outages, about 1900 MW, there would be no overloads on PSE lines. Running the outage at this high level illustrates the need for a Raver-Paul flow threshold that results in significant overloads if violated.

The prior study results indicate that for light summer loads, using peak summer line ratings, PSE lines overload for the breaker failure outage of the Raver-Paul 500 kV line and Centralia generator unit #2, unless the MEGA and E.C. generation is tripped. The RAS scheme can protect PSE lines from overloading. During light summer load periods, line ratings will actually be higher than those used, because during off-peak periods air temperatures are lower, and sun radiation is lower. Tripping will not be needed during winter conditions because the Raver-Paul line loading is low.

The White River-Fern Hill 57.5 kV line overloads with outages of the Raver-Paul line. A relay has been installed at White River to detect when the line is being overloaded and the relay will sent a signal to automatically trip the line breaker at White River. All the power system simulations were done with either the White River-Fern Hill line open, or with the relay modeled to open the line up if the flow level on the line is above its seasonal rating.

## COSTS

The transmission facility costs to install up to 25 MW of new generation that is tapped to the Frederickson-Boeing Puyallup 115 kV line are expected to include the following:

| | Low Range | High Range |
|---|---|---|
| RAS to add E.C. generator tripping for line overloads, and for Raver-Paul trip signal | 30,000 | 60,000 |
| Capacity up-rate of Dieringer-Boeing Auburn 115 kV line | 75,000 | 100,000 |
| Frederickson – E.C. 115 kV line extension | 140,000 | 210,000 |
| Protection, controls, fiber-optics additions to Frederickson & Boeing Puyallup Substations | 50,000 | 100,000 |
| Totals | $295,000 | $470,000 |

## POWER FLOW DRAWINGS

Schematic type power flow drawings of selected conditions are given in post-script files. The drawings provided do not include the thousands of unique combinations of conditions that could be shown. For each season, hundreds of outages were simulated for each level of proposed generation at Frederickson, without and with the proposed West Coast project. These drawings only include summer No Outage cases without and with the MEGA project and the E.C. project.

They are given in the following order:

| File Name: | Condition | Season | Generatio in MW | | | |
|---|---|---|---|---|---|---|
| | | | PSE | MEGA | E.C. | West-coast |
| 02hsnB4c149.PS | No Outage | HS | 149 | | | 270 |
| 02hsnB4c303.PS | No Outage | HS | 149 | 154 | | 270 |
| 02hsnB4c328.PS | No Outage | HS | 149 | 154 | 25 | 270 |

# SYSTEM IMPACT STUDY
# OASIS Reference No. 17855
# 150 MW GENERATION ADDITION TO FREDERICKSON 115 kV BUS

September 29, 2000
PSE Electric Transmission

## INTRODUCTION

This study is in response to OASIS Reference No. 117855 and the System Impact Study Agreement executed by PSE's merchant function on May 17, 2000 requesting, among other things, 150 MW of Firm Point-to-Point Transmission Service for proposed new steam generation located at PSE's 115 kV Frederickson Substation located in Pierce County, Washington. This study summarizes the results of analyses done to develop reliable transmission alternatives that integrate the proposed generation at Frederickson. This report summarizes studies done to find threshold levels where new generation could be added without large impacts to the existing transmission system. The added generation would be a steam unit with possible sizes being 50, 100, or 150 MW (200 MW was included to explore sensitivities).

## CONCLUSION

If a new generator is installed at Frederickson Generating Station and connected to the existing 115 kV bus, and if the size is 150 MW or smaller, then impacts to the existing transmission system are expected to be minimal. A requirement for this addition is that during conditions of high north to south flow on the Raver-Paul 500 kV line, some generation at Frederickson may need to be tripped automatically if an outage of the Raver-Paul 500 kV line were to occur. The only line requiring conductor temperature upgrade is the Electron Heights-Boeing Puyallup-Frederickson 115 kV line. Also, at the highest generation level, a Remedial Action Scheme should be employed to trip or ramp generation at Frederickson in the event that two of the three 115 kV lines to Frederickson becomes out-of-service. An estimate of the cost for transmission interconnection facilities and improvements is $800,000.

## STUDY ASSUMPTIONS

Summer and winter seasons were studied, with a focus on high Raver-Paul loading and high north to south flows on lines going through Pierce County. Load sensitivity was performed for the summer season. The lines through Pierce County are:

Raver-Paul 500 kV line
White River-Cowlitz-Olympia 230 kV line
Covington-Cowlitz-Chehalis 230 kV line
Frederickson-St. Clair 115 kV line
Electron Heights-Blumaer 115 kV line
White River-Fern Hill 57.5 kV line

The time frame was 2001 with the following improvements assumed to be completed:

Chief Joe-Monroe #4 line re-converted to 345 kV operation.
Bothell-Snoking #2 and Snoking-Maple Valley #2 230 kV lines energized.
Schultz-Raver #2 500 kV line rerouted from Raver to Echo Lake.
Bothell #2 and #3 230-115 kV transformers replaced with 300 MVA transformers.

Reactive power margin and voltage stability was not determined, it is anticipated that addition of generation with full reactive capability at Frederickson will improve voltage regulation in the area. This can be confirmed with reactive margin studies. Transient stability was not confirmed, and would be done when stability models, and machine specific parameters are provided.

The proposed Westcoast generator was studied as a sensitivity, to understand the combined impacts of the Frederickson steam turbine generator and the Westcoast generator. The total MW output of the Westcoast generators was modeled as 270 MW.

**OUTAGE ASSUMPTIONS**

Outages taken included single contingency (N-1) outages and common mode outages. The single contingency outages are taken automatically, and include all lines in southern King, Pierce and Thurston Counties. The common mode outages are:

White River north 230 bus, south 230 bus, north115 bus, and south 115 bus
Krain Corner 115 bus, Alderton 115 bus, Frederickson 115 bus
Electron Heights 115 bus, Saint Clair 115bus, Blumaer 115 bus
West Olympia 115 bus, Plum Street 57.5 bus
PSE Olympia north 115 bus, and south 115 bus, Tono phase shifter
BPA Olympia east 230 bus, west 230 bus, and 115 bus

The following use governor load-flow following WSCC guidelines.

Raver-Paul 500 line; Trip BC Hydro
Raver-Paul 500 line; Trip BC Hydro, FGStm, WC
Raver-Paul-Centralia G2 500 BKF; Trip BC Hydro
Raver-Paul-Centralia G2 500 BKF; Trip BC Hydro, FGStm, WC
Raver-Paul-Centralia G2 500 BKF & Centralia G1; Trip BC Hydro
Raver-Paul-Centralia G2 500 BKF & Centralia G1; Trip BC Hydro, FGStm, WC
Paul-Allston 1&2 500 lines on common right-of-way; Trip BC Hydro

The formula for tripping BC Hydro generation is:

Trip generation = 1.3 x (Westside NI north-to-south – 1450 MW)

FGStm stands for tripping the proposed Frederickson steam turbine and gen.
WC stands for tripping the proposed Westcoast generator.
BKF stands for breaker failure.

**FINDINGS**

The transmission through-flow can be seen in Table 1. It shows line flows before outages are taken for heavy summer, lighter summer, and heavy winter. Line flows on the Raver-Paul 500 kV line, as an example are 1800 to 1900 MW in the summer, and decrease to 1200 MW in the winter. In these seasons, the West Side Northern Intertie (WSNI) is 2850 MW in the summer cases, and is 1450 MW in the winter cases. If the winter import OTC goes above 1450 MW, then transmission through-flow will increase in the winter. Load sensitivity that was performed for the summer season was to reduce the area load by 1000 MW, from 5758 to 4758 MW, an 18% reduction. The results indicated that for lines at or near overload, the overloads increased slightly as loads were scaled down by 1000 MW. This is a favorable result because as loads go down in the summer, ambient air temperatures also cool, as in night-time conditions, and line ratings go up.

Summer

During the summer season loading on lines can be closer to line ratings than during other seasons because of transmission through-flow, and because the line ratings are significantly lower in the summer on lines having a lower conductor temperature rating.

The results of outage simulations are given in Table 2, for single contingency outages (N-1), and common mode outages, except that the Raver-Paul 500 kV outage results are given in Tables 3-6, and are discussed later. The outage results for other than Raver-Paul 500 kV show that line loadings remain within their ratings up to an addition of 150 MW of generation. An exception is the double line loss of the Alderton-Frederickson and Frederickson-St. Clair 115 kV lines. This outage is an N-1 outage if one of the other two lines to Frederickson is already out for some reason. The temperature rating of the Electron Heights-Boeing Puyallup-Frederickson 115 kV line should be raised to significantly increase the threshold levels at which generation can safely generate during conditions such as line maintenance, unplanned outages, and the double line outage. The 1272 Kcmil Narcissus conductor portions should be uprated to 75C conductor rating, and the 795 Kcmil Tern portions to 100C conductor rating.

Raver-Paul 500 kV Outage

The most severe outage is the Raver-Paul 500 kV outage, and combination outages, that include the Raver-Paul 500 kV line. The combination outages studied are a breaker failure at Paul that trips both the Raver-Paul line and the Centralia #2 generator, and the same breaker failure when the Centralia #1 generator is also out of service. Results are given in Tables 3-6, and include summer heavy load, summer light load, without and with a proposed Westcoast IPP connected to BPA South Tacoma Switch. The tables show when PSE lines will overload without tripping the Frederickson steam generator, or an equivalent amount in MW at Frederickson.

BPA arms a RAS when there are high north to south flows on the Raver-Paul 500 kV line. The RAS sends trip signals to selected generators north of this line when the RAS detects that the line is tripped out of service. The generators that are armed are determined according to the flow level on the Raver-Paul line, and other factors, as described in BPA Dispatcher Standing Order (DSO) 307. In the power system simulations, for high flow levels on the Raver-Paul line, the generators that were tripped included Whitehorn, Fredonia, 1024 MW at Chief Joseph, and units in Canada following the formula:

$$MWtoTrip = 1.3(IngledowCusterflow - 1450MW)$$

The results indicate that for light summer loads [using peak summer line ratings], or for Frederickson steam generator sizes above 100 MW, PSE lines overload for the breaker failure outage of the Raver-Paul 500 kV line and Centralia generator unit #2, unless the Frederickson steam generator is tripped. If the Westcoast generator is installed at about 270 MW, and if it is tripped for the same outage, then the above holds true for Frederickson steam generator sizes above 50 MW. The Frederickson steam generator, or one of the combustion turbine generators may need to be tripped during summer load and temperature conditions if the Raver-Paul 500 kV line loading is high enough. Tripping will not be needed during winter conditions because the Raver-Paul line loading is low.

The Tables 3-6 show overloads for the breaker failure outage and when the other Centralia generator unit #1 is off line. The Raver-Paul pre-outage flow is above 2000 MW. In practice, BPA would reduce the flow on the Raver-Paul 500 kV line, following

DSO 307 for Level 4, so that the overloads would not happen if the outage were to occur. But running the outage at this high level illustrates the need for a Raver-Paul flow threshold that results in significant overloads if violated.

The White River-Fern Hill 57.5 kV line overloads with outages of the Raver-Paul line. A relay is being installed at White River to detect when the line is being overloaded and the relay will sent a signal to automatically trip the line breaker at White River. All the power system simulations were done with either the White River-Fern Hill line open, or with the relay modeled to open the line up if the flow level on the line is above its seasonal rating.

Winter

Some common mode outages do not achieve a solution for winter loading conditions. The Olympia 230 kV bus is divided between east and west segments with both 230-115 kV transformers on one bus segment, the east bus. Loss of the Olympia 230 west bus results in no solution.

**COSTS**

Transmission costs to install up to 150 MW of new generation at Frederickson are expected to include the following:

| | |
|---|---|
| RAS for Frederickson generator tripping for Raver-Paul outage, and for loss of two lines | $50,000 |
| Breaker and line bay at Frederickson for generator, 115 kV | $300,000 |
| Conductor temperature upgrade of Electron Heights-Boeing Puyallup-Frederickson 115 kV line | $400,000 |

**POWER FLOW DRAWINGS**

Schematic type power flow drawings of selected conditions are given following the tables. The drawings provided are a few that represent the thousands of unique combinations of conditions that could be shown. For each season, hundreds of outages were simulated for each level of proposed steam generation at Frederickson, without and with the proposed Westcoast project. The drawings include summer No Outage cases without and with Frederickson steam generator at 150 MW, and without and with the proposed Westcoast project.

They are given in the following order:

| Figure | Condition | Season | Frederick-son Steam | West-coast |
|---|---|---|---|---|
| 1 | No Outage | HS | 0 | 0 |
| 2 | No Outage | HS | 150 | 0 |
| 3 | No Outage | HS | 0 | 270 |
| 4 | No Outage | HS | 150 | 270 |
| 5 | No Outage | HW | 0 | 0 |
| 6 | No Outage | HW | 150 | 0 |
| 7 | No Outage | HW | 0 | 270 |
| 8 | No Outage | HW | 150 | 270 |
| 9 | BPA Olympia 115 kV Bus | HW | 0 | 0 |
| 10 | BPA Olympia 115 kV Bus | HW | 150 | 0 |
| 11 | Freder-SW 28 Tie & Freder-Tillicum Tap | HS | 150 | 0 |
| 12 | White River-Cowlitz-Olympia B 230 kV | HS | 0 | 0 |
| 13 | Bkf Raver-Paul & Centr G2 | HS | 0 | 0 |

| | | | | |
|---|---|---|---|---|
| 14 | White River-Cowlitz-Olympia B 230 kV | HS | 150 | 0 |
| 15 | Bkf Raver-Paul & Centr G2 | HS | 150 | 0 |
| 16 | Bkf Raver-Paul & Centr G2, trip F.Steam | HS | 150 | 0 |
| 17 | White River-Cowlitz-Olympia B 230 kV | HS -1000 | 0 | 0 |
| 18 | Bkf Raver-Paul & Centr G2 | HS -1000 | 0 | 0 |
| 19 | White River-Cowlitz-Olympia B 230 kV | HS -1000 | 150 | 0 |
| 20 | Bkf Raver-Paul & Centr G2 | HS -1000 | 150 | 0 |
| 21 | Bkf Raver-Paul & Centr G2, trip F.Steam | HS -1000 | 150 | 0 |

# FREDONIA
# 110 MW

Fredonia - 110 MW

# System Impact Study for

# Fredonia 2-55 MW Combustion Turbines

# Mt. Vernon, WA

**PSE OASIS Reference No. 131212**
**May 31, 2001**

**Puget Sound Energy, Inc.**
**Electric Transmission Department**

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**Executive Summary**

On January 18, 2001, the merchant function of Puget Sound Energy submitted an OASIS request (OASIS Reference No. 131212 for long term Firm Point-to-Point Transmission Service (the "Requested Service") for the purpose of integrating 110 MW, 150 MW and 200 MW's of generation at the Fredonia Generating Substation in Mt. Vernon, Washington. By letter dated April 3, 2001, the Requested Service was revised and limited to 110 MW and the start date revised from June 1, 2001 to July 1, 2001. The term of the Requested Service is for 25 years. The expected date of commercial operation is July 1, 2001.

PSE determined that a System Impact Study (the "Study") would be required to evaluate the impact of the Requested Service on PSE's Transmission System. The purpose of the Study is to identify any system constraints and redispatch options, additional Direct Assignment Facilities or Network Upgrades required to provide the Requested Service. Power flow simulation studies were performed to insure that the Requested Service was accomplished in compliance with PSE, WSCC and NERC reliability criteria. The time involved in completing the Study was a function of a pre-existing OASIS request (No. 130752) for a 50 MW generator at March Point, which also required a System Impact Study, and the complexity of the Study for the Fredonia request, the latter covering a five-year period and incorporating, among other things, the proposed generation at March Point.

The base conditions used for the Study are the following:

a) Puget Sound area HLH (heavy load hour) loads beginning the summer of 2001 through the summer 2006;
b) all existing generation in Skagit and Whatcom Counties running;
c) known industrial loads adjusted to account for their on-site generation and/or displaced load
d) maximum accepted WSCC Path Rating #3 (Northwest-Canada) for the Westside Northern Intertie ("WSNI") north to south (i.e., B.C. to U.S.) power flow (2,850 MW from BC Hydro's Ingledow Substation to BPA's Custer Substation).

The constraints and proposed system upgrades for removing the constraints are as follows:

**Constraint #1**: <u>The Sedro Woolley-Sedro NT (north tap) 230 kV transmission line.</u>

**Discussion:** Failure of any of the following lines can cause the Sedro-Sedro NT 230 kV line to exceed its maximum thermal design limit of 100C conductor temperature: a) the Horseranch Substation's 230 kV power circuit breaker, b) several 230 kV power circuit breakers failures at Sedro Woolley Substation, c) single lines such as Monroe-Custer 500 kV, d) Sedro-HRTap-SCL Bothell 230 kV, and e) the double line outage of the Sedro-Hrtap-SCL Bothell and Bothell-Sammamish 230 kV.

**Constraint Mitigation:** Uprate the line to a 115C conductor temperature, or higher. This should produce a line rating of at least 442 MVA, summer emergency.

**Constraint #2:** The Texaco East Substation to March Point Substation 115 kV transmission line.

**Discussion:** Since 1993-94, when the original MPCC Phase I and later Phase II was added, a loss of the March Point-Texaco West 115 kV line or a line breaker failure at the March Point Substation south 115 kV bus would cause very high thermal overloads on the Texaco East-March Point 115 kV line. This condition needs to be corrected as it exists with or without the proposed Fredonia 110 MW generation addition (even after the existing two Fredonia CT's are moved to the 230 kV).

**Constraint Mitigation:** Uprate the Texaco East-March Point 115 kV, 55C line to a 100C conductor temperature rating. By connecting the two existing Fredonia CT's to the Sedro-March Point 230 kV line the Texaco East-March Point 115 kV overload decreases to the point where the line does not have to be reconductored (as recommended in the MPCC SIS).

**Constraint #3:** The March Point-Beaver Lake 115 kV line between Peth Corner Substation and Mt. Vernon Substation.

**Discussion:** Failure of any of the following Substation can cause sections of the March Point-Beaver Lake 115 kV line between Peth Corner and Mt. Vernon Substations to exceed their maximum thermal design limit of 55 C conductor temperature: a) the Sedro Woolley-Fredonia 230 kV line, b) Sedro-HRTap-SCL Bothell 230 kV line, c) the double line outage of the Sedro-Hrtap-SCL Bothell and Bothell-Sammamish 230kV lines, and d) several 230 kV power circuit breakers at Sedro Woolley Substation and March Point. The line section between Mt. Vernon Substation and Big Rock Substation can exceed 98% of its maximum thermal design limit of 55 C conductor temperature.

**Constraint Mitigation:** Uprate the March Point-Beaver Lake 115 kV line to at least a 65C conductor temperature rating between Peth Corner Substation and Mt. Vernon Substation. It would be prudent to include the line section from Mt. Vernon Substation to Big Rock Substation because many contingencies cause this line to carry loads over 90% of its thermal rating. It is generally understood that the line will probably be uprated to 100C.

**Constraint #4:** WSNI and BPA's Transmission System

**Discussion:** The study results show that there could be a 1338 MW reduction to the WSNI (north to south) Operational Transfer Capability ("OTC") after the addition of the proposed 2-Fredonia 55 MW generators and moving the two existing Fredonia CT's to the Sedro-March Point 230 kV line. A new bottleneck (limiting element) appears to have been created with this project. The new bottleneck becomes the 0.18 mile long Sedro-Sedro NT 230 kV line which overloads due to a 230 kV power circuit breaker failure at the Horseranch Substation. This line also overloads for other outages (see Constraint #1, above).

The study results show that the WSNI could be decreased by only 424 MW's (instead of the 1338 MW's) if the 0.18 mile long Sedro-Sedro NT 230 kV, 1-795 kcmil ACSR, 100C line could be replaced by a larger diameter conductor. The bottleneck (after the Sedro-Sedro NT line is reconductored) would be the BPA Sedro NT-Murray 230 kV line, which happens to be the bottleneck in the system today for north to south WSNI power transfers.

**Note:** Depending on system conditions, the Study indicated that additional power could flow out of the PSE Sedro Woolley 230 kV bus into the Sedro NT bus after construction of the proposed project.

**Constraint Mitigation:** Install RAS (remedial action scheme) by adding line loss logic that will trip the existing two Fredonia CT's in the event of a Horseranch Substation 230 kV circuit breaker failure or loss of the Sedro-HRTap-SCL Bothell 230 kV line. Installing RAS can be made by adding Line Loss Logic to the Sedro-HRTap-SCL Bothell 230 kV line at Sedro Woolley Substation [PDN 3158 **and** PDN 734] which can then be used to successfully integrate the proposed new Fredonia generation.

The Study concluded that with the existing transmission system and committed transfers the Fredonia 110 MW Requested Service cannot be accomplished on a year round firm basis without interruptions. Local area network upgrades and resolution of the impacts on the WSNI and on BPA's transmission system are recommended.

## 1. Introduction

On January 18, 2001, PSE's merchant function submitted an OASIS request (Reference No. 131212) for 110 MW, 150 MW and 200 MW's (subsequently revised to a single request of 110 MW's) of long term Firm Point-to-Point Transmission Service from the existing PSE Fredonia generation site into PSE's transmission network, as a network resource, for the period June 1, 2001 (subsequently revised to July 1, 2001) through December 31, 2025, (the "Requested Service"). PSE determined that a System Impact Study (the "Study") would be required to evaluate the impact of the Requested Service on PSE's Transmission System. On or about January 25, 2001, the parties executed a System Impact Study Agreement. Power flow studies were performed to examine whether the Requested Service could be accommodated while remaining in compliance with PSE, WSCC and NERC reliability criteria.

## 2. Study Criteria and Assumptions

The Study incorporated existing planning and operating criteria, standards and procedures in conformance with WSCC Reliability Criteria in order to determine necessary Transmission System reinforcements and re-dispatch requirements.

The Study included a number of individual power flow simulation studies (thermal) to determine the system capabilities with and without the 110 MW Fredonia generation. The power flow simulation studies were conducted with the following assumptions and goals:

**Assumptions**

- Assume the proposed Fredonia 2-55 MW generators will be running from July 1, 2001 through the summer 2006.

- Assume all existing generation in Whatcom and Skagit Counties is on line.

- Assume known customer-owned generation in Whatcom and Skagit Counties is on line.

- Assume the full WSCC accepted path rating for the Northwest-Canada Path #3 where up to 2,850 MW of power is flowing from BC Hydro's Ingledow Substation near Vancouver, B.C. toward BPA's Custer Substation near Ferndale, WA.

- Assume that the impacts and required network upgrades to the local area system and the WSCC Northwest-Canada Path #3 are brought about solely by the addition of the proposed 2-55 MW's of generation located at the Fredonia Generation site. This SIS does not determine the impacts and the required network upgrades for the loss of the Intalco load or generation additions at PSE's industrial customer facilities, for example.

- Assume all equipment is in service; then run contingency analysis to determine system impacts

**Goals**

- Identify PSE's transmission constraints in Skagit and Whatcom Counties and any network upgrades

- Identify any constraints on the Westside Northern Intertie ("WSNI").

**Study Limitations**

Pursuant to PSE's Open Access Transmission Tariff ("OATT"), the Study is:

> "An assessment by the Transmission Provider of (i) the adequacy of the Transmission System to accommodate a request for either Firm Point-To-Point Transmission Service or Network Integration Transmission Service and (ii) whether any additional costs may be incurred in order to provide transmission service."

"Transmission System" is defined in the OATT as: "The facilities owned, controlled or operated by the Transmission Provider that are used to provide transmission service under Part II and Part III of the Tariff."

However, PSE noted in the System Impact Study Agreement that it would extend the scope of its Study to determine if there are impacts to the WSNI capacity and neighboring systems resulting from adding the proposed Fredonia generation and the Study does that. BPA may not necessarily agree with PSE's analysis.

Lastly, much of the Intalco load has been displaced and there are a number of generation projects being added or proposed for addition by various parties in the Whatcom and Skagit county area, which could have a material impact on path ratings and transfer capabilities. The results of this Study are a snapshot in time and are based on the most current information and input assumptions available at the time the Study was conducted. Studies done at a later date will likely yield different conclusions.

## 3. Study Conditions

Several base cases were used in the study. The majority of the base cases were conducted using slightly modified versions of the BPA summer 2000, spring 2000 and winter 2000-01 cases. These were the base cases used by both BPA and PSE Operations Planning staff during 2000. The base case was modified to reflect completed upgrade projects and changes to the areas industrial loads and customer-owned generation. The area loads (except customer-owned substation loads, which were held constant) were grown 1.5% per year for two years to reflect annual load growth. These modifications to the 2000 base cases were necessary to fulfill the requirement of being able to have the two Fredonia 55 MW generators run through the first part of its requested time period (July 1, 2001 to July 1, 2002).

A 2006 heavy summer load base case was used to see what the potential system impacts of adding the 110 MW's of generation at the Fredonia generation site might be further out in time.

The study conditions used the summer season base case. The summer season is one of the most restrictive times of year for the transmission system, and is one of the times when the transmission system is highly stressed. This is when the equipment ratings (capabilities) are at their minimums, the WSNI is being maximized (power flows from Canada to the U.S.) and when the Puget Sound area loads, including loads in the area of the proposed Fredonia generation, are at their lowest.

## 4. Study Results

**Findings**
Adding the 2-55 MW Fredonia CT's impacts both the local area PSE 115 kV and 230 kV transmission system and the bulk transmission main power grid, which is owned and operated by BPA.

**Local Network Impacts**
Two local area 115 kV lines can thermally overload resulting from the original (1993-94) MPCC Phase 1 and Phase 2 projects. Adding the 2-55 MW CT's at the Fredonia Generation site and moving the 2 existing Fredonia CT's to the Sedro-March Pt. 230 kV line decrease the amount of these line overloads (compared to today's system). Nevertheless, the lines remain overloaded and must be uprated to successfully run all of the generation located in west Skagit County.

The two line overloads without the proposed new 110 MW's of generation are:

A. The 1.75 mile long Texaco East-March Point 115 kV line;

B. The March Point – Beaver Lake 115 kV line from Peth Corner Substation to the Hickox Susbstation Tap (7.1 miles) and continuing on from the Hickox Tap to the Mt. Vernon Substation (2.64 miles)

The new line overloads created by adding the proposed 2-55 MW Fredonia generators are:

C. The 0.18 mile long Sedro Woolley-Sedro NT 230 kV line which taps the BPA Custer-Murray 230 kV line.

D. The 38.7 mile long Sedro Woolley-HorseranchTap-SCL Bothell 230 kV line (Sedro-HRTap section)

**Discussion of Local Network Impacts**

Note: The contingency numbers (shown below) match those in the summer base cases contained in the Appendix's at the end of the study.

**A. Texaco East – March Point 115 kV Line**

This line consists of 1-1272 kcmil AAC rated at 55C conductor temperature. The Texaco East-March Point 115 kV line can overload today without the addition of the proposed 2-55 MW generators.

Existing System (2001 loads) Without the 2-55 MW Generators

Contingency #1: Loss of the Texaco West-March Point 115 kV line.
Local Area Impact: Thermally overloads the Texaco East-March Point 115 kV line – 177.5% of its emergency rating.

Contingency #36: Breaker failure at Sedro Woolley 230 kV Bus which causes loss of the Sedro Woolley 230-115 kV transformer and the BPA Custer-SedroNT-Murray 230 kV line.
Local Area Impact Thermally overloads the Texaco East-March Point 115 kV line – 102.5% of its emergency rating.

Contingency #45: Line breaker failure on the March Point south 115 kV Bus.
Local Area Impact: Thermally overloads the Texaco East-March Point 115 kV line – 157.8% of its emergency rating.

Contingency #376: Loss of the Sedro Woolley 230-115 kV transformer.
Local Area Impact: Thermally overloads the Texaco East-March Point 115 kV line – 100.4% of its emergency rating.

Existing System With the 2-55 MW Generators

Contingency #1: Loss of the Texaco West-March Point 115 kV line
Local Area Impact: Thermally overloads the Texaco East-March Point 115 kV line – 132.2% of its emergency rating.

Contingency #45: Line breaker failure on the March Point south 115 kV Bus Local Area Impact: Thermally overloads the Texaco East-March Point 115 kV line – 133.2% of its emergency rating.

**B. March Point – Beaver Lake 115 kV Line**

These line sections consists of 1-795 kcmil ACSR rated at 55C conductor temperature. The March Point-Beaver Lake 115 kV line can overload today without the addition of the proposed 2-55 MW generators. Additional generation exacerbates the problem. Moreover, the addition of the 2-55 MW generators causes this line to overload for other contingencies that do not occur without the generators.

Contingency #5: Breaker failure at BPA's Custer 500 kV bus causes loss of the BCH Ingledow-Custer #1 500 kV line and the Custer-Monroe #1 500 kV line.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | Without 2-55 MW Generation % of Line Emergency Rating | After 2-55 MW Generation |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | | 104.2% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | | 98.1 |

Contingency #26: Single line loss of the BPA Custer-SedroNT-Murray 230 kV line.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| **March Pt-Beaver Lake 115 kV Line Section Name** | **Without 2-55 MW Generation % of Line Emergency Rating** | **After 2-55 MW Generation** |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | | 100.0% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | | 93.9 |

Contingency #28: Breaker failure at BPA's Custer 230 kV Bus which causes loss of the BPA Custer-SedroNT-Murray 230 kV line and the Portal Way 230-115 kV transformer.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| **March Pt-Beaver Lake 115 kV Line Section Name** | **Without 2-55 MW Generation % of Line Emergency Rating** | **After 2-55 MW Generation** |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | | 103.1% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | | 97.0 |

Contingency #29: Breaker failure at BPA's Custer 230 kV Bus which causes loss of the BPA Custer-SedroNT-Murray 230 kV line and the Custer-Intalco #2 230 kV line.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| **March Pt-Beaver Lake 115 kV Line Section Name** | **Without 2-55 MW Generation % of Line Emergency Rating** | **After 2-55 MW Generation** |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | | 100.0% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | | 93.9 |

Contingency #35: Breaker failure at Sedro Woolley 230 kV Bus which causes loss of the BPA Bellingham-Sedro Woolley 230 kV line and the Sedro-HRTap-SCL Bothell 230 kV line.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| **March Pt-Beaver Lake 115 kV Line Section Name** | **Without 2-55 MW Generation % of Line Emergency Rating** | **After 2-55 MW Generation** |
|---|---|---|

| | |
|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | 106.4% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | 100.2 |

Contingency #36: Breaker failure at Sedro Woolley 230 kV Bus which causes loss of the Sedro Woolley 230-115 kV transformer and the BPA Custer-SedroNT-Murray 230 kV line.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | Without 2-55 MW Generation % of Line Emergency Rating | After 2-55 MW Generation |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | 106% | 109.5% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | 99.8 | 103.4 |
| Mt. Vernon-Big Rock, 2.7 mi. | | 93.0 |

Contingency #37: Breaker failure at Sedro Woolley 230 kV Bus which causes loss of the Sedro Woolley-March Point 230 kV line and the BPA Custer-SedroNT-Murray 230 kV line.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | Without 2-55 MW Generation % of Line Emergency Rating | After 2-55 MW Generation |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | 103.1% | 127.3% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | 96.9 | 121.2 |
| Mt. Vernon-Big Rock, 2.7 mi. | | 110.8 |
| Big Rock-Beaver Lake, 2.6 mi. | | 105.0 |
| Beaver Lake-Beverly Park, 39 mi. | | 105.0 |

Contingency #38: Breaker failure at Sedro Woolley 230 kV Bus which causes loss of the Sedro Woolley-Fredonia 230 kV line and the BPA Custer-SedroNT-Murray 230 kV line.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | Without 2-55 MW Generation % of Line Emergency Rating | After 2-55 MW Generation |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | 103.1% | 112.8% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | 96.9 | 106.6 |
| Mt. Vernon-Big Rock, 2.7 mi. | | 96.2 |

Contingency #39: Breaker failure at Sedro Woolley 230 kV Bus which causes loss of the Sedro Woolley 230-115 kV transformer and the Sedro-Hranch-SCL Bothell 230 kV line.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | **Without 2-55 MW Generation** % of Line Emergency Rating | **After 2-55 MW Generation** |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | 114.1% | 118.6% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | 107.9 | 112.5 |
| Mt.Vernon-Big Rock, 2.7 mi. | 97.4 | 102.0 |
| Big Rock-Beaver Lake, 2.6 mi. | | 96.2 |

Contingency #46: Single line loss of the Sedro-Hranch-SCL Bothell 230 kV line – all 3-legs.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | **Without 2- 55 MW Generation** % of Line Emergency Rating | **After 2-55 MW Generation** |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | 104.2% | 111.0% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | 98.1 | 104.8 |
| Mt.Vernon-Big Rock, 2.7 mi. | | 94.4 |

Contingency #47: Double circuit line loss of both the Sedro-Hranch-SCL Bothell 230 kV line and the SCL Bothell-Sammamish 230 kV line.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | **Without 2-55 MW Generation** % of Line Emergency Rating | **After 2-55 MW Generation** |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | 104.0% | 110.9% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | 98.0 | 104.7 |
| Mt.Vernon-Big Rock, 2.7 mi. | | 94.3 |

Contingency #48: Breaker failure causing the loss of the BPA Murray 230 kV bus.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

**Without 2-55 MW** **After 2-55 MW**

| March Pt-Beaver Lake 115 kV Line Section Name | Generation<br>% of Line Emergency Rating | Generation |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | 100.5% | 105.9% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | 94.4 | 99.8 |

Contingency #50: Breaker failure (on SedroNT line) causing the loss of the BPA Murray 230 kV bus.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | Without 2-55 MW Generation<br>% of Line Emergency Rating | After 2-55 MW Generation |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | | 101.1% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | | 95.0 |

Contingency #51: Breaker failure at the PSE Horseranch 230 kV Substation.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | Without 2-55 MW Generation<br>% of Line Emergency Rating | After 2-55 MW Generation |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | 108.4% | 115.0% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | 102.2 | 108.8 |
| Mt. Vernon-Big Rock, 2.7 mi. | 91.7 | 98.4 |

Contingency #2228: Loss of the BPA Custer-Monroe #1 500 kV line.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | Without 2-55 MW Generation<br>% of Line Emergency Rating | After 2-55 MW Generation |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | (less than 90%) | 105.0% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | | 98.8 |

Contingency #4920: Open the BPA Custer-SedroNT-Murray 230 kV line at Murray Substation.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | Without 2-55 MW Generation % of Line Emergency Rating | After 2-55 MW Generation |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | (less than 90%) | 104.8% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | | 98.7 |

Contingency #5976: Open the Sedro-HRTap-SCL Bothell 230 kV line at Sedro Woolley Substation.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | Without 2-55 MW Generation % of Line Emergency Rating | After 2-55 MW Generation |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | (less than 90%) | 111.2% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | | 105.1 |
| Mt. Vernon-Big Rock, 2.7 mi. | | 94.6 |

Contingency #5977: Loss of the Sedro-Fredonia 230 kV line.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | Without 2-55 MW Generation % of Line Emergency Rating | After 2-55 MW Generation |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | | 114.6% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | | 108.4 |
| Mt. Vernon-Big Rock, 2.7 mi. | | 98.0 |

### C. Sedro Woolley-SedroNT 230 kV line

This 0.18-mile line consists of 1-795 kcmil ACSR rated at 100C conductor temperature.

Contingency #39: Breaker failure at Sedro Woolley 230 kV Bus which causes loss of the Sedro Woolley 230-115 kV transformer and the Sedro-Hranch-SCL Bothell 230 kV line.
Local Area Impact: Thermally overloads the Sedro-SedroNT 230 kV line (105.9% of its emergency rating).

Contingency #46: Single line loss of the Sedro-Hranch-SCL Bothell 230 kV line – all 3-legs.

Local Area Impact: Thermally overloads the Sedro-SedroNT 230 kV line (114.5% of its emergency rating).

Contingency #47: Double circuit line loss of both the Sedro-Hranch-SCL Bothell 230 kV line and the SCL Bothell-Sammamish 230 kV line.
Local Area Impact: Thermally overloads the Sedro-SedroNT 230 kV line (113.8% of its emergency rating).

Contingency #51: Breaker failure at the PSE Horseranch 230 kV Substation.
Local Area Impact: Thermally overloads the Sedro-SedroNT 230 kV line (119.0% of its emergency rating).

Contingency #5976: Open the Sedro-HRTap-SCL Bothell 230 kV line at Sedro Woolley Substation.
Local Area Impact: Thermally overloads the Sedro-SedroNT 230 kV line (115.1% of its emergency rating).

**D. <u>Sedro Woolley-HorseranchTap-SCL Bothell 230 kV line (Sedro-HRTap section)</u>**

This 38.7 mile long line consists of 2-795 kcmil ACSR rated at 75C conductor temperature.

Contingency #48: Breaker failure causing the loss of the BPA Murray 230 kV bus.
<u>Local Area Impact:</u> Thermally overloads the Sedro-HRTap-SCL Bothell 230 kV line from Sedro to the Horseranch Tap (105.4% of its emergency rating).

Contingency #2228: Loss of the BPA Custer-Monroe #1 500 kV line.
Local Area Impact: Thermally overloads the Sedro-HRTap-SCL Bothell 230 kV line from Sedro Woolley Substation to the Horseranch Tap (105.3% of its emergency rating).

Contingency #4920: Open the BPA Custer-SedroNT-Murray 230 kV line at Murray Substation.
Local Area Impact: Thermally overloads the Sedro-HRTap-SCL Bothell 230 kV line from Sedro Woolley Substation to the Horseranch Tap (105.6% of its emergency rating).

The effects of lower Puget Sound area loads (LLH, Light Load Hour) were also studied to see if the addition of the Fredonia generators would create additional problems or worsen the ones found above. No new line sections (not already identified in the HLH studies) were found and many of those identified with the heavier load level were reduced.

**<u>Discussion of Non-PSE; Neighboring Systems; Main Grid Network Impacts</u>**

The power flow study results indicate impacts on BPA's 230 kV system. It appears that there are contingencies that will cause the BPA SedroNT-Murray 230 kV line to overload. Some of these contingencies do not cause line overloads today (without the Fredonia 2-55 MW generators).

There are other contingencies that can cause the BPA line(s) to overload even in today's system, but overloads of this particular line increase with the addition of the Fredonia generators.

Today's limiting facility (i.e., constraint) that restricts WSNI OTC is the same line that will be forced to carry some of the additional power of the proposed Fredonia generator. If the WSNI path is to be used to protect the Sedro-SedroNT 230 kV line from overloading (so the Fredonia generation can run) the analysis in this Study indicates that the WSNI OTC would have to be restricted by 1338 MW's. If the Sedro-SedroNT 230 kV were reconductored with a higher capacity conductor, then the limiting element (restricting the intertie) would become the SedroNT-Murray 230 kV line. The study results show that the WSNI could be decreased by only 424 MW's (instead of the 1338 MW's) if the 0.18 mile long Sedro-Sedro NT 230 kV line could be uprated to a higher conductor temperature. A RAS could be installed with line loss logic on the Sedro-HRTap-SCL Bothell 230 kV line that would trip the two existing Fredonia CT's decreasing the power flow on the SedroNT-Murray 230 kV line. This would result in increasing the WSNI north to south OTC.

Negative impacts to the WSNI OTC during LLH (light load hour) generally appear to be lower for the same contingencies as at the HLH. However, the overload of the Sedro-Sedro NT 230 kV line seems like it can be worse and could limit the WSNI OTC even more than during HLH. Removing the bottleneck, which consists of uprating it to a higher conductor temperature, can eliminate this constraint.

Adding the Fredonia generators will increase the WSNI OTC when the power flow is moving from the U.S. to B.C. This effect (adding south-to-north OTC) appears to occur for most of the seasons (winter, spring/fall, and summer). The Portal Way-ARCO Central 115 kV line looks like it could become the limiting element for the summer south to north base case. This happens with or without the addition of the 2-55 MW Fredonia CT's.

## 5. Conclusions and Recommendations

### Conclusions

The Study indicates that with the existing transmission system and WSCC accepted path rating(s) for the WSNI (WSCC Path #3), the Requested Service cannot be accommodated. There are impacts to: (a) the local area transmission system, (b) the WSNI (joint ownership) and (c) BPA's transmission system. The local area facilities impacted involve power flows (resulting from contingencies) exceeding their thermal design limits. These facilities can probably be upgraded to higher capacities.

The non-PSE owned (BPA) facilities impacted: (a) depending on system conditions some of the Fredonia generators power could flow on BPA transmission system, and (b) power flows (resulting from contingencies) on BPA's SedroNT-Murray 230 kV line exceeding its design limit and thus limiting the WSNI (WSCC Path #3). The SedroNT-Murray 230 kV line may already be at BPA's maximum desired capacity rating. Adding the Fredonia generation will increase the capacity of the WSNI when the power is moving from the U.S. to B.C.

Higher Puget Sound area loads would appear to cause the line overloads shown from the power flow studies to become worse. This conclusion is based on the power flow comparison of heavier load base case results versus the lighter-load base case results.

All of the power studies assumed that all other lines were in service. System outages, such as for maintenance and construction, may cause the local network and the WSNI to become much more constrained, beyond what was found and presented in this study.

### Recommendations

**A. PSE Facilities (Local Area Network, Estimated to be valid through summer, 2002)**

Complete the following upgrades.

| Overloads | Proposed System Upgrade |
|---|---|
| Sedro-SedroNT 230 kV Line | Uprate 0.18 miles of 1-795 kcmil ACSR @ 100C to 115C conductor temperature, or higher |
| Texaco East-March Pt 115 kV | Upgrade the existing 1-1272 kcmil AAC, 55C to 100C, 1.7 mi. |
| Beaver Lake-March Pt 115 kV | |
| A) PethCrn-HickoxTap | Upgrade to 65C from 55C, 7.08 mi. |
| B) Hickox Tap-Mt. Vernon | Upgrade to 65C from 55C, 2.64 mi. |
| Sedro-HRTap 230 kV Line | Upgrade line to 80C or higher from 75C, 39 mi., OR Run back generation via Power Dispatcher control if upgrading the line is not feasible |

**B. BPA Facilities (Main Grid; Neighboring Systems, Estimated to be valid through summer, 2002)**

Install RAS (remedial action scheme) in Sedro Woolley Substation to add Line Loss Logic to the Sedro-HRTap-SCL Bothell 230 kV line to trip the existing 2-Fredonia CT's. It may be necessary to occasionally (summer) operate the Horseranch Substation 230 kV circuit breaker open until the RAS in installed. This may have contract implications, however.

**C. PSE Facilities (Local Area Network, Estimated to be valid through summer, 2006)**

The only new local area impact found by adding the Fredonia generation to the summer 2006 base case was a 102.3% overload of the Sedro-Horseranch tap 230 kV line caused by a BPA Murray 230 kV breaker failure and subsequent loss of all the Murray 230 kV lines. This potential line overload can be removed by having the PSE Load Dispatchers reschedule generation, as necessary.

**D. BPA Facilities (Main Grid; Neighboring Systems, Estimated to be valid through summer, 2006)**

The summer 2006 base case shows that the BPA Snohomish-Bothell #2 230 kV line (which currently connects to BPA Snoking Substation and not Bothell Substation) is loaded to 95% of its emergency summer rating before contingencies and no additional Fredonia generation. The Snohomish-Bothell #2 230 kV line loads to 97% of its emergency rating after the addition of the Fredonia generation, a 2% increase.

The line overloads after many contingencies even without the addition of the proposed Fredonia generation. The line needs to be uprated regardless of the decision whether to add generation at Fredonia.

# APPENDIX A

Contingency Analysis Detailed Report

```
 *** MUST 4.00  ***  THU, APR 19 2001   7:15 ***
     01HSNS02BCH=2850/300WASK=1223,SCL=100,NO NEW FREDONIA(BASE)
     ALL WA/SK GEN ON,INDUSTRIAL LD ADJ.,NO LINE UPRATES,NO MPCC
Subsys.File D:\Summer-2000\subni-us.sub
Monit.File  D:\Summer-2000\monzonepsregion-Fredonia100MW-pti-VER5.mon
Contin.File D:\Summer-2000\NIandSINGLE-ALL-Fredonia100MW.con
Exclud.File D:\Summer-2000\PTI-EXCLUDE.EXC
                        Summer 2001 Without Fredonia and Without MPCC
 Detailed report on selected contingencies. Total 6866. Selected   38
 ----------------------------------------------------------------

Study transfer not defined


 ******* Contingency     3 BKFCUSMON2T1


 Branches with  MW flow  more than     90.0 % of nominal rating
**   From bus   ** **    To bus   ** CKT InitFlow    Rating IntLd% BaseFlow
21870 HICKOX T 115 22163 PETHCORN 115 1    -105.1     110.0   95.5    -92.6
20330 MURRAY   230 21282 SEDRO NT 230 1    -430.3     426.3  100.9   -355.0


 ******* Contingency     5 BKFINGCUS1M1


 Branches with  MW flow  more than     90.0 % of nominal rating
**   From bus   ** **    To bus   ** CKT InitFlow    Rating IntLd% BaseFlow
21870 HICKOX T 115 22057 MTVERNON 115 1     106.7     110.0   97.0     85.8
21870 HICKOX T 115 22163 PETHCORN 115 1    -113.4     110.0  103.1    -92.6
20330 MURRAY   230 21282 SEDRO NT 230 1    -480.5     426.3  112.7   -355.0
20449 SEDRO    230 23097 HRNCHTAP 230 1     631.5     638.2   98.9    459.6


 ******* Contingency    22 BKRPWAYLYNN


 Branches with  MW flow  more than     90.0 % of nominal rating
**   From bus   ** **    To bus   ** CKT InitFlow    Rating IntLd% BaseFlow
```

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 21183 | ARCO C | 115 | 21268 | PORTALWY | 115 | 1 | 146.6 | 159.0 | 92.2 | 100.8 |
| 21239 | KENDALL | 115 | 21438 | SUMAS CG | 115 | 1 | -101.9 | 46.0 | 221.5 | -33.1 |
| 21239 | KENDALL | 115 | 22113 | NUGENT | 115 | 1 | 97.9 | 46.0 | 212.8 | 29.1 |

******* Contingency 24 BKRPWAY115S

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** | ** | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21941 | LABOUNTY | 115 | 21541 | BAKERVUE | 115 | 1 | 125.9 | 129.1 | 97.5 | 77.3 |
| 22179 | PLYMOUTH | 115 | 21541 | BAKERVUE | 115 | 1 | -111.1 | 110.0 | 101.0 | -62.6 |
| 21239 | KENDALL | 115 | 21438 | SUMAS CG | 115 | 1 | -43.5 | 46.0 | 94.5 | -33.1 |

******* Contingency 25 BKRPWAYVISS

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** | ** | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21941 | LABOUNTY | 115 | 21541 | BAKERVUE | 115 | 1 | 125.0 | 129.1 | 96.8 | 77.3 |
| 22179 | PLYMOUTH | 115 | 21541 | BAKERVUE | 115 | 1 | -110.2 | 110.0 | 100.2 | -62.6 |
| 21239 | KENDALL | 115 | 21438 | SUMAS CG | 115 | 1 | -43.1 | 46.0 | 93.8 | -33.1 |

******* Contingency 28 BKFCUSMURPWY

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** | ** | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 103.3 | 110.0 | 94.0 | 85.8 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -110.1 | 110.0 | 100.1 | -92.6 |
| 20449 | SEDRO | 230 | 23097 | HRNCHTAP | 230 | 1 | 590.2 | 638.2 | 92.5 | 459.6 |

******* Contingency 31 DCCUSMURSED

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** | ** | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 22097 | NORLUM | 115 | 21514 | ALGER | 115 | 1 | -102.9 | 108.0 | 95.3 | -40.7 |
| 20039 | BELNGM P | 115 | 21514 | ALGER | 115 | 1 | 106.5 | 108.0 | 98.6 | 44.3 |
| 20039 | BELNGM P | 115 | 22507 | WOBURN | 115 | 1 | 121.9 | 115.9 | 105.1 | 54.0 |
| 21963 | LKLOUIST | 115 | 22507 | WOBURN | 115 | 1 | -115.3 | 115.9 | 99.5 | -47.4 |
| 20448 | SEDRO | 115 | 21963 | LKLOUIST | 115 | 1 | -112.3 | 108.0 | 104.0 | -44.4 |

******* Contingency 35 BKFSEDBOTBHM

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** | ** | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 106.6 | 110.0 | 96.9 | 85.8 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -113.3 | 110.0 | 103.0 | -92.6 |
| 20330 | MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -487.8 | 426.3 | 114.4 | -355.0 |
| 20467 | SNOHOMSH | 230 | 98766 | SBTPTI&1 | 230 | 1 | 439.5 | 426.3 | 103.1 | 314.5 |

******* Contingency 36 BKFSEDTXCUSM

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** | ** | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 22057 | MTVERNON | 115 | 21563 | BIGROCK | 115 | 1 | 101.8 | 110.0 | 92.6 | 74.4 |
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 113.3 | 110.0 | 103.0 | 85.8 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -120.0 | 110.0 | 109.1 | -92.6 |
| 21250 | MARCHPT | 115 | 22150 | PADILTAP | 115 | 1 | -143.4 | 143.0 | 100.3 | -106.4 |
| 22150 | PADILTAP | 115 | 21439 | TEXACO E | 115 | 1 | -147.1 | 143.0 | 102.9 | -110.1 |

******* Contingency 37 BKFMPTTXCUSM

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** | ** | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 109.4 | 110.0 | 99.4 | 85.8 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -116.1 | 110.0 | 105.6 | -92.6 |

******* Contingency 39 BKFSEDTXHRBO

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** | ** | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21529 | ARLNGTON | 115 | 20033 | BEAVERLK | 115 | 1 | -105.6 | 110.0 | 96.0 | -67.9 |
| 20033 | BEAVERLK | 115 | 21563 | BIGROCK | 115 | 1 | -105.7 | 110.0 | 96.1 | -68.0 |
| 22057 | MTVERNON | 115 | 21563 | BIGROCK | 115 | 1 | 112.1 | 110.0 | 101.9 | 74.4 |
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 123.6 | 110.0 | 112.3 | 85.8 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -130.3 | 110.0 | 118.4 | -92.6 |
| 21250 | MARCHPT | 115 | 22150 | PADILTAP | 115 | 1 | -135.5 | 143.0 | 94.7 | -106.4 |
| 20330 | MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -520.6 | 426.3 | 122.1 | -355.0 |
| 20467 | SNOHOMSH | 230 | 98766 | SBTPTI&1 | 230 | 1 | 447.7 | 426.3 | 105.0 | 314.5 |
| 22150 | PADILTAP | 115 | 21439 | TEXACO E | 115 | 1 | -139.1 | 143.0 | 97.3 | -110.1 |

******* Contingency 40 BKRSEDROW115

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|
| 20448 SEDRO | 115 | 20026 | BAKER SW | 115 | 1 | -119.2 | 98.0 | 121.7 | -60.1 |
| 21870 HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 101.3 | 110.0 | 92.1 | 85.8 |
| 21870 HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -108.0 | 110.0 | 98.2 | -92.6 |
| 21250 MARCHPT | 115 | 22150 | PADILTAP | 115 | 1 | -141.1 | 143.0 | 98.7 | -106.4 |
| 22150 PADILTAP | 115 | 21439 | TEXACO E | 115 | 1 | -144.8 | 143.0 | 101.2 | -110.1 |

******* Contingency 42 BKRSEDROE115

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|
| 20448 SEDRO | 115 | 20026 | BAKER SW | 115 | 2 | -119.2 | 98.0 | 121.7 | -59.1 |
| 21250 MARCHPT | 115 | 22150 | PADILTAP | 115 | 1 | -129.8 | 143.0 | 90.8 | -106.4 |
| 22150 PADILTAP | 115 | 21439 | TEXACO E | 115 | 1 | -133.5 | 143.0 | 93.4 | -110.1 |

******* Contingency 45 BKRMARPTS115

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|
| 21870 HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -101.7 | 110.0 | 92.5 | -92.6 |
| 21250 MARCHPT | 115 | 22150 | PADILTAP | 115 | 1 | -219.8 | 143.0 | 153.7 | -106.4 |
| 22150 PADILTAP | 115 | 21439 | TEXACO E | 115 | 1 | -223.5 | 143.0 | 156.3 | -110.1 |

******* Contingency 46 SLSEDROHRBOT

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|
| 22057 MTVERNON | 115 | 21563 | BIGROCK | 115 | 1 | 101.2 | 110.0 | 92.0 | 74.4 |
| 21870 HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 112.6 | 110.0 | 102.4 | 85.8 |
| 21870 HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -119.3 | 110.0 | 108.5 | -92.6 |
| 20330 MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -540.3 | 426.3 | 126.7 | -355.0 |
| 20449 SEDRO | 230 | 99882 | SEDPTI&1 | 230 | 1 | 396.0 | 402.0 | 98.5 | 105.5 |
| 20467 SNOHOMSH | 230 | 98766 | SBTPTI&1 | 230 | 1 | 450.0 | 426.3 | 105.6 | 314.5 |

******* Contingency 47 DCBOTSAMSEDH

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|
| 22057 MTVERNON | 115 | 21563 | BIGROCK | 115 | 1 | 101.1 | 110.0 | 91.9 | 74.4 |
| 21870 HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 112.5 | 110.0 | 102.3 | 85.8 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -119.2 | 110.0 | 108.4 | -92.6 |
| 20330 | MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -535.8 | 426.3 | 125.7 | -355.0 |
| 20449 | SEDRO | 230 | 99882 | SEDPTI&1 | 230 | 1 | 393.4 | 402.0 | 97.9 | 105.5 |
| 20467 | SNOHOMSH | 230 | 98766 | SBTPTI&1 | 230 | 1 | 399.5 | 426.3 | 93.7 | 314.5 |

******* Contingency 48 BUSMURRAY230

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** | ** | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|
| 21870 HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 107.6 | 110.0 | 97.8 | 85.8 |
| 21870 HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -114.3 | 110.0 | 103.9 | -92.6 |
| 20449 SEDRO | 230 | 23097 | HRNCHTAP | 230 | 1 | 630.9 | 638.2 | 98.9 | 459.6 |

******* Contingency 51 BKFHRSUB

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** | ** | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|
| 21529 ARLNGTON | 115 | 20033 | BEAVERLK | 115 | 1 | -99.2 | 110.0 | 90.1 | -67.9 |
| 20033 BEAVERLK | 115 | 21563 | BIGROCK | 115 | 1 | -99.3 | 110.0 | 90.2 | -68.0 |
| 22057 MTVERNON | 115 | 21563 | BIGROCK | 115 | 1 | 105.7 | 110.0 | 96.1 | 74.4 |
| 21870 HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 117.1 | 110.0 | 106.5 | 85.8 |
| 21870 HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -123.8 | 110.0 | 112.6 | -92.6 |
| 20330 MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -576.4 | 426.3 | 135.2 | -355.0 |
| 20449 SEDRO | 230 | 99882 | SEDPTI&1 | 230 | 1 | 414.7 | 402.0 | 103.2 | 105.5 |

******* Contingency 53 BKFMONTAP230

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** | ** | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|
| 21870 HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -103.5 | 110.0 | 94.1 | -92.6 |
| 20330 MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -429.9 | 426.3 | 100.9 | -355.0 |

******* Contingency 67 BKRBOT4230

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** | ** | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|
| 20467 SNOHOMSH | 230 | 98766 | SBTPTI&1 | 230 | 1 | 481.5 | 426.3 | 113.0 | 314.5 |
| 20467 SNOHOMSH | 230 | 9993 | SNOSNO&1 | 230 | 1 | 343.5 | 364.1 | 94.3 | 263.4 |

******* Contingency 320 20011 ALLSTON 230 20012 ALLSTON 500 1

```
 Branches with  MW flow  more than      90.0 % of nominal rating
**    From bus     ** **     To bus     ** CKT InitFlow     Rating IntLd% BaseFlow
20678 COSMOPLS 115 20997 RAYMOND  115 1       64.1       55.8  114.8     41.2


 ******* Contingency   498 21183 ARCO C   115 21525 ARCO N   115 1


 Branches with  MW flow  more than      90.0 % of nominal rating
**    From bus     ** **     To bus     ** CKT InitFlow     Rating IntLd% BaseFlow
21183 ARCO C   115 21268 PORTALWY 115 1      160.9      159.0  101.2    100.8


 ******* Contingency   602 21534 AVON PMP 115 22494 WILSN TP 115 1


 Branches with  MW flow  more than      90.0 % of nominal rating
**    From bus     ** **     To bus     ** CKT InitFlow     Rating IntLd% BaseFlow
21250 MARCHPT  115 22150 PADILTAP 115 1     -142.6      143.0   99.7   -106.4
22150 PADILTAP 115 21439 TEXACO E 115 1     -146.3      143.0  102.3   -110.1


 ******* Contingency   644 20026 BAKER SW 115 20448 SEDRO    115 1


 Branches with  MW flow  more than      90.0 % of nominal rating
**    From bus     ** **     To bus     ** CKT InitFlow     Rating IntLd% BaseFlow
20448 SEDRO    115 20026 BAKER SW 115 2     -119.2       98.0  121.7    -59.1


 ******* Contingency   645 20026 BAKER SW 115 20448 SEDRO    115 2


 Branches with  MW flow  more than      90.0 % of nominal rating
**    From bus     ** **     To bus     ** CKT InitFlow     Rating IntLd% BaseFlow
20448 SEDRO    115 20026 BAKER SW 115 1     -119.2       98.0  121.7    -60.1


 ******* Contingency  1159 20065 BOTHELL  230 23097 HRNCHTAP 230 1


 Branches with  MW flow  more than      90.0 % of nominal rating
**    From bus     ** **     To bus     ** CKT InitFlow     Rating IntLd% BaseFlow
20467 SNOHOMSH 230 98766 SBTPTI&1 230 1      490.3      426.3  115.0    314.5
20467 SNOHOMSH 230  9993 SNOSNO&1 230 1      344.2      364.1   94.5    263.4
```

******* Contingency 1700 20647 CHEHALIS 115 20961 PE ELL 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|
| 20678 | COSMOPLS | 115 20997 | RAYMOND | 115 1 | 58.6 | 55.8 | 105.1 | 41.2 |

******* Contingency 1705 20093 CHEHALIS 230 20647 CHEHALIS 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|
| 20678 | COSMOPLS | 115 20997 | RAYMOND | 115 1 | 58.8 | 55.8 | 105.4 | 41.2 |

******* Contingency 2225 20137 CUSTER W 500 20323 MONROE 500 &2

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 22057 | MTVERNON | 115 1 | 100.5 | 110.0 | 91.4 | 85.8 |
| 21870 | HICKOX T | 115 22163 | PETHCORN | 115 1 | -107.3 | 110.0 | 97.5 | -92.6 |
| 20330 | MURRAY | 230 21282 | SEDRO NT | 230 1 | -443.6 | 426.3 | 104.0 | -355.0 |
| 20449 | SEDRO | 230 23097 | HRNCHTAP | 230 1 | 580.9 | 638.2 | 91.0 | 459.6 |

******* Contingency 2226 20137 CUSTER W 500 20323 MONROE 500 &1

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|
| 20137 | CUSTER W | 500 23629 | CUSMON&2 | 500 2 | 1870.3 | 2061.2 | 90.7 | 1028.6 |
| 21870 | HICKOX T | 115 22057 | MTVERNON | 115 1 | 107.5 | 110.0 | 97.7 | 85.8 |
| 21870 | HICKOX T | 115 22163 | PETHCORN | 115 1 | -114.2 | 110.0 | 103.8 | -92.6 |
| 20330 | MURRAY | 230 21282 | SEDRO NT | 230 1 | -485.4 | 426.3 | 113.9 | -355.0 |
| 20449 | SEDRO | 230 23097 | HRNCHTAP | 230 1 | 638.2 | 638.2 | 100.0 | 459.6 |

******* Contingency 3614 20812 HOLCOMB 115 20961 PE ELL 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|
| 20678 | COSMOPLS | 115 20997 | RAYMOND | 115 1 | 57.3 | 55.8 | 102.7 | 41.2 |

******* Contingency 4348 21249 LYNDEN 115 22272 SCHUETT 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21239 | KENDALL | 115 | 21438 | SUMAS CG | 115 | 1 | -101.9 | 46.0 | 221.5 | -33.1 |
| 21239 | KENDALL | 115 | 22113 | NUGENT | 115 | 1 | 97.9 | 46.0 | 212.8 | 29.1 |

******* Contingency 4419 21250 MARCHPT 115 21440 TEX_WEST 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21250 | MARCHPT | 115 | 22150 | PADILTAP | 115 | 1 | -247.2 | 143.0 | 172.9 | -106.4 |
| 22150 | PADILTAP | 115 | 21439 | TEXACO E | 115 | 1 | -250.9 | 143.0 | 175.4 | -110.1 |

******* Contingency 4919 20330 MURRAY 230 21282 SEDRO NT 230 1

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 106.4 | 110.0 | 96.7 | 85.8 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -113.1 | 110.0 | 102.8 | -92.6 |
| 20449 | SEDRO | 230 | 23097 | HRNCHTAP | 230 | 1 | 632.5 | 638.2 | 99.1 | 459.6 |

******* Contingency 5970 20448 SEDRO 115 20449 SEDRO 230 1

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 100.7 | 110.0 | 91.5 | 85.8 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -107.4 | 110.0 | 97.6 | -92.6 |
| 21250 | MARCHPT | 115 | 22150 | PADILTAP | 115 | 1 | -140.1 | 143.0 | 98.0 | -106.4 |
| 22150 | PADILTAP | 115 | 21439 | TEXACO E | 115 | 1 | -143.7 | 143.0 | 100.5 | -110.1 |

******* Contingency 5975 20449 SEDRO 230 23097 HRNCHTAP 230 1

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 22057 | MTVERNON | 115 | 21563 | BIGROCK | 115 | 1 | 101.4 | 110.0 | 92.2 | 74.4 |
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 112.9 | 110.0 | 102.6 | 85.8 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -119.6 | 110.0 | 108.7 | -92.6 |
| 20330 | MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -544.7 | 426.3 | 127.8 | -355.0 |
| 20449 | SEDRO | 230 | 99882 | SEDPTI&1 | 230 | 1 | 398.4 | 402.0 | 99.1 | 105.5 |

******* Contingency 6311 21438 SUMAS CG 115 22272 SCHUETT 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|
| 21595 BRITTON | 115 22443 | VANWYCK | 115 1 | -102.2 | 109.0 | 93.8 | -23.5 |
| 21239 KENDALL | 115 21438 | SUMAS CG | 115 1 | -111.9 | 46.0 | 243.3 | -33.1 |
| 21239 KENDALL | 115 22113 | NUGENT | 115 1 | 107.9 | 46.0 | 234.6 | 29.1 |
| 22443 VANWYCK | 115 22113 | NUGENT | 115 1 | -104.2 | 109.0 | 95.6 | -25.4 |

******* Contingency 6447 21439 TEXACO E 115 22494 WILSN TP 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|
| 21607 BURLIGTN | 115 23004 | RITA | 115 1 | 172.2 | 143.0 | 120.4 | 40.1 |
| 20448 SEDRO | 115 23004 | RITA | 115 1 | -170.2 | 143.0 | 119.0 | -38.1 |

# MARCH POINT

# 50 MW

March Point - 50 MW

# System Impact Study for

# MPCC 50 MW Combustion Turbine

# At Texaco West Substation

# Near Anacortes, WA

**PSE OASIS Reference No. 130752**
**March 7, 2001**

**Puget Sound Energy, Inc.**
**Electric Transmission Department**

**Table of Contents**

## Executive Summary

On December 27, 2000, March Point Cogeneration Company ("MPCC") submitted an OASIS request (OASIS Reference No. 130752) to Puget Sound Energy, Inc. ("PSE") for long term Firm Point-to-Point Transmission Service (the "Requested Service") from a proposed 50 MW generator located at the Texaco West substation near Anacortes, Washington to Bonneville Power Administration's ("BPA") Mid-Columbia bus. The term of the Requested Service is one year, from September 1, 2001 through September 1, 2002.

PSE determined that a System Impact Study (the "Study") would be required to evaluate the impact of the Requested Service on PSE's Transmission System. The purpose of the Study is to identify any system constraints and redispatch options, additional Direct Assignment Facilities or Network Upgrades required to provide the Requested Service. Power flow simulation studies were performed to ensure that the MPCC transmission request was accomplished in compliance with PSE, WSCC and NERC reliability criteria.

The base conditions used for the Study are the following:

a) PSE's native load requirements for the summer of 2002;
b) all existing generation in Skagit and Whatcom Counties running; and
c) maximum accepted WSCC Path Rating #3 (Northwest-Canada) for the Westside Northern Intertie ("WSNI") north to south (i.e., B.C. to U.S.) power flow (2,850 MW from BC Hydro's Ingledow Substation to BPA's Custer Substation).

The constraints and proposed system upgrades for removing the constraints are as follows:

**Constraint #1**: The Texaco West Substation to March Point Substation 115 kV transmission line.

**Discussion:** During summer heavy load hours (i.e. hours between 0700 – 2200), opening the Texaco East-March Point 115 kV line at Texaco East Substation causes the Texaco West-March Point 115 kV line to exceed its maximum thermal design limit of 100C conductor temperature.

**Constraint Mitigation:** Reconductor the Texaco West-March Point 115 kV line using 1-1590 kcmil ACSR, Lapwing with a 100C conductor temperature rating.

Note: Outages of this line (to reconductor it) must not interfere with PSE's obligations to run its owned and contracted generation.

**Constraint #2:** The Texaco East Substation to March Point Substation 115 kV transmission line.

**Discussion:** Since 1993-94, when the original MPCC Phase I and later Phase II was added, a loss of the March Point-Texaco West 115 kV line or a line breaker failure at the March Point Substation south 115 kV bus would cause very high thermal overloads on the Texaco East-March Point 115 kV line. This condition needs to be corrected as it exists with or without the proposed MPCC 50 MW generation addition.

**Constraint Mitigation:** Reconductor the Texaco East-March Point 115 kV line using 1-1590 kcmil ACSR, Lapwing with a 100C conductor temperature rating.

Note: Outages of this line (to reconductor it) must not interfere with PSE's obligations to run its owned and contracted generation.

**Constraint #3:** <u>The March Point-Beaver Lake 115 kV line between Peth Corner Substation and Mt. Vernon Substation.</u>

**Discussion:** During summer HLH (heavy load hours between 0700 – 2200) a forced outage of the Sedro-Horseranch-SCL Bothell 230 kV line can cause sections of the March Point-Beaver Lake 115 kV line between Peth Corner and Mt. Vernon Substations to exceed their maximum thermal design limit of 55 C conductor temperature. Loss of the Sedro Woolley-Rita 115 kV line will overload this line during LLH (light load hours, 2300-0600).

**Constraint Mitigation:** Uprate the March Point-Beaver Lake 115 kV line to 65C conductor temperature rating between Peth Corner Substation and the Hickox Tap; and, uprate the line section from the Hickox Tap to Mt. Vernon Substation to 60C conductor temperature rating.

**Constraint #4:** <u>WSNI and BPA's Transmission System</u>

**Discussion:** The study results show that there could be a 173 MW reduction to the WSNI (north to south) Operational Transfer Capability ("OTC") after the addition of the proposed MPCC 50 MW generator.

**Note:** In addition to the impact on the WSNI OTC, the Study indicated that an additional 17.1 MW of power will move through BPA's transmission system after the addition of the MPCC 50 MW generator. This is the difference in power flow through the PSE Sedro Woolley 230 kV (connecting to BPA's Custer-SedroNT-Murray 230 kV line) before and after the MPCC 50 MW generator integration. This condition occurs with all lines in service.

**Constraint Mitigation:** PSE recommends that MPCC contact BPA, perhaps via an OASIS request, to get additional information regarding impacts of the MPCC 50 MW generation on the WSNI and on BPA's transmission system.

The Study concluded that with the existing transmission system and committed transfers the MPCC Requested Service cannot be accomplished. Local area network upgrades and resolution of the impacts on the WSNI and on BPA's transmission system are recommended.

There are no Direct Assignment Facilities associated with this request for Transmission Service.

## 1. Introduction

On December 27, 2000, March Point Cogeneration Company ("MPCC") submitted an OASIS request (Reference No. 130752) for 50 MW of long term Firm Point-to-Point Transmission Service from March Point's West Substation to the Mid-Columbia bus for the period September 1, 2001 through September 1, 2002, (the "Requested Service"). PSE determined that a System Impact Study (the "Study") would be required to evaluate the impact of the Requested Service on PSE's Transmission System. On or about January 19, 2001, the parties executed a System Impact Study Agreement. Power flow studies were performed to examine whether the MPCC transmission request could be accommodated while remaining in compliance with PSE, WSCC and NERC reliability criteria.

## 2. Study Criteria and Assumptions

The Study incorporated existing planning and operating criteria, standards and procedures in conformance with WSCC Reliability Criteria in order to determine necessary Transmission System reinforcements and re-dispatch requirements.

The Study included a number of individual power flow simulation studies (thermal) to determine the system capabilities with and without the 50 MW MPCC generator. The power flow simulation studies were conducted with the following assumptions and goals:

**Assumptions**

- Assume the proposed MPCC 50 MW generator will be running from September 1, 2001 through August 31, 2002.

- Assume all existing generation in Whatcom and Skagit Counties is on line.

- Assume the full WSCC accepted path rating for the Northwest-Canada Path #3 where up to 2,850 MW of power is flowing from BC Hydro's Ingledow Substation near Vancouver, B.C. toward BPA's Custer Substation near Ferndale, WA.

- Assume all equipment is in service; then run contingency analysis to determine system impacts

**Goals**

- Identify PSE's transmission constraints in Skagit and Whatcom Counties and any network upgrades

- Identify any constraints on the Westside Northern Intertie ("WSNI").

**Study Limitations**

Pursuant to PSE's Open Access Transmission Tariff ("OATT"), the Study is:

> "An assessment by the Transmission Provider of (i) the adequacy of the Transmission System to accommodate a request for either Firm Point-To-Point Transmission Service or Network Integration Transmission Service and (ii) whether any additional costs may be incurred in order to provide transmission service."

"Transmission System" is defined in the OATT as: "The facilities owned, controlled or operated by the Transmission Provider that are used to provide transmission service under Part II and Part III of the Tariff."

However, PSE noted in the System Impact Study Agreement that it would extend the scope of its Study to determine if there are impacts to the WSNI capacity and neighboring systems resulting from adding the proposed MPCC generation and the Study does that. BPA may not necessarily agree with PSE's analysis.

Lastly, there are a number of generation projects being added or proposed for addition by various parties in the Whatcom and Skagit county area, which could have a material impact on path ratings and transfer capabilities. The results of this Study are a snapshot in time and are based on the most current information and input assumptions available at the time the Study was conducted. Studies done at a later date will likely yield different conclusions.

### 3. Study Conditions

The power flow studies were conducted using a slightly modified version of the BPA summer 2000, spring 2000 and winter 2000-01 cases. These were the base cases used by both BPA and PSE Operations Planning staff during 2000. The base case was modified to reflect completed upgrade projects and changes to the areas industrial loads. The area loads (except customer-owned substation loads, which were held constant) were grown 1.5% per year for two years to reflect annual load growth. These modifications to the 2000 base cases were necessary to fulfill the requirement of being able to have the MPCC 50 MW generator run through its entire requested time period (September 1, 2001 to September 1, 2002).

The study conditions used the summer season base case. The summer season is one of the most restrictive times of year for the transmission system, and is one of the times when the transmission system is highly stressed. This is when the equipment ratings (capabilities) are at their minimums, the WSNI is being maximized (power flows from Canada to the U.S.) and when the Puget Sound area loads, including loads in the area of the proposed MPCC generation, are at their lowest.

## 4. Study Results

**Findings**

Adding the 50 MW of MPCC generation impacts both the local area PSE 115 kV transmission system and the bulk transmission main power grid which is owned and operated by BPA.

**Local Network Impacts**

Two local area 115 kV lines can thermally overload resulting from the original (1993-94) MPCC Phase 1 and Phase 2 projects. Adding the 50 MW of generation at Texaco West Substation increases the amount of these line overloads and creates a new line overload condition.

The two line overloads without the proposed new 50 MW's of generation are:

A. The 1.75 mile long Texaco East-March Point 115 kV line;

B. The March Point – Beaver Lake 115 kV line from Peth Corner Substation to the Hickox Susbstation Tap (7.1 miles) and continuing on from the Hickox Tap to the Mt. Vernon Substation (2.64 miles)

The new line overload created by adding the proposed 50 MW generator is:

C. The 1.14 mile long Texaco West-March Point 115 kV line.

**Discussion of Local Network Impacts**

**A. Texaco East – March Point 115 kV Line**

This line consists of 1-1272 kcmil AAC rated at 55C conductor temperature. The Texaco East-March Point 115 kV line can overload today without the addition of the proposed MPCC 50 MW generator. Additional generation exacerbates the problem. (Contingency numbers shown below match those found in the Appendices.)

Existing System (2002 loads) Without the MPCC 50 MW Generator

Contingency #1: Loss of the Texaco West-March Point 115 kV line.
Local Area Impact: Thermally overloads the Texaco East-March Point 115 kV line – 177.5% of its emergency rating.

Contingency #36: Breaker failure at Sedro Woolley 230 kV Bus which causes loss of the Sedro Woolley 230-115 kV transformer and the BPA Custer-SedroNT-Murray 230 kV line.
Local Area Impact: Thermally overloads the Texaco East-March Point 115 kV line – 102.5% of its emergency rating.

Contingency #45: Line breaker failure on the March Point south 115 kV Bus.
Local Area Impact: Thermally overloads the Texaco East-March Point 115 kV line – 157.8% of its emergency rating.

Contingency #376: Loss of the Sedro Woolley 230-115 kV transformer.
Local Area Impact: Thermally overloads the Texaco East-March Point 115 kV line – 100.4% of its emergency rating.

Existing System With the MPCC 50 MW Generator

Contingency #1: Loss of the Texaco West-March Point 115 kV line
Local Area Impact: Thermally overloads the Texaco East-March Point 115 kV line – 201.8% of its emergency rating.

Contingency #36: Breaker failure at Sedro Woolley 230 kV Bus which causes loss of the Sedro Woolley 230-115 kV transformer and the BPA Custer-SedroNT-Murray 230 kV line.
Local Area Impact: Thermally overloads the Texaco East-March Point 115 kV line – 106.3% of its emergency rating.

Contingency #45: Line breaker failure on the March Point south 115 kV Bus
Local Area Impact: Thermally overloads the Texaco East-March Point 115 kV line – 175.6% of its emergency rating.

Contingency #58: Loss of the Rita-Burlington 115 kV line section.
Local Area Impact: Thermally overloads the Texaco East-March Point 115 kV line – 103.6% of its emergency rating.

Contingency #376: Loss of the Sedro Woolley 230-115 kV transformer.
Local Area Impact: Thermally overloads the Texaco East-March Point 115 kV line – 104.5% of its emergency rating.

Contingency #381: Loss of the Sedro Woolley-Rita 115 kV line section.
Local Area Impact: Thermally overloads the Texaco East-March Point 115 kV line – 102.7% of its emergency rating.

**B. March Point – Beaver Lake 115 kV Line**

These line sections consists of 1-795 kcmil ACSR rated at 55C conductor temperature. The March Point-Beaver Lake 115 kV line can overload today without the addition of the proposed MPCC 50 MW generator. Additional generation exacerbates the problem. Moreover, the addition of the MPCC 50 MW generator causes this line to overload for other contingencies that do not occur without the 50 MW generator.

Contingency #39: Breaker failure at Sedro Woolley 230 kV Bus which causes loss of the Sedro Woolley 230-115 kV transformer and the Sedro-Hranch-SCL Bothell 230 kV line.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| **March Pt-Beaver Lake 115 kV Line Section Name** | **Without MPCC 50 MW Generation % of Line Emergency Rating** | **After 50 MW Generation** |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | 114.1% | 121% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | 107.9 | 114.7 |
| Mt.Vernon-Big Rock, 2.7 mi. | 97.4 | 104.2 |

Contingency #382: Open Sedro-HRTap-SCL Bothell line on the Sedro Woolley Substation end.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| **March Pt-Beaver Lake 115 kV Line Section Name** | **Without MPCC 50 MW Generation % of Line Emergency Rating** | **After 50 MW Generation** |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | 104.4% | 110.4% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | (below 90%) | 104.2 |

Contingency #36: Breaker failure at Sedro Woolley 230 kV Bus which causes loss of the Sedro Woolley 230-115 kV transformer and the BPA Custer-SedroNT-Murray 230 kV line.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| **March Pt-Beaver Lake 115 kV Line Section Name** | **Without MPCC 50 MW Generation % of Line Emergency Rating** | **After 50 MW Generation** |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | 106% | 112.9% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | 99.8 | 106.6 |

Contingency #37: Breaker failure at Sedro Woolley 230 kV Bus which causes loss of the Sedro Woolley-March Point 230 kV line and the BPA Custer-SedroNT-Murray 230 kV line.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | Without MPCC 50 MW Generation % of Line Emergency Rating | After 50 MW Generation |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | 103.1% | 112.1% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | 96.9 | 105.8 |

Contingency #46: Single line loss of the Sedro-Hranch-SCL Bothell 230 kV line – all 3-legs.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | Without MPCC 50 MW Generation % of Line Emergency Rating | After 50 MW Generation |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | 104.2% | 110.2% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | 98.1 | 103.9 |

Contingency #47: Double circuit line loss of both the Sedro-Hranch-SCL Bothell 230 kV line and the SCL Bothell-Sammamish 230 kV line.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | Without MPCC 50 MW Generation % of Line Emergency Rating | After 50 MW Generation |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | 104.0% | 110.0% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | 98.0 | 103.8 |

Contingency #48: Breaker failure causing the loss of the BPA Murray 230 kV bus.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| | Without MPCC 50 MW | After 50 MW |
|---|---|---|

| March Pt-Beaver Lake 115 kV Line Section Name | Generation % of Line Emergency Rating | Generation |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | 100.5% | 106.2% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | 94.4 | 100.0 |

Contingency #51: Breaker failure at the PSE Horseranch 230 kV Substation.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | Without MPCC 50 MW Generation % of Line Emergency Rating | After 50 MW Generation |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | 108.4% | 114.3% |
| Hickox Tap-Mt. Vernon, 2.7 mi. | 102.2 | 108.1 |
| Mt. Vernon-Big Rock, 2.7 mi. | 91.7 | 97.5 |

Contingency #259 and #260: Loss of the Sedro-March Pt 230 kV line or Mt. Point 230-115 kV transformer.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | Without MPCC 50 MW Generation % of Line Emergency Rating | After 50 MW Generation |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | (less than 90%) | 100.2% |

Contingency #376: Loss of the Sedro Woolley Substation 230-115 kV transformer.
Local Area Impact: Thermally overloads the March Point-Beaver Lake 115 kV line.

| March Pt-Beaver Lake 115 kV Line Section Name | Without MPCC 50 MW Generation % of Line Emergency Rating | After 50 MW Generation |
|---|---|---|
| Peth Corner-Hickox Tap, 7.1 mi. | (less than 90%) | 101.3% |

### C. <u>Texaco West - March Point 115 kV line</u>

This 1.14-mile line consists of 1-1272 kcmil AAC rated at 100C conductor temperature.

Contingency #266: Open the Texaco East Substation end of the Texaco East-March Point 115 kV line.
Local Area Impact: Thermally overloads the Texaco West-March Point 115 kV line – 108% of its emergency rating.

Contingency #43: Line breaker failure on the March Point East 115 kV Bus.
Local Area Impact: Thermally overloads the Texaco West-March Point 115 kV line – 108% of its emergency rating.

The effects of less Puget Sound area loads (LLH, Light Load Hour) were also studied to see if the addition of the MPCC generator would create additional problems or worsen the ones found above. No new line sections (not already identified in the HLH studies) were found and many of those identified with the heavier load level were reduced. Loss of either the BPA Custer-Monroe #1 500 kV line or PSE Sedro-Rita 115 kV line could overload the March Point-Beaver Lake line between Peth Corner and the Hickox Tap (102.1% and 105.6%, respectively) which did not occur at the heavier load levels.

### <u>Discussion of Non-PSE; Neighboring Systems; Main Grid Network Impacts</u>

The power flow study results indicate impacts on BPA's 230 kV system. It appears that there are contingencies that will cause the BPA SedroNT-Murray 230 kV line to overload. Some of these contingencies do not cause line overloads today (without the MPCC generator). There are other contingencies that can cause the BPA line(s) to overload even in today's system, but overloads of this particular line increase with the addition of the MPCC generator.

Today's limiting facility (i.e., constraint) that restricts WSNI OTC is the same line that will be forced to carry some of the additional power of the proposed MPCC generator. If the WSNI path is to be used to protect the SedroNT-Murray 230 kV line from overloading (so the MPCC generation can run) the analysis in this Study indicates that the WSNI OTC would have to be restricted by 173.3 MW's. A power flow comparison (before and after the 50 MW generation addition) showed that 17.1 MW's of additional power flowed into BPA's transmission system over the Sedro Woolley-Sedro NT 230 kV line after the addition of the generator.

## 5. Conclusions and Recommendations

### Conclusions

The Study indicates that with the existing transmission system and WSCC accepted path rating(s) for the WSNI (WSCC Path #3), the Requested Service cannot be accommodated. There are impacts to: (a) the local area transmission system, (b) the WSNI (joint ownership) and (c) BPA's transmission system. The local area facilities impacted involve power flows (resulting from contingencies) exceeding their thermal design limits. These facilities (three transmission lines) can probably be upgraded to higher capacities.

The non-PSE owned (BPA) facilities impacted involve: (a) some of the MPCC generator power using BPA transmission system, and (b) power flows (resulting from contingencies) on BPA's SedroNT-Murray 230 kV line exceeding its design limit and thus limiting the WSNI (WSCC Path #3). The SedroNT-Murray 230 kV line may already be at BPA's maximum desired capacity rating.

Higher Puget Sound area loads would appear to cause the line overloads shown from the power flow studies to become worse. This conclusion is based on the power flow comparison of heavier load base case results versus the lighter-load base case results.

### Recommendations

**PSE Facilities (Local Area Network)**

Complete the following upgrades.

| Overloads | Proposed System Upgrade |
|---|---|
| Texaco West-March Pt 115 kV | Reconductor with 1-1590 kcmil ACSR, Lapwing 100C, 1.2 mi. |
| Texaco East-March Pt 115 kV | Reconductor with 1-1590 kcmil ACSR, Lapwing 100C, 1.7 mi. |
| Beaver Lake-March Pt 115 kV | |
| A) PethCrn-HickoxTap | Upgrade to 65C from 55C, 7.08 mi. |
| B) Hickox Tap-Mt. Vernon | Upgrade to 60C from 55C, 2.64 mi. |

**BPA Facilities (Main Grid; Neighboring Systems)**

1. Contact BPA's Transmission Business Line (TBL). PSE will have to be notified by BPA that MPCC has obtained BPA transmission capacity for use of BPA's system.

2. Contact BPA's TBL. PSE will have to be notified by BPA that WSNI OTC has been restored.

# APPENDIX A

## Contingency Analysis Detailed Report

```
*** MUST 4.00  ***  MON, MAR 05 2001  11:51 ***
     02HSNS02 BCH=2850/300 WASK=1123,SCL=100, INDUSTRIAL LD ADJ. .
     ALL WA/SK GEN ON - BASE CASE MPCC 50 MW GEN. Not Running
Subsys.File D:\Summer-2000\subni-us.sub
Monit.File  D:\Summer-2000\monzonepsregion-MPCC.mon
Contin.File D:\Summer-2000\contzonepsregion-fredonia.con
Exclud.File none

 Detailed report on selected contingencies. Total  465. Selected    7
 --------------------------------------------------------------------

Study transfer not defined


 ******* Contingency     1 SLTEXWMPT115


 Branches with  MW flow  more than     90.0 % of nominal rating
**    From bus    ** **    To bus    ** CKT InitFlow   Rating IntLd% BaseFlow
21250 MARCHPT  115 22150 PADILTAP 115 1    -250.2     143.0  174.9   -107.1
22150 PADILTAP 115 21439 TEXACO E 115 1    -253.8     143.0  177.5   -110.8


 ******* Contingency    15 20026 BAKER SW 115 20448 SEDRO    115 1


 Branches with  MW flow  more than     90.0 % of nominal rating
**    From bus    ** **    To bus    ** CKT InitFlow   Rating IntLd% BaseFlow
20448 SEDRO    115 20026 BAKER SW 115 2    -119.1      98.0  121.5    -59.0


 ******* Contingency    16 20026 BAKER SW 115 20448 SEDRO    115 2


 Branches with  MW flow  more than     90.0 % of nominal rating
**    From bus    ** **    To bus    ** CKT InitFlow   Rating IntLd% BaseFlow
20448 SEDRO    115 20026 BAKER SW 115 1    -119.1      98.0  121.5    -60.1
```

******* Contingency 256 21249 LYNDEN 115 22272 SCHUETT 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|
| 21438 SUMAS CG | 115 21239 | KENDALL | 115 1 | 101.7 | 46.0 | 221.2 | 32.6 |
| 22113 NUGENT | 115 21239 | KENDALL | 115 1 | -97.7 | 46.0 | 212.4 | -28.6 |

******* Contingency 376 20448 SEDRO 115 20449 SEDRO 230 1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|
| 21870 HICKOX T | 115 22163 | PETHCORN | 115 1 | -104.5 | 110.0 | 95.0 | -90.0 |
| 21250 MARCHPT | 115 22150 | PADILTAP | 115 1 | -140.0 | 143.0 | 97.9 | -107.1 |
| 22150 PADILTAP | 115 21439 | TEXACO E | 115 1 | -143.6 | 143.0 | 100.4 | -110.8 |

******* Contingency 382 20449 SEDRO 230 23097 HRNCHTAP 230 1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|
| 21870 HICKOX T | 115 22057 | MTVERNON | 115 1 | 108.1 | 110.0 | 98.3 | 83.3 |
| 21870 HICKOX T | 115 22163 | PETHCORN | 115 1 | -114.9 | 110.0 | 104.4 | -90.0 |
| 20330 MURRAY | 230 21282 | SEDRO NT | 230 1 | -506.8 | 426.3 | 118.9 | -330.3 |

******* Contingency 409 21438 SUMAS CG 115 22272 SCHUETT 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|
| 22443 VANWYCK | 115 21595 | BRITTON | 115 1 | 102.1 | 109.0 | 93.7 | 22.9 |
| 21438 SUMAS CG | 115 21239 | KENDALL | 115 1 | 111.9 | 46.0 | 243.3 | 32.6 |
| 22113 NUGENT | 115 21239 | KENDALL | 115 1 | -107.9 | 46.0 | 234.5 | -28.6 |
| 22113 NUGENT | 115 22443 | VANWYCK | 115 1 | 104.1 | 109.0 | 95.5 | 24.8 |

# APPENDIX B

## Contingency Analysis Detailed Report

```
*** MUST 4.00  ***  MON, MAR 05 2001  11:15 ***
    02HSNS02 BCH=2850/300 WASK=1173,SCL=100, INDUSTRIAL LD ADJ.
    ALL WA/SK GEN ON - BASE CASE MPCC 50 MW GEN. IN SERVICE
Subsys.File D:\Summer-2000\subni-us.sub
Monit.File  D:\Summer-2000\monzonepsregion-MPCC.mon
Contin.File D:\Summer-2000\contzonepsregion-fredonia.con
Exclud.File none

Detailed report on selected contingencies. Total  465. Selected   12
--------------------------------------------------------------------

Study transfer not defined


******* Contingency     1 SLTEXWMPT115


Branches with  MW flow  more than     90.0 % of nominal rating
**    From bus    ** **    To bus    ** CKT InitFlow    Rating IntLd% BaseFlow
21250 MARCHPT   115 22150 PADILTAP 115 1    -284.9     143.0  199.2   -110.3
22150 PADILTAP 115 21439 TEXACO E 115 1    -288.6     143.0  201.8   -114.0


******* Contingency    15 20026 BAKER SW 115 20448 SEDRO     115 1


Branches with  MW flow  more than     90.0 % of nominal rating
**    From bus    ** **    To bus    ** CKT InitFlow    Rating IntLd% BaseFlow
20448 SEDRO     115 20026 BAKER SW 115 2    -119.1      98.0  121.5    -59.0


******* Contingency    16 20026 BAKER SW 115 20448 SEDRO     115 2


Branches with  MW flow  more than     90.0 % of nominal rating
**    From bus    ** **    To bus    ** CKT InitFlow    Rating IntLd% BaseFlow
20448 SEDRO     115 20026 BAKER SW 115 1    -119.1      98.0  121.5    -60.1


******* Contingency    58 21607 BURLIGTN 115 23004 RITA      115 1
```

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** ** To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|
| 21870 HICKOX T 115 | 22163 PETHCORN 115 | 1 | -101.2 | 110.0 | 92.0 | -95.8 |
| 21250 MARCHPT 115 | 22150 PADILTAP 115 | 1 | -144.5 | 143.0 | 101.1 | -110.3 |
| 22150 PADILTAP 115 | 21439 TEXACO E 115 | 1 | -148.2 | 143.0 | 103.6 | -114.0 |

******* Contingency 256 21249 LYNDEN 115 22272 SCHUETT 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** ** To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|
| 21438 SUMAS CG 115 | 21239 KENDALL 115 | 1 | 101.7 | 46.0 | 221.2 | 32.3 |
| 22113 NUGENT 115 | 21239 KENDALL 115 | 1 | -97.7 | 46.0 | 212.4 | -28.3 |

******* Contingency 259 20290 MARCH PT 230 20449 SEDRO 230 1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** ** To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|
| 21870 HICKOX T 115 | 22057 MTVERNON 115 | 1 | 103.3 | 110.0 | 93.9 | 89.0 |
| 21870 HICKOX T 115 | 22163 PETHCORN 115 | 1 | -110.2 | 110.0 | 100.1 | -95.8 |

******* Contingency 260 20290 MARCH PT 230 21250 MARCHPT 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** ** To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|
| 21870 HICKOX T 115 | 22057 MTVERNON 115 | 1 | 103.4 | 110.0 | 94.0 | 89.0 |
| 21870 HICKOX T 115 | 22163 PETHCORN 115 | 1 | -110.3 | 110.0 | 100.2 | -95.8 |

******* Contingency 266 21250 MARCHPT 115 22150 PADILTAP 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** ** To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|
| 21250 MARCHPT 115 | 21440 TEX_WEST 115 | 1 | -286.0 | 264.9 | 108.0 | -186.3 |

******* Contingency 376 20448 SEDRO 115 20449 SEDRO 230 1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** ** To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|
| 21870 HICKOX T 115 | 22057 MTVERNON 115 | 1 | 104.6 | 110.0 | 95.1 | 89.0 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -111.5 | 110.0 | 101.3 | -95.8 |
| 21250 | MARCHPT | 115 | 22150 | PADILTAP | 115 | 1 | -145.7 | 143.0 | 101.9 | -110.3 |
| 22150 | PADILTAP | 115 | 21439 | TEXACO E | 115 | 1 | -149.4 | 143.0 | 104.5 | -114.0 |

******* Contingency 381 20448 SEDRO 115 23004 RITA 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -101.0 | 110.0 | 91.8 | -95.8 |
| 21250 | MARCHPT | 115 | 22150 | PADILTAP | 115 | 1 | -143.2 | 143.0 | 100.2 | -110.3 |
| 22150 | PADILTAP | 115 | 21439 | TEXACO E | 115 | 1 | -146.9 | 143.0 | 102.7 | -114.0 |

******* Contingency 382 20449 SEDRO 230 23097 HRNCHTAP 230 1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21563 | BIGROCK | 115 | 22057 | MTVERNON | 115 | 1 | -103.0 | 110.0 | 93.6 | -77.3 |
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 114.6 | 110.0 | 104.2 | 89.0 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -121.5 | 110.0 | 110.4 | -95.8 |
| 20330 | MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -521.5 | 426.3 | 122.3 | -339.5 |

******* Contingency 409 21438 SUMAS CG 115 22272 SCHUETT 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 22443 | VANWYCK | 115 | 21595 | BRITTON | 115 | 1 | 102.2 | 109.0 | 93.7 | 22.6 |
| 21438 | SUMAS CG | 115 | 21239 | KENDALL | 115 | 1 | 111.9 | 46.0 | 243.3 | 32.3 |
| 22113 | NUGENT | 115 | 21239 | KENDALL | 115 | 1 | -107.9 | 46.0 | 234.6 | -28.3 |
| 22113 | NUGENT | 115 | 22443 | VANWYCK | 115 | 1 | 104.1 | 109.0 | 95.5 | 24.5 |

# APPENDIX C

## Contingency Analysis Detailed Report

*** MUST 4.00 *** MON, MAR 05 2001 15:03 ***
02HSNS02 BCH=2850/300 WASK=1173,SCL=100, INDUSTRIAL LD ADJ.
ALL WA/SK GEN ON - BASE CASE MPCC 50 MW GEN. Not Running
Subsys.File D:\Summer-2000\subni-us.sub
Monit.File D:\Summer-2000\monzonepsregion-MPCC.mon
Contin.File D:\Summer-2000\NI-ALL.con
Exclud.File none

Detailed report on selected contingencies. Total 77. Selected 13

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Study transfer not defined

******* Contingency 5 BKFINGCUS1M1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | | ** ** To bus | | | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 102.5 | 110.0 | 93.2 | 83.3 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -109.3 | 110.0 | 99.3 | -90.0 |
| 20330 | MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -446.0 | 426.3 | 104.6 | -330.3 |
| 20449 | SEDRO | 230 | 23097 | HRNCHTAP | 230 | 1 | 579.6 | 638.2 | 90.8 | 422.7 |

******* Contingency 22 BKRPWAYLYNN

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | | ** ** To bus | | | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21438 | SUMAS CG | 115 | 21239 | KENDALL | 115 | 1 | 101.7 | 46.0 | 221.2 | 32.6 |
| 22113 | NUGENT | 115 | 21239 | KENDALL | 115 | 1 | -97.7 | 46.0 | 212.4 | -28.6 |

******* Contingency 24 BKRPWAY115S

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | | ** ** To bus | | | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21541 | BAKERVUE | 115 | 21941 | LABOUNTY | 115 | 1 | -129.5 | 129.1 | 100.3 | -77.2 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21541 | BAKERVUE | 115 | 22179 | PLYMOUTH | 115 | 1 | 114.5 | 110.0 | 104.1 | 62.2 |
| 20039 | BELNGM P | 115 | 22179 | PLYMOUTH | 115 | 1 | -101.6 | 110.0 | 92.3 | -49.2 |
| 21438 | SUMAS CG | 115 | 21239 | KENDALL | 115 | 1 | 43.8 | 46.0 | 95.3 | 32.6 |

******* Contingency 25 BKRPWAYVISS

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** CKT | | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21541 | BAKERVUE | 115 | 21941 | LABOUNTY | 115 | 1 | -128.6 | 129.1 | 99.6 | -77.2 |
| 21541 | BAKERVUE | 115 | 22179 | PLYMOUTH | 115 | 1 | 113.7 | 110.0 | 103.3 | 62.2 |
| 20039 | BELNGM P | 115 | 22179 | PLYMOUTH | 115 | 1 | -100.7 | 110.0 | 91.6 | -49.2 |
| 21438 | SUMAS CG | 115 | 21239 | KENDALL | 115 | 1 | 43.5 | 46.0 | 94.5 | 32.6 |

******* Contingency 35 BKFSEDBOTBHM

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** CKT | | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 102.5 | 110.0 | 93.2 | 83.3 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -109.2 | 110.0 | 99.3 | -90.0 |
| 20330 | MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -455.5 | 426.3 | 106.9 | -330.3 |

******* Contingency 36 BKFSEDTXCUSM

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** CKT | | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 109.8 | 110.0 | 99.8 | 83.3 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -116.6 | 110.0 | 106.0 | -90.0 |
| 21250 | MARCHPT | 115 | 22150 | PADILTAP | 115 | 1 | -142.8 | 143.0 | 99.9 | -107.1 |
| 22150 | PADILTAP | 115 | 21439 | TEXACO E | 115 | 1 | -146.5 | 143.0 | 102.5 | -110.8 |

******* Contingency 37 BKFMPTTXCUSM

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** CKT | | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 106.6 | 110.0 | 96.9 | 83.3 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -113.4 | 110.0 | 103.1 | -90.0 |

******* Contingency 39 BKFSEDTXHRBO

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus ** | ** To bus ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|
| 21529 ARLNGTON 115 | 20033 BEAVERLK 115 | 1 | -100.5 | 110.0 | 91.4 | -65.1 |
| 20033 BEAVERLK 115 | 21563 BIGROCK 115 | 1 | -100.7 | 110.0 | 91.5 | -65.2 |
| 21563 BIGROCK 115 | 22057 MTVERNON 115 | 1 | -107.1 | 110.0 | 97.4 | -71.6 |
| 21870 HICKOX T 115 | 22057 MTVERNON 115 | 1 | 118.7 | 110.0 | 107.9 | 83.3 |
| 21870 HICKOX T 115 | 22163 PETHCORN 115 | 1 | -125.5 | 110.0 | 114.1 | -90.0 |
| 21250 MARCHPT 115 | 22150 PADILTAP 115 | 1 | -135.8 | 143.0 | 95.0 | -107.1 |
| 20330 MURRAY 230 | 21282 SEDRO NT 230 | 1 | -483.4 | 426.3 | 113.4 | -330.3 |
| 22150 PADILTAP 115 | 21439 TEXACO E 115 | 1 | -139.5 | 143.0 | 97.6 | -110.8 |

******* Contingency 45 BKRMARPTS115

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus ** | ** To bus ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|
| 21870 HICKOX T 115 | 22163 PETHCORN 115 | 1 | -99.4 | 110.0 | 90.4 | -90.0 |
| 21250 MARCHPT 115 | 22150 PADILTAP 115 | 1 | -222.0 | 143.0 | 155.2 | -107.1 |
| 22150 PADILTAP 115 | 21439 TEXACO E 115 | 1 | -225.6 | 143.0 | 157.8 | -110.8 |

******* Contingency 46 SLSEDROHRBOT

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus ** | ** To bus ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|
| 21870 HICKOX T 115 | 22057 MTVERNON 115 | 1 | 107.9 | 110.0 | 98.1 | 83.3 |
| 21870 HICKOX T 115 | 22163 PETHCORN 115 | 1 | -114.6 | 110.0 | 104.2 | -90.0 |
| 20330 MURRAY 230 | 21282 SEDRO NT 230 | 1 | -503.0 | 426.3 | 118.0 | -330.3 |

******* Contingency 47 DCBOTSAMSEDH

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus ** | ** To bus ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|
| 21870 HICKOX T 115 | 22057 MTVERNON 115 | 1 | 107.7 | 110.0 | 97.9 | 83.3 |
| 21870 HICKOX T 115 | 22163 PETHCORN 115 | 1 | -114.4 | 110.0 | 104.0 | -90.0 |
| 20330 MURRAY 230 | 21282 SEDRO NT 230 | 1 | -496.8 | 426.3 | 116.5 | -330.3 |

******* Contingency 48 BUSMURRAY230

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus ** | ** To bus ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|
| 21870 HICKOX T 115 | 22057 MTVERNON 115 | 1 | 103.8 | 110.0 | 94.4 | 83.3 |
| 21870 HICKOX T 115 | 22163 PETHCORN 115 | 1 | -110.5 | 110.0 | 100.5 | -90.0 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 20449 | SEDRO | 230 | 23097 | HRNCHTAP | 230 | 1 | 582.7 | 638.2 | 91.3 | 422.7 |

******* Contingency 51 BKFHRSUB

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** | ** | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21563 | BIGROCK | 115 | 22057 | MTVERNON | 115 | 1 | -100.8 | 110.0 | 91.7 | -71.6 |
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 112.5 | 110.0 | 102.2 | 83.3 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -119.2 | 110.0 | 108.4 | -90.0 |
| 20330 | MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -540.3 | 426.3 | 126.8 | -330.3 |

# APPENDIX D

## Contingency Analysis Detailed Report

```
*** MUST 4.00  ***  MON, MAR 05 2001  15:09 ***
    02HSNS02 BCH=2850/300 WASK=1173,SCL=100, INDUSTRIAL LD ADJ.
    ALL WA/SK GEN ON - BASE CASE MPCC 50 MW GEN. IN SERVICE
Subsys.File D:\Summer-2000\subni-us.sub
Monit.File  D:\Summer-2000\monzonepsregion-MPCC.mon
Contin.File D:\Summer-2000\NI-ALL.con
Exclud.File none

 Detailed report on selected contingencies. Total   77. Selected   18
 ---------------------------------------------------------------

Study transfer not defined


 ******* Contingency     5 BKFINGCUS1M1


 Branches with  MW flow  more than     90.0 % of nominal rating
**    From bus    ** **    To bus    ** CKT InitFlow    Rating IntLd% BaseFlow
21870 HICKOX T 115 22057 MTVERNON 115 1     108.4     110.0   98.5     89.0
21870 HICKOX T 115 22163 PETHCORN 115 1    -115.2     110.0  104.8    -95.8
20330 MURRAY   230 21282 SEDRO NT 230 1    -456.2     426.3  107.0   -339.5
20449 SEDRO    230 23097 HRNCHTAP 230 1     593.9     638.2   93.1    435.7


 ******* Contingency    22 BKRPWAYLYNN


 Branches with  MW flow  more than     90.0 % of nominal rating
**    From bus    ** **    To bus    ** CKT InitFlow    Rating IntLd% BaseFlow
21438 SUMAS CG 115 21239 KENDALL  115 1     101.7      46.0  221.2     32.3
22113 NUGENT   115 21239 KENDALL  115 1     -97.7      46.0  212.4    -28.3


 ******* Contingency    24 BKRPWAY115S


 Branches with  MW flow  more than     90.0 % of nominal rating
**    From bus    ** **    To bus    ** CKT InitFlow    Rating IntLd% BaseFlow
21541 BAKERVUE 115 21941 LABOUNTY 115 1    -129.1     129.1  100.0    -76.1
21541 BAKERVUE 115 22179 PLYMOUTH 115 1     114.1     110.0  103.8     61.2
```

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20039 | BELNGM P | 115 | 22179 | PLYMOUTH | 115 | 1 | -101.2 | 110.0 | 92.0 | -48.2 |
| 21438 | SUMAS CG | 115 | 21239 | KENDALL | 115 | 1 | 43.7 | 46.0 | 94.9 | 32.3 |

******* Contingency 25 BKRPWAYVISS

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21541 | BAKERVUE | 115 | 21941 | LABOUNTY | 115 | 1 | -128.2 | 129.1 | 99.3 | -76.1 |
| 21541 | BAKERVUE | 115 | 22179 | PLYMOUTH | 115 | 1 | 113.3 | 110.0 | 103.0 | 61.2 |
| 20039 | BELNGM P | 115 | 22179 | PLYMOUTH | 115 | 1 | -100.3 | 110.0 | 91.2 | -48.2 |
| 21438 | SUMAS CG | 115 | 21239 | KENDALL | 115 | 1 | 43.3 | 46.0 | 94.2 | 32.3 |

******* Contingency 26 SLCUSSEDMUR

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 103.7 | 110.0 | 94.3 | 89.0 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -110.6 | 110.0 | 100.5 | -95.8 |

******* Contingency 28 BKFCUSMURPWY

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 107.6 | 110.0 | 97.8 | 89.0 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -114.4 | 110.0 | 104.0 | -95.8 |
| 20449 | SEDRO | 230 | 23097 | HRNCHTAP | 230 | 1 | 576.3 | 638.2 | 90.3 | 435.7 |

******* Contingency 29 BKFCUSMURIN2

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 103.7 | 110.0 | 94.3 | 89.0 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -110.6 | 110.0 | 100.5 | -95.8 |

******* Contingency 35 BKFSEDBOTBHM

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 109.2 | 110.0 | 99.3 | 89.0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -116.1 | 110.0 | 105.5 | -95.8 |
| 20330 | MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -472.7 | 426.3 | 110.9 | -339.5 |

******* Contingency 36 BKFSEDTXCUSM

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21529 | ARLNGTON | 115 | 20033 | BEAVERLK | 115 | 1 | -99.1 | 110.0 | 90.1 | -70.7 |
| 20033 | BEAVERLK | 115 | 21563 | BIGROCK | 115 | 1 | -99.2 | 110.0 | 90.2 | -70.9 |
| 21563 | BIGROCK | 115 | 22057 | MTVERNON | 115 | 1 | -105.7 | 110.0 | 96.1 | -77.3 |
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 117.3 | 110.0 | 106.6 | 89.0 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -124.2 | 110.0 | 112.9 | -95.8 |
| 21250 | MARCHPT | 115 | 22150 | PADILTAP | 115 | 1 | -148.3 | 143.0 | 103.7 | -110.3 |
| 22150 | PADILTAP | 115 | 21439 | TEXACO E | 115 | 1 | -152.0 | 143.0 | 106.3 | -114.0 |

******* Contingency 37 BKFMPTTXCUSM

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21563 | BIGROCK | 115 | 22057 | MTVERNON | 115 | 1 | -104.8 | 110.0 | 95.2 | -77.3 |
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 116.4 | 110.0 | 105.8 | 89.0 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -123.3 | 110.0 | 112.1 | -95.8 |

******* Contingency 39 BKFSEDTXHRBO

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | To bus | | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21529 | ARLNGTON | 115 | 20033 | BEAVERLK | 115 | 1 | -108.0 | 110.0 | 98.1 | -70.7 |
| 20033 | BEAVERLK | 115 | 21563 | BIGROCK | 115 | 1 | -108.1 | 110.0 | 98.3 | -70.9 |
| 21529 | ARLNGTON | 115 | 21187 | BEVERLY | 115 | 1 | 106.0 | 110.0 | 96.4 | 68.8 |
| 21563 | BIGROCK | 115 | 22057 | MTVERNON | 115 | 1 | -114.6 | 110.0 | 104.2 | -77.3 |
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 126.2 | 110.0 | 114.7 | 89.0 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -133.1 | 110.0 | 121.0 | -95.8 |
| 21250 | MARCHPT | 115 | 22150 | PADILTAP | 115 | 1 | -141.5 | 143.0 | 98.9 | -110.3 |
| 20330 | MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -496.2 | 426.3 | 116.4 | -339.5 |
| 22150 | PADILTAP | 115 | 21439 | TEXACO E | 115 | 1 | -145.2 | 143.0 | 101.5 | -114.0 |

******* Contingency 43 BKRMARPTE115

Branches with MW flow more than 90.0 % of nominal rating

** From bus ** ** To bus ** CKT InitFlow Rating IntLd% BaseFlow

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21250 | MARCHPT | 115 | 21440 | TEX_WEST | 115 | 1 | -286.0 | 264.9 | 108.0 | -186.3 |

******* Contingency 45 BKRMARPTS115

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 101.6 | 110.0 | 92.3 | 89.0 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -108.4 | 110.0 | 98.6 | -95.8 |
| 21250 | MARCHPT | 115 | 22150 | PADILTAP | 115 | 1 | -247.5 | 143.0 | 173.1 | -110.3 |
| 22150 | PADILTAP | 115 | 21439 | TEXACO E | 115 | 1 | -251.1 | 143.0 | 175.6 | -114.0 |

******* Contingency 46 SLSEDROHRBOT

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21563 | BIGROCK | 115 | 22057 | MTVERNON | 115 | 1 | -102.7 | 110.0 | 93.4 | -77.3 |
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 114.3 | 110.0 | 103.9 | 89.0 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -121.2 | 110.0 | 110.2 | -95.8 |
| 20330 | MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -517.6 | 426.3 | 121.4 | -339.5 |

******* Contingency 47 DCBOTSAMSEDH

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21563 | BIGROCK | 115 | 22057 | MTVERNON | 115 | 1 | -102.5 | 110.0 | 93.2 | -77.3 |
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 114.1 | 110.0 | 103.8 | 89.0 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -121.0 | 110.0 | 110.0 | -95.8 |
| 20330 | MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -511.4 | 426.3 | 120.0 | -339.5 |

******* Contingency 48 BUSMURRAY230

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 110.0 | 110.0 | 100.0 | 89.0 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -116.9 | 110.0 | 106.2 | -95.8 |
| 20449 | SEDRO | 230 | 23097 | HRNCHTAP | 230 | 1 | 600.2 | 638.2 | 94.0 | 435.7 |

******* Contingency 50 BKFMURCUSSED

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | | ** ** To bus | | | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 105.0 | 110.0 | 95.5 | 89.0 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -111.9 | 110.0 | 101.7 | -95.8 |

******* Contingency 51 BKFHRSUB

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | | ** ** To bus | | | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21529 | ARLNGTON | 115 | 20033 | BEAVERLK | 115 | 1 | -100.6 | 110.0 | 91.5 | -70.7 |
| 20033 | BEAVERLK | 115 | 21563 | BIGROCK | 115 | 1 | -100.8 | 110.0 | 91.6 | -70.9 |
| 21563 | BIGROCK | 115 | 22057 | MTVERNON | 115 | 1 | -107.2 | 110.0 | 97.5 | -77.3 |
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 118.9 | 110.0 | 108.1 | 89.0 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -125.7 | 110.0 | 114.3 | -95.8 |
| 20330 | MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -554.5 | 426.3 | 130.1 | -339.5 |

# APPENDIX E

## FCITC Single Study

```
*** MUST 4.00   ***  MON, MAR 05 2001  12:00 ***
    02HSNS02 BCH=2850/300 WASK=1173,SCL=100, INDUSTRIAL LD ADJ.
    ALL WA/SK GEN ON - BASE CASE MPCC 50 MW GEN. Not Running
Subsys.File D:\Summer-2000\subni-us.sub
Monit.File  D:\Summer-2000\monzonepsregion-MPCC.mon
Contin.File D:\WINTER00-01\NI-ALL.con
Exclud.File none

 Study transfer level -      100.0 MW. Total violations: 6
 First violation      -    -1265.4 MW.

Study transfer. From NIBCH          To NIPNW          . Transfer level -     100.0 MW


 Violations report ordered by transfer capability. Total      6 violations


    N     Export L: Limiting constraint
PTDF =Base Case Flow=                                         PreShift    MW        TDF
                C: Contingency description
Init    Final                                            Ncon   Flow   Rating              LODF
     1    2421.7 L:20330 MURRAY    230 21282 SEDRO NT 230 1      -540.3  -426.3 -0.09013          -
                C:BKFHRSUB                                  45
                  Open 20324 MONROE T 230 23107 HRTAP MS 230 1     NA
                  Open 20324 MONROE T 230 23107 HRTAP MS 230 2     NA
                  Open 20467 SNOHOMSH 230 23107 HRTAP MS 230 1
                  Open 20467 SNOHOMSH 230 23107 HRTAP MS 230 2                         0.45382 -
                  Open 21443 HORSRNCH 230 23107 HRTAP MS 230 1     NA                  0.45382 -
                  Open 20322 MONROE   230 20324 MONROE T 230 1
                  Open 20065 BOTHELL  230 23097 HRNCHTAP 230 1                         0.34113
                  Open 20449 SEDRO    230 23097 HRNCHTAP 230 1                         0.42400 -
                  Open 21443 HORSRNCH 230 23097 HRNCHTAP 230 1     NA                 -0.33821
     2    2768.7 L:20330 MURRAY    230 21282 SEDRO NT 230 1      -503.0  -426.3 -0.08356          -
                C:SLSEDROHRBOT                              40
                  Open 20065 BOTHELL  230 23097 HRNCHTAP 230 1                        -0.01405 -
                  Open 20449 SEDRO    230 23097 HRNCHTAP 230 1                        -0.42185
                  Open 21443 HORSRNCH 230 23097 HRNCHTAP 230 1                         0.07367
     3    2839.3 L:20330 MURRAY    230 21282 SEDRO NT 230 1      -496.8  -426.3 -0.08321          -
                C:DCBOTSAMSEDH                              41
                  Open 20065 BOTHELL  230 23097 HRNCHTAP 230 1                        -0.00681 -
                  Open 20449 SEDRO    230 23097 HRNCHTAP 230 1                        -0.42382
                  Open 21443 HORSRNCH 230 23097 HRNCHTAP 230 1                         0.07746
                  Open 20065 BOTHELL  230 20438 SAMMAMSH 230 &1                        0.03975
                  Open 20065 BOTHELL  230 20438 SAMMAMSH 230 &1                        0.03090
     4    3014.4 L:20330 MURRAY    230 21282 SEDRO NT 230 1      -483.4  -426.3 -0.08487          -
                C:BKFSEDTXHRBO                              39
```

```
          Open 20065 BOTHELL  230 23097 HRNCHTAP 230 1                          -0.01387 -
          Open 20449 SEDRO    230 23097 HRNCHTAP 230 1                          -0.43242
          Open 21443 HORSRNCH 230 23097 HRNCHTAP 230 1                           0.07290
          Open 20448 SEDRO    115 20449 SEDRO    230 1                           0.12508 -
5   3269.7 L:20330 MURRAY   230 21282 SEDRO NT 230 1    -455.5  -426.3 -0.07004          -
         C:BKFSEDBOTBHM                                35
          Open 20065 BOTHELL  230 23097 HRNCHTAP 230 1                          -0.01236 -
          Open 20449 SEDRO    230 23097 HRNCHTAP 230 1                          -0.48250
          Open 21443 HORSRNCH 230 23097 HRNCHTAP 230 1                           0.06440
          Open 20038 BELLNGHM 230 20449 SEDRO    230 1                           0.26851
6   3460.1 L:20330 MURRAY   230 21282 SEDRO NT 230 1    -446.0  -426.3 -0.08665          -
         C:BKFINGCUS1M1                                5
          Open  4058 ING500   500 20137 CUSTER W 500 1                           0.00359
          Open 20137 CUSTER W 500 20323 MONROE   500 &1                         -0.10055
          Open 20137 CUSTER W 500 20323 MONROE   500 &1                         -0.00659
```

# APPENDIX F

## FCITC Single Study

```
*** MUST 4.00   ***  MON, MAR 05 2001  12:04 ***
     02HSNS02 BCH=2850/300 WASK=1173,SCL=100, INDUSTRIAL LD ADJ.
     ALL WA/SK GEN ON - BASE CASE MPCC 50 MW GEN. IN SERVICE
 Subsys.File D:\Summer-2000\subni-us.sub
 Monit.File  D:\Summer-2000\monzonepsregion-MPCC.mon
 Contin.File D:\WINTER00-01\NI-ALL.con
 Exclud.File none

  Study transfer level -      100.0 MW. Total violations: 6
  First violation      -    -1438.5 MW.

 Study transfer. From NIBCH         To NIPNW         . Transfer level -    100.0 MW


  Violations report ordered by transfer capability. Total     6 violations


      N   Export L: Limiting constraint                          PreShift    MW       TDF          P'
Case Flow=
               C: Contingency description                     Ncon   Flow  Rating              LODF
Init   Final
   1   2248.4 L:20330 MURRAY    230 21282 SEDRO NT 230 1          -554.5  -426.3 -0.08909
              C:BKFHRSUB                                     45
                Open 20324 MONROE T 230 23107 HRTAP MS 230 1     NA
                Open 20324 MONROE T 230 23107 HRTAP MS 230 2     NA
                Open 20467 SNOHOMSH 230 23107 HRTAP MS 230 1
                Open 20467 SNOHOMSH 230 23107 HRTAP MS 230 2
                Open 21443 HORSRNCH 230 23107 HRTAP MS 230 1     NA
                Open 20322 MONROE   230 20324 MONROE T 230 1
                Open 20065 BOTHELL  230 23097 HRNCHTAP 230 1
                Open 20449 SEDRO    230 23097 HRNCHTAP 230 1
                Open 21443 HORSRNCH 230 23097 HRNCHTAP 230 1     NA
   2   2579.6 L:20330 MURRAY    230 21282 SEDRO NT 230 1          -517.6  -426.3 -0.08249
              C:SLSEDROHRBOT                                 40
                Open 20065 BOTHELL  230 23097 HRNCHTAP 230 1
                Open 20449 SEDRO    230 23097 HRNCHTAP 230 1
                Open 21443 HORSRNCH 230 23097 HRNCHTAP 230 1
   3   2651.2 L:20330 MURRAY    230 21282 SEDRO NT 230 1          -511.4  -426.3 -0.08213
              C:DCBOTSAMSEDH                                 41
                Open 20065 BOTHELL  230 23097 HRNCHTAP 230 1
                Open 20449 SEDRO    230 23097 HRNCHTAP 230 1
                Open 21443 HORSRNCH 230 23097 HRNCHTAP 230 1
                Open 20065 BOTHELL  230 20438 SAMMAMSH 230 &1
                Open 20065 BOTHELL  230 20438 SAMMAMSH 230 &1
   4   2854.2 L:20330 MURRAY    230 21282 SEDRO NT 230 1          -496.2  -426.3 -0.08392
```

```
        C:BKFSEDTXHRBO                                        39
          Open 20065 BOTHELL  230 23097 HRNCHTAP 230 1
          Open 20449 SEDRO    230 23097 HRNCHTAP 230 1
          Open 21443 HORSRNCH 230 23097 HRNCHTAP 230 1
          Open 20448 SEDRO    115 20449 SEDRO    230 1
5   3011.8 L:20330 MURRAY   230 21282 SEDRO NT 230 1       -472.7  -426.3 -0.06877
        C:BKFSEDBOTBHM                                        35
          Open 20065 BOTHELL  230 23097 HRNCHTAP 230 1
          Open 20449 SEDRO    230 23097 HRNCHTAP 230 1
          Open 21443 HORSRNCH 230 23097 HRNCHTAP 230 1
          Open 20038 BELLNGHM 230 20449 SEDRO    230 1
6   3338.9 L:20330 MURRAY   230 21282 SEDRO NT 230 1       -456.2  -426.3 -0.08591
        C:BKFINGCUS1M1                                        5
          Open  4058 ING500   500 20137 CUSTER W 500 1
          Open 20137 CUSTER W 500 20323 MONROE   500 &1
          Open 20137 CUSTER W 500 20323 MONROE   500 &1
```

# APPENDIX G

## Contingency Analysis Detailed Report

```
*** MUST 4.00  ***  MON, MAR 05 2001  12:20 ***
    02HSNS02 BCH=2850/300 WASK=1173,SCL=100, INDUSTRIAL LD ADJ.
    ALL WA/SK GEN ON - LLH CASE, MPCC 50 MW GEN. IN SERVICE
Subsys.File D:\Summer-2000\subni-us.sub
Monit.File  D:\Summer-2000\monzonepsregion-MPCC.mon
Contin.File D:\Summer-2000\contzonepsregion-fredonia.con
Exclud.File none

Detailed report on selected contingencies. Total  465. Selected   12
-------------------------------------------------------------------

Study transfer not defined


******* Contingency     1 SLTEXWMPT115


Branches with  MW flow  more than     90.0 % of nominal rating
**   From bus    ** **    To bus   ** CKT InitFlow    Rating IntLd% BaseFlow
21250 MARCHPT  115 22150 PADILTAP 115 1    -278.4     143.0  194.7   -106.2
22150 PADILTAP 115 21439 TEXACO E 115 1    -282.1     143.0  197.3   -109.9


******* Contingency    15 20026 BAKER SW 115 20448 SEDRO    115 1


Branches with  MW flow  more than     90.0 % of nominal rating
**   From bus    ** **    To bus   ** CKT InitFlow    Rating IntLd% BaseFlow
20448 SEDRO    115 20026 BAKER SW 115 2    -121.7      98.0  124.2    -60.3


******* Contingency    16 20026 BAKER SW 115 20448 SEDRO    115 2


Branches with  MW flow  more than     90.0 % of nominal rating
**   From bus    ** **    To bus   ** CKT InitFlow    Rating IntLd% BaseFlow
20448 SEDRO    115 20026 BAKER SW 115 1    -121.7      98.0  124.2    -61.4


******* Contingency    58 21607 BURLIGTN 115 23004 RITA     115 1
```

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|
| 21250 | MARCHPT 115 | 22150 | PADILTAP 115 | 1 | -148.2 | 143.0 | 103.7 | -106.2 |
| 22150 | PADILTAP 115 | 21439 | TEXACO E 115 | 1 | -151.9 | 143.0 | 106.2 | -109.9 |

******* Contingency 256 21249 LYNDEN 115 22272 SCHUETT 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|
| 21438 | SUMAS CG 115 | 21239 | KENDALL 115 | 1 | 104.8 | 46.0 | 227.7 | 31.4 |
| 22113 | NUGENT 115 | 21239 | KENDALL 115 | 1 | -101.8 | 46.0 | 221.2 | -28.4 |
| 22113 | NUGENT 115 | 22443 | VANWYCK 115 | 1 | 99.1 | 109.0 | 90.9 | 25.7 |

******* Contingency 259 20290 MARCH PT 230 20449 SEDRO 230 1

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|
| 21534 | AVON PMP 115 | 22494 | WILSN TP 115 | 1 | -134.2 | 143.0 | 93.9 | -83.7 |
| 21870 | HICKOX T 115 | 22057 | MTVERNON 115 | 1 | 105.2 | 110.0 | 95.6 | 87.2 |
| 21870 | HICKOX T 115 | 22163 | PETHCORN 115 | 1 | -110.2 | 110.0 | 100.1 | -92.2 |

******* Contingency 260 20290 MARCH PT 230 21250 MARCHPT 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|
| 21534 | AVON PMP 115 | 22494 | WILSN TP 115 | 1 | -134.6 | 143.0 | 94.1 | -83.7 |
| 21870 | HICKOX T 115 | 22057 | MTVERNON 115 | 1 | 105.3 | 110.0 | 95.7 | 87.2 |
| 21870 | HICKOX T 115 | 22163 | PETHCORN 115 | 1 | -110.3 | 110.0 | 100.3 | -92.2 |

******* Contingency 266 21250 MARCHPT 115 22150 PADILTAP 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** | From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|
| 21250 | MARCHPT 115 | 21440 | TEX_WEST 115 | 1 | -279.7 | 264.9 | 105.6 | -183.7 |

******* Contingency 376 20448 SEDRO 115 20449 SEDRO 230 1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|
| 21870 HICKOX T | 115 22057 | MTVERNON 115 | 1 | 104.7 | 110.0 | 95.2 | 87.2 |
| 21870 HICKOX T | 115 22163 | PETHCORN 115 | 1 | -109.7 | 110.0 | 99.7 | -92.2 |
| 21250 MARCHPT | 115 22150 | PADILTAP 115 | 1 | -145.9 | 143.0 | 102.0 | -106.2 |
| 22150 PADILTAP | 115 21439 | TEXACO E 115 | 1 | -149.5 | 143.0 | 104.6 | -109.9 |

******* Contingency 381 20448 SEDRO 115 23004 RITA 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|
| 21250 MARCHPT | 115 22150 | PADILTAP 115 | 1 | -147.3 | 143.0 | 103.0 | -106.2 |
| 22150 PADILTAP | 115 21439 | TEXACO E 115 | 1 | -151.0 | 143.0 | 105.6 | -109.9 |

******* Contingency 382 20449 SEDRO 230 23097 HRNCHTAP 230 1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|
| 21529 ARLNGTON | 115 20033 | BEAVERLK 115 | 1 | -100.0 | 110.0 | 91.0 | -74.4 |
| 20033 BEAVERLK | 115 21563 | BIGROCK 115 | 1 | -100.2 | 110.0 | 91.1 | -74.5 |
| 21563 BIGROCK | 115 22057 | MTVERNON 115 | 1 | -104.8 | 110.0 | 95.3 | -79.1 |
| 21870 HICKOX T | 115 22057 | MTVERNON 115 | 1 | 112.9 | 110.0 | 102.6 | 87.2 |
| 21870 HICKOX T | 115 22163 | PETHCORN 115 | 1 | -117.9 | 110.0 | 107.2 | -92.2 |
| 20330 MURRAY | 230 21282 | SEDRO NT 230 | 1 | -513.8 | 426.3 | 120.5 | -331.6 |

******* Contingency 409 21438 SUMAS CG 115 22272 SCHUETT 115 1

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | ** ** | To bus | ** CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|
| 22443 VANWYCK | 115 21595 | BRITTON 115 | 1 | 104.9 | 109.0 | 96.2 | 24.3 |
| 21438 SUMAS CG | 115 21239 | KENDALL 115 | 1 | 111.9 | 46.0 | 243.3 | 31.4 |
| 22113 NUGENT | 115 21239 | KENDALL 115 | 1 | -108.9 | 46.0 | 236.8 | -28.4 |
| 22113 NUGENT | 115 22443 | VANWYCK 115 | 1 | 106.2 | 109.0 | 97.5 | 25.7 |

**APPENDIX H**

# Contingency Analysis Detailed Report

```
 *** MUST 4.00  ***  MON, MAR 05 2001  15:12 ***
     02HSNS02 BCH=2850/300 WASK=1173,SCL=100, INDUSTRIAL LD ADJ.
     ALL WA/SK GEN ON - LLH CASE, MPCC 50 MW GEN. IN SERVICE
Subsys.File D:\Summer-2000\subni-us.sub
Monit.File  D:\Summer-2000\monzonepsregion-MPCC.mon
Contin.File D:\Summer-2000\NI-ALL.con
Exclud.File none

 Detailed report on selected contingencies. Total   77. Selected   15
 -------------------------------------------------------------------

Study transfer not defined


 ******* Contingency     5 BKFINGCUS1M1


 Branches with  MW flow  more than     90.0 % of nominal rating
**    From bus     ** **    To bus    ** CKT InitFlow    Rating IntLd% BaseFlow
21563 BIGROCK  115 22057 MTVERNON 115 1      -99.2     110.0   90.2    -79.1
21870 HICKOX T 115 22057 MTVERNON 115 1      107.3     110.0   97.6     87.2
21870 HICKOX T 115 22163 PETHCORN 115 1     -112.3     110.0  102.1    -92.2
20330 MURRAY   230 21282 SEDRO NT 230 1     -452.3     426.3  106.1   -331.6
20449 SEDRO    230 23097 HRNCHTAP 230 1      600.0     638.2   94.0    436.3


 ******* Contingency    22 BKRPWAYLYNN


 Branches with  MW flow  more than     90.0 % of nominal rating
**    From bus     ** **    To bus    ** CKT InitFlow    Rating IntLd% BaseFlow
21438 SUMAS CG 115 21239 KENDALL  115 1      104.8      46.0  227.7     31.4
22113 NUGENT   115 21239 KENDALL  115 1     -101.8      46.0  221.2    -28.4
22113 NUGENT   115 22443 VANWYCK  115 1       99.1     109.0   90.9     25.7


 ******* Contingency    24 BKRPWAY115S


 Branches with  MW flow  more than     90.0 % of nominal rating
**    From bus     ** **    To bus    ** CKT InitFlow    Rating IntLd% BaseFlow
21541 BAKERVUE 115 21941 LABOUNTY 115 1     -131.5     129.1  101.8    -72.3
```

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21541 | BAKERVUE | 115 | 22179 | PLYMOUTH | 115 | 1 | 120.9 | 110.0 | 109.9 | 61.7 |
| 20039 | BELNGM P | 115 | 22179 | PLYMOUTH | 115 | 1 | -111.8 | 110.0 | 101.6 | -52.7 |
| 21438 | SUMAS CG | 115 | 21239 | KENDALL | 115 | 1 | 44.4 | 46.0 | 96.6 | 31.4 |
| 22113 | NUGENT | 115 | 21239 | KENDALL | 115 | 1 | -41.4 | 46.0 | 90.1 | -28.4 |

******* Contingency 25 BKRPWAYVISS

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** | ** To bus | | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21541 | BAKERVUE | 115 | 21941 | LABOUNTY | 115 | 1 | -130.9 | 129.1 | 101.4 | -72.3 |
| 21541 | BAKERVUE | 115 | 22179 | PLYMOUTH | 115 | 1 | 120.2 | 110.0 | 109.3 | 61.7 |
| 20039 | BELNGM P | 115 | 22179 | PLYMOUTH | 115 | 1 | -111.2 | 110.0 | 101.1 | -52.7 |
| 21438 | SUMAS CG | 115 | 21239 | KENDALL | 115 | 1 | 44.2 | 46.0 | 96.0 | 31.4 |

******* Contingency 28 BKFCUSMURPWY

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** | ** To bus | | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21563 | BIGROCK | 115 | 22057 | MTVERNON | 115 | 1 | -99.3 | 110.0 | 90.3 | -79.1 |
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 107.5 | 110.0 | 97.7 | 87.2 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -112.5 | 110.0 | 102.2 | -92.2 |
| 20449 | SEDRO | 230 | 23097 | HRNCHTAP | 230 | 1 | 590.9 | 638.2 | 92.6 | 436.3 |

******* Contingency 35 BKFSEDBOTBHM

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** | ** To bus | | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21563 | BIGROCK | 115 | 22057 | MTVERNON | 115 | 1 | -100.1 | 110.0 | 91.0 | -79.1 |
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 108.2 | 110.0 | 98.4 | 87.2 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -113.2 | 110.0 | 102.9 | -92.2 |
| 20330 | MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -471.2 | 426.3 | 110.5 | -331.6 |

******* Contingency 36 BKFSEDTXCUSM

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** | ** To bus | | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21529 | ARLNGTON | 115 | 20033 | BEAVERLK | 115 | 1 | -104.7 | 110.0 | 95.2 | -74.4 |
| 20033 | BEAVERLK | 115 | 21563 | BIGROCK | 115 | 1 | -104.9 | 110.0 | 95.3 | -74.5 |
| 21529 | ARLNGTON | 115 | 21187 | BEVERLY | 115 | 1 | 102.6 | 110.0 | 93.3 | 72.2 |
| 21563 | BIGROCK | 115 | 22057 | MTVERNON | 115 | 1 | -109.5 | 110.0 | 99.5 | -79.1 |
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 117.6 | 110.0 | 106.9 | 87.2 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -122.6 | 110.0 | 111.4 | -92.2 |
| 21250 | MARCHPT | 115 | 22150 | PADILTAP | 115 | 1 | -147.7 | 143.0 | 103.3 | -106.2 |
| 22150 | PADILTAP | 115 | 21439 | TEXACO E | 115 | 1 | -151.4 | 143.0 | 105.9 | -109.9 |

******* Contingency 37 BKFMPTTXCUSM

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21529 | ARLNGTON | 115 | 20033 | BEAVERLK | 115 | 1 | -105.7 | 110.0 | 96.1 | -74.4 |
| 20033 | BEAVERLK | 115 | 21563 | BIGROCK | 115 | 1 | -105.9 | 110.0 | 96.2 | -74.5 |
| 21529 | ARLNGTON | 115 | 21187 | BEVERLY | 115 | 1 | 103.6 | 110.0 | 94.1 | 72.2 |
| 21563 | BIGROCK | 115 | 22057 | MTVERNON | 115 | 1 | -110.4 | 110.0 | 100.4 | -79.1 |
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 118.6 | 110.0 | 107.8 | 87.2 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -123.6 | 110.0 | 112.3 | -92.2 |

******* Contingency 39 BKFSEDTXHRBO

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21529 | ARLNGTON | 115 | 20033 | BEAVERLK | 115 | 1 | -113.4 | 110.0 | 103.1 | -74.4 |
| 20033 | BEAVERLK | 115 | 21563 | BIGROCK | 115 | 1 | -113.5 | 110.0 | 103.2 | -74.5 |
| 21529 | ARLNGTON | 115 | 21187 | BEVERLY | 115 | 1 | 111.2 | 110.0 | 101.1 | 72.2 |
| 21563 | BIGROCK | 115 | 22057 | MTVERNON | 115 | 1 | -118.1 | 110.0 | 107.4 | -79.1 |
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 126.2 | 110.0 | 114.8 | 87.2 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -131.2 | 110.0 | 119.3 | -92.2 |
| 21250 | MARCHPT | 115 | 22150 | PADILTAP | 115 | 1 | -141.7 | 143.0 | 99.1 | -106.2 |
| 20330 | MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -485.9 | 426.3 | 114.0 | -331.6 |
| 22150 | PADILTAP | 115 | 21439 | TEXACO E | 115 | 1 | -145.3 | 143.0 | 101.6 | -109.9 |

******* Contingency 43 BKRMARPTE115

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21250 | MARCHPT | 115 | 21440 | TEX_WEST | 115 | 1 | -279.7 | 264.9 | 105.6 | -183.7 |

******* Contingency 45 BKRMARPTS115

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus | | ** ** | | To bus | ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|---|---|---|---|
| 21534 | AVON PMP | 115 | 21607 | BURLIGTN | 115 | 1 | 136.6 | 143.0 | 95.6 | 77.6 |
| 21534 | AVON PMP | 115 | 22494 | WILSN TP | 115 | 1 | -142.7 | 143.0 | 99.8 | -83.7 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21870 HICKOX T 115 | 22057 MTVERNON 115 | 1 | 103.5 | 110.0 | 94.1 | 87.2 |
| 21870 HICKOX T 115 | 22163 PETHCORN 115 | 1 | -108.5 | 110.0 | 98.6 | -92.2 |
| 21250 MARCHPT 115 | 22150 PADILTAP 115 | 1 | -230.9 | 143.0 | 161.5 | -106.2 |
| 22150 PADILTAP 115 | 21439 TEXACO E 115 | 1 | -234.6 | 143.0 | 164.1 | -109.9 |

******* Contingency 46 SLSEDROHRBOT

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus ** | ** To bus ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|
| 21529 ARLNGTON 115 | 20033 BEAVERLK 115 | 1 | -99.8 | 110.0 | 90.7 | -74.4 |
| 20033 BEAVERLK 115 | 21563 BIGROCK 115 | 1 | -99.9 | 110.0 | 90.9 | -74.5 |
| 21563 BIGROCK 115 | 22057 MTVERNON 115 | 1 | -104.5 | 110.0 | 95.0 | -79.1 |
| 21870 HICKOX T 115 | 22057 MTVERNON 115 | 1 | 112.7 | 110.0 | 102.4 | 87.2 |
| 21870 HICKOX T 115 | 22163 PETHCORN 115 | 1 | -117.7 | 110.0 | 107.0 | -92.2 |
| 20330 MURRAY 230 | 21282 SEDRO NT 230 | 1 | -510.5 | 426.3 | 119.7 | -331.6 |

******* Contingency 47 DCBOTSAMSEDH

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus ** | ** To bus ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|
| 21529 ARLNGTON 115 | 20033 BEAVERLK 115 | 1 | -99.6 | 110.0 | 90.6 | -74.4 |
| 20033 BEAVERLK 115 | 21563 BIGROCK 115 | 1 | -99.8 | 110.0 | 90.7 | -74.5 |
| 21563 BIGROCK 115 | 22057 MTVERNON 115 | 1 | -104.4 | 110.0 | 94.9 | -79.1 |
| 21870 HICKOX T 115 | 22057 MTVERNON 115 | 1 | 112.5 | 110.0 | 102.3 | 87.2 |
| 21870 HICKOX T 115 | 22163 PETHCORN 115 | 1 | -117.5 | 110.0 | 106.8 | -92.2 |
| 20330 MURRAY 230 | 21282 SEDRO NT 230 | 1 | -504.4 | 426.3 | 118.3 | -331.6 |

******* Contingency 48 BUSMURRAY230

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus ** | ** To bus ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|
| 21563 BIGROCK 115 | 22057 MTVERNON 115 | 1 | -99.3 | 110.0 | 90.3 | -79.1 |
| 21870 HICKOX T 115 | 22057 MTVERNON 115 | 1 | 107.4 | 110.0 | 97.7 | 87.2 |
| 21870 HICKOX T 115 | 22163 PETHCORN 115 | 1 | -112.4 | 110.0 | 102.2 | -92.2 |
| 20449 SEDRO 230 | 23097 HRNCHTAP 230 | 1 | 597.3 | 638.2 | 93.6 | 436.3 |

******* Contingency 51 BKFHRSUB

Branches with MW flow more than 90.0 % of nominal rating

| ** From bus ** | ** To bus ** | CKT | InitFlow | Rating | IntLd% | BaseFlow |
|---|---|---|---|---|---|---|
| 21529 ARLNGTON 115 | 20033 BEAVERLK 115 | 1 | -103.0 | 110.0 | 93.6 | -74.4 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20033 | BEAVERLK | 115 | 21563 | BIGROCK | 115 | 1 | -103.1 | 110.0 | 93.7 | -74.5 |
| 21529 | ARLNGTON | 115 | 21187 | BEVERLY | 115 | 1 | 100.8 | 110.0 | 91.6 | 72.2 |
| 21563 | BIGROCK | 115 | 22057 | MTVERNON | 115 | 1 | -107.7 | 110.0 | 97.9 | -79.1 |
| 21870 | HICKOX T | 115 | 22057 | MTVERNON | 115 | 1 | 115.8 | 110.0 | 105.3 | 87.2 |
| 21870 | HICKOX T | 115 | 22163 | PETHCORN | 115 | 1 | -120.8 | 110.0 | 109.8 | -92.2 |
| 20330 | MURRAY | 230 | 21282 | SEDRO NT | 230 | 1 | -536.1 | 426.3 | 125.8 | -331.6 |

# SUMAS II

# 720 MW

Sumas II - 720 MW

# Sumas II - Transmission Constraints Scoping Study

## Summary.

Sumas II has been proposed as a generation addition in Whatcom County, located adjacent to the existing Sumas cogeneration facility. The generation proposed has been described at two sets of CT's and steam units. Each CT and steam unit pair would generate between 355 and 370 MW. The MW output could be connected to B.C. Hydro facilities across the border with Canada, or into the Whatcom County system. This study addresses only the option to connect the generators to the Whatcom County system. Because of Initiative 4-90 in Whatcom County, the project developer has suggested the generation be integrated using 115 kV transmission facilities.

Two generation connection choices are discussed with this report, either to connect one generator pair to BPA Bellingham Substation (360 MW), or to connect one generator pair to BPA Bellingham Substation and a second generator pair to PSE Portal Way Substation (720 MW total). Each generator pair would be connected to Bellingham or Portal Way on a 115 kV radial transmission line. All the combinations and connection possibilities are not addressed. The ones used are probably the least expensive. The attention of this study is more on the transmission problems from adding 360 or 720 MW to existing North-to-South obligations from Skagit County through King County.

Because of time constraints, this is a scoping study and only addresses summer conditions for the year 2004, in the Northern Intertie North-to-South direction. While the summer is usually the most limiting, there may be other facilities that overload in association with the proposed Sumas II generation for South-to-North flows, for light summer loads, or during higher winter load conditions. This would be verified with further studies.

The projects identified in this are not the only ones that could correct system constraints, nor are they necessarily the one that would be selected as the result of a more extensive study and a complete environmental review and permitting process. They were selected so that a rough approximation of the ultimate system costs that may be associated with these generation projects could be determined.

The cost estimates are given in the following table. The table does not include costs for constructing the generating facilities or the transmission facilities to bring them to BPA Bellingham and Portal Way Substations. The generation developer will have accurate estimates through the services of consulting engineers. The table indicates a significant step to integrate the first generator pair (360 MW). This is due to facilities needed to resolve problems in Skagit and Snohomish Counties. (The estimates have been developed from experience with similar projects. They have not been reviewed by transmission and substation design engineers because of time constraints.)

Enclosure 1

# Table - Cost Estimates

| Stages of Sumas II Generation Additions | | Cost Estimates ($ x1000) | | |
|---|---|---|---|---|
| Facility Additions | | Low | High | Altern-atives |
| **Phase 1** Improvements to Recover NI 2850 summer | | | | |
| Beverly-Hilton Lake 115 kV uprate from 75 to 100C | 3.4 mi | 50 | 100 | |
| Monroe-Snohomish #1 230 kV uprate from 90 to 100C | 10 mi | 50 | 250 | |
| Snohomish-Bothell #1 230 kV uprate from 80 to 100C | 7.6 mi | 50 | 250 | |
| Snohomish-Bothell #2 230 kV uprate from 90 to 100C | 7.4 mi | 30 | 100 | |
| Bothell 230 kV line get-away re-arrangement | 5 lines | 300 | 700 | |
| Sammamish 115 kV trf breakers and switch replacement | 2 each | 600 | 800 | |
| Re-terminate Snoking-Maple V #1 230 kV line onto Talbot N | 1 bkr | 1,100 | 1,350 | |
| Subtotal | | 2,180 | 3,550 | |
| **Phase 2** Improvements for Sumas II - 360 MW | | | | |
| At BPA Bellingham install #2 230-115 kV trf and breakers | | 4,200 | 5,600 | |
| 50 Mvar, 115 kV capacitor bank at BPA Bellingham | | 300 | 450 | |
| Sedro-Horse Ranch #2 230 kV rebuild w/ 2-Tern on | 39 mi | 8,000 | 16,000 | |
| H-frame or rebuild with single steel poles | | | | 31,200 |
| Sedro-Beaver Lake 115 kV, build Narcissus | 4.8 mi | 1,200 | 1,600 | |
| At Sedro Woolley install 2 230 breakers & 1 line bay | | 1,500 | 2,000 | |
| At Horse Ranch install 2 230 breakers & 1 line bay | | 2,000 | 2,600 | |
| Snohomish-Beverly #3 & #4 115 kV uprate 50C to 100C | 1.3 mi ea | 50 | 200 | |
| Bothell-Sammamish 230 kV 2-Tern re-cond. on H-frame | 13.4 mi | 3,350 | 5,360 | |
| or rebuild with steel poles | | | | 13,400 |
| Cottage Brook-Fall City 115 kV uprate from 75C to 90C | 18.2 mi | 1,200 | 2,700 | |
| Subtotal | | 21,800 | 36,510 | 65,750 |
| **Phase 3** Improvements for Sumas II - 720 MW | | | | |
| At Portal Way install #2 230-115 kV trf and breakers | | 4,200 | 5,600 | |
| 50 Mvar, 115 kV capacitor bank at Portal Way | | 300 | 450 | |
| Convert Snohomish-Boeing 115 kV to 230 kV | | | | |
| Terminate at Snohomish 230 kV, bkr & line bay | | 1,100 | 1,800 | |
| Terminate Boeing 115 at Beverly, bkr & line bay | | 450 | 800 | |
| Terminate HR, Snoh & Both 230 kV lines at Beverly | 3 each | 4,000 | 6,500 | |
| At Beverly install #2 230-115 kV trf and breakers | | 3,900 | 5,300 | |
| Monroe-Snohomish #1 230 kV uprate from 90 to 100C | 0.75 mi | 25 | 150 | |
| Rebuild Samm-Lakeside #2 to 230 w/ Jefferson H-frame | 7.1 mi | 2,000 | 3,500 | |
| or rebuild with single steel poles | | | | 7,100 |
| Rebuild Lakeside-Talbot #2 to 230 w/ Jefferson H-frame | 8.9 mi | 2,500 | 4,400 | |
| or rebuild with single steel poles | | | | 8,900 |
| Terminate at Sammamish 230 kV, bkr & line bay | | 900 | 1,300 | |
| Terminate at Talbot N 230 kV, bkr & line bay | | 900 | 1,300 | |
| Re-terminate Snoking-Maple V #1 230 kV line to Talbot S | 1 bkr | ① | ① | |
| At Lakeside, terminate Samm & Talbot 230 kV lines, and install 230-115 kV trf and breakers | | 6,900 | 10,600 | |
| Hilton Lake-Lake Leota 115 kV uprate from 75 to 100C | 11.2 mi | 300 | 750 | |
| Cottage Brook-Fall City 115 kV leave at 75C | | -1,200 | -2,700 | |
| Subtotal | | 26,275 | 39,750 | |
| **Total - Recover NI 2850 + 720 MW** | | 50,255 | 79,810 | |

Footnotes:

① Cost included in Phase 2, but with the Sammamish-Talbot 230 kV line, put Snoking onto Talbot South bus instead of Talbot North.

## I. Existing System Assessment.

Some facilities are near, at, or above their limits with north to south BCH flow on the West Side Northern Intertie (NI). These facilities for NtoS include:

1. Sedro - Bellingham #3 & #4 115 lines
2. Sedro NT - Murray 230 line
3. March Point - Beverly 115 line
4. Snohomish - Bothell #1 & #2 230 lines
5. Bothell - Snoking 230 line(s)
6. Snoking - Maple Valley 230 line(s)
7. Beverly - Cottage Brook and Cottage Brook - Fall City 115 kV lines

SCL has begun opening their transmission network north of Broad Street Substation, separating North Seattle from the downtown area and South Seattle. This action shifts power flow on to PSE and BPA facilities east of Seattle that carry power in the north / south direction.

With all PSE CT's on in the Summer, the sum of PSE and IPP generation represented in Whatcom and Skagit Counties is 1186 MW. With all CT's on in the winter, except for Whitehorn Unit 1, the sum is 1200 MW. The additional amount in the winter is because units can run at higher output levels during cooler weather. Without PSE CT's, the amounts are 774 and 817 MW. When PSE CT's are running, to mitigate overloaded facilities from certain outages when there is north to south BCH flow, the CT's are then tripped. The outages wired for generator tripping are the loss of both Custer-Monroe 500 kV lines, the loss of the Monroe-Echo Lake 500 kV line, and the loss of the Raver-Paul 500 kV line.

There are several outages that cause overloads during high north to south imports and high PSE generation. BPA has proposed several breaker additions, to use the second SCL owned 230 kV circuit between Bothell, Snoking, and Maple Valley, and to repair and re-energize the Chief Joe-Snohomish #4 line from 230 to 345 kV. BPA anticipates the Bothell-Snoking 1&2 230 and Snoking-Maple Valley 1&2 230 kV lines to be upgraded to 100C conductor rating. PSE has proposed several line upgrades, and to install a 230 kV breaker at Sammamish Substation. The tables in Appendix A assume that these breakers and line upgrades have been completed. Recently, some new outages have been identified that are quite severe. They are the bus segment outages of the SCL Bothell 230 kV bus.

After the proposed upgrades and additions have been completed, with full PSE generation during the summer and winter, there will be facility maintenance outages that will limit the north to south capability to less than 2850 MW in the summer and 1450 MW in the winter.

## II. Improvements to Recover NI 2850 Summer - Phase 1.

The following is a discussion of improvements to recover the 2850 MW NI Rating in the summer when the SCL Skagit and PSE Northern generation is fully on or at a minimum. The maximum / minimum summer generation for PSE in Whatcom and Skagit is 1186 / 260 MW, and for SCL in Skagit is 650 / 100 MW.

In the Existing System Assessment, certain facilities were assumed to have been completed. The items taking the longest time are probably connecting the Bothell-Snoking #2 and Snoking-Maple Valley #2 230 kV lines, and restoring the Chief Joe-Snohomish #4 to 345 kV operation.

In addition to the breaker additions, upgrades and these improvements (assumed as completed in the above tables), BPA and PSE plan to replace the transformer at BPA Bellingham with a higher capacity 230-115 kV transformer. Also, BPA is proposing to move the Snoking tap from the Monroe-Sammamish 230 kV line to the Monroe-Echo Lake 500 kV line, and install a 500-230 kV transformer at Snoking Substation. The Snoking tap line is already constructed for 500 kV. A new transformer at Snoking would provide load relief to the surrounding 500-230 transformers. The following discussion and findings are made with the assumption that the Bellingham 230-115 kV transformer and the Snoking 500-230 kV transformer are installed.

An alternative that was studied was to build a second Monroe-Echo Lake 500 kV line instead of retaining the single 500 kV line configuration. This would be built on right-of-way that is separate from the existing 500 kV line, using portions of the Monroe-Sammamish and Sammamish-Maple Valley lines, with a 500-230 kV transformer at Novelty, instead of Snoking. This seems to be a better long-range plan, but is much more expensive. It does not resolve all the 230 kV problems in King County associated with the Sumas II project.

The Monroe-Snohomish 230 kV line segment that overloads (circuit #1) is one side of a 10 mile long double circuit, and it must be uprated from 90C to 100C. Circuit #2 is already 100C rated. This uprate is probably minor, and would not be required if a second Sedro Woolley-Horse Ranch 230 kV line were constructed for the proposed Sumas II generators.

The Snohomish-Bothell #1 230 kV line must be upgraded from 80C to 100C, and the Snohomish-Bothell #2 230 kV line must be upgraded from 90C to 100C. After these lines are upgraded, they will load to 105% for the double line outage.

The Bothell 230 kV bus must be rearranged. The current layout can now cause the Snohomish-Bothell #2 to overload to 140% for a loss of the Bothell #4 230 bus section. This condition is at SCL Skagit generation at 100 MW; at higher levels, the overload percent goes down. After the Snoking 500-230 kV transformer is installed, the overload goes down to 119%. A rearrangement of the lines into Bothell can resolve the overloads from bus segment outages. This includes moving the Sammamish line from the Bothell #2 bus segment to the #4 bus segment. The proposed Bothell-Snoking #2 should terminate on the #2 bus segment. The Diablo #3 line and the Snohomish #1 line should be swapped, so that Diablo #3 line terminates on #4 bus segment, and Snohomish #1 line terminates on #3 bus segment.

The Beverly-Cottage Brook 115 kV line needs to be uprated from 75C to 80C minimum.

The Sammamish 115 kV transformer breakers and disconnects load beyond their emergency ratings under a loss of the other transformer. These two 1600 A breakers and switches need to be replaced with 2000 A minimum hardware. The transformers have a higher emergency rating.

The Maple Valley 230 kV bus has two sections, with the Sammamish-Maple Valley and Snoking-Maple Valley #1 230 kV lines connected to the #2 section. An outage of the #2 section results in loss of both lines to the north. The Fall City-Cottage Brook 115 kV line overloads. When the Snoking-Maple Valley #2 230 kV line is connected to the Maple Valley #1 section, an outage of the #2 section can result in the new Snoking-Maple Valley #2 line overloading by 111% above its 1063 A (100C) rating. A solution is to relocate either the Sammamish-Maple Valley or the Snoking-Maple Valley #1 230 kV line to the Talbot North 230 kV bus. The Talbot North and South buses are such a short distance from the Maple Valley bus, that they are effectively bus sections of the Maple Valley bus. Doing this removes overloading on the Snoking-Maple Valley #2 line, and it reduces overloading on the Fall City-Cottage Brook 115 kV line to 104%.

## III. Improvements for Sumas II at 360 MW - Phase 2.

The PSE CT's at Whitehorn and Fredonia are part of a generation dropping remedial action scheme (RAS) that is triggered when certain 500 kV facility outages occur. This must also be applied to all the Sumas II generators. The generators are tripped for Monroe-Custer #1 & #2, Monroe-Echo Lake, or Raver-Paul 500 kV outages during North to South flows, and the Sumas II connected to BPA Bellingham is tripped for BPA Bellingham 230 bus or 230-115 tx outage.

The connection studied for 360 MW is with a single 115 kV line from the Sumas II site to BPA Bellingham Substation, terminating on a 115 kV breaker. A 115 kV capacitor bank at BPA Bellingham Substation is installed to compensate the large reactive losses in the 115 kV line. The 115 kV line modeled is 22 miles of 2 Tern bundled conductor. The generators supply 368 MW, and the line has real power and reactive losses of 12.7 MW and 97 MVAR. An alternative single conductor might be Jefferson, a 1.6 inch AAC trapezoidal with lower, but adequate ampacity, higher reactance and 1/4 lower resistance.

The 360 MW of the proposed Sumas II generator causes a net increase in flow through the system for during North-to-South NI flows. The impact will be sufficient to require additional lines and some reconfiguration of buses.

A second 230-115 kV transformer must be added at BPA Bellingham or the Sedro-Bellingham #3 & #4 115 kV lines must be rebuilt to a higher capacity. The current Sedro-Bellingham RAS trips the lines for certain outages. If this happens, a single 230-115 kV transformer at BPA Bellingham would severely overload due to power flowing from the 115 kV side to the 230 side, and south on the Bellingham-Sedro 230 kV line. The second transformer reduces loading on the Sedro-Bellingham #3 & #4 115 kV lines, but also mitigates overloading on a single Bellingham transformer if the 115 kV lines do trip. A second transformer at BPA Bellingham is less expensive than rebuilding the Sedro-Bellingham 115 kV lines.

The Custer-Murray 230 kV line between its Sedro NT tap point and Murray is constructed with 795 Drake conductor, rated for 100C. This line is at 102% for a breaker failure at Horse Ranch substation. With the addition of 360 MW, it overloads to 120% for the same outage. One option is to rebuild the line from Sedro NT tap point to Murray, a distance of 26 miles. A difficulty with this option is that other lines overload from Murray to Snohomish to Bothell Substations, as well as the March Point-Beverly 115 kV line.

Another option is to rebuild the March Point-Beverly 115 kV line between Beaver Lake and Horse Ranch, and to construct new 230 and 115 kV lines back to Sedro Woolley. This results in a Sedro-March Point 115 kV line and a new second Sedro-Horse Ranch 230 kV line. The line configuration used was 2-Tern bundled conductor with restricted H-frame construction. For cost purposes, it is assumed that the existing 115 kV line will have to be replaced, and the new line moved in from the edge of the right-of-way. Two breakers are added to the Horse Ranch Substation. The Snohomish-Beverly #3 & #4 115 kV lines are upgraded to 100C because the March Point-Beverly 115 kV line no longer brings power to the Beverly 115 kV bus.

Either of the Bothell-Snoking #1 & #2 230 kV lines overloads to 113% of its 100C rating for the loss of the other line. To resolve these overloads, the lines must either be uprated to 110C, rebuilt with higher capacity conductors, or a parallel line constructed. BPA has not uprated any of their lines above 100C as a practice to avoid conductor loss of life. If BPA were able to economically uprate these lines (not rebuilding them) then the following line uprates would be required. The Cottage Brook-Fall City 115 kV line must be uprated from 55C to 75C.

If the Bothell-Snoking #1 & #2 230 kV lines cannot be uprated above 100C, and if they were rebuilt, the impedance would likely be lower with larger conductors, and the Snoking-Maple Valley #1 & #2 230 kV lines may then overload. The cost to rebuild the Snoking-Maple Valley lines will be high, because they are 25 miles long on double circuit steel towers. The Bothell-Snoking #1 & #2 230 kV lines are 3.7 miles long. With this option, the same 115 kV lines must be uprated. This option is described in the cost estimates for Phase 3. A disadvantage with upgrading the lines to a higher temperature is that they are only marginally adequate with all lines in service. There is little room to allow for maintenance, and generation and imports will need to be curtailed more often.

The third option for the Bothell-Snoking #1 & #2 lines is to reduce their loading by building another line parallel to them. A parallel line that could be converted for 230 kV use would be either the #1 or #2 circuit of the Sammamish-Lakeside and Lakeside-Talbot 115 kV lines. With this option, overloads on the Cottage Brook-Fall City 115 kV line can be mitigated, and a shorter distance of the Beverly-Cottage Brook 115 kV line must be uprated. This option is described more fully in the following section IV on Sumas II at 720 MW.

The Bothell-Sammamish 230 kV line has one Tern 795 conductor rated for 100C. It can be re-conductored, or a second conductor can be added. If a second conductor is added, it will have a lower impedance, with twice the capacity, relieving load on the Bothell-Snoking and Snoking-Maple Valley #1 & #2 230 kV lines. Any change may require moving the outside pole of the H-frame structures to the inside pole position to gain sufficient distance from the outside edge of the right-of-way. An alternative to retaining the H-frame configuration would be to use tall single steel poles at a much higher cost. If the double line outage is mitigated by other measures, there are other overloads at Monroe Substation that overload this line.

## IV. Improvements for Sumas II at 720 MW - Phase 3.

To connect an additional 360 MW of generation form Sumas II, a 115 kV line was modeled as constructed between the Sumas II site and Portal Way. The line is constructed with the same conductor and framing as the Sumas II-BPA Bellingham 115 kV line. A second 230-115 kV transformer is needed at Portal Way, and a 115 kV capacitor bank is added to the Portal Way bus.

Loading on the Custer-Murray 230 kV line between Sedro NT and Murray remains within its rating due to the second Sedro-Horse Ranch 230 kV circuit. To mitigate flows on the Monroe-Snohomish and Snohomish-Bothell #1 & #2 230 kV lines, the Snohomish-Boeing 115 kV line is converted to 230, tapped to Snohomish with a 230 kV breaker, and terminated at Beverly with the existing Horse Ranch-Bothell 230 kV line with a new three breaker 230 kV bus. To convert the line, the Boeing end is re-terminated on a 115 kV breaker at Beverly Park. A 230-115 kV transformer could be installed at Beverly Park Substation if desired by Snohomish PUD. With the addition of a Beverly 230-115 kV transformer, the Beverly-Cottage Brook 115 kV line must be uprated from 75C to 100C.

The Bothell-Snoking 1&2 230 kV lines overload to 118% of their 100C rating, and the Snoking-Talbot North #1 230 kV line overloads to 109% of its 100C rating. The Beverly-Cottage Brook 115 kV line overloads to 118% before uprating, and the Cottage Brook-Fall City 115 kV line overloads to 121% before uprating.

In the Puget Sound area, there are three 500 kV line segments where parallel 500 kV lines are noticeably absent. Only a single line exists between Monroe and Echo Lake, Echo Lake and Raver, and Raver and Paul. BPA is installing a second Echo Lake-Raver 500 kV line to mitigate overloads from outages during South-to-North NI exports.

Two options can be used to mitigate parallel path outages for North-to-South flows with the Sumas II project. One is to construct a second 500 kV line from Monroe to Echo Lake, using the 345 kV line that is energized at 230 kV between Monroe, the proposed Novelty site, and the Echo Lake-Maple Valley 1&2 500 kV lines. A 500-230 kV transformer would be tapped to this line that would supply Novelty-Sammamish 230 kV lines. This would be an alternative to the Snoking 500 kV tap conversion and 500-230 kV transformer at Snoking. It also requires conversion of the Sammamish-Lakeside and Lakeside-Talbot 2 115 kV line to 230 kV. While this line can be constructed on a separate right-of-way from the existing Monroe-Echo Lake 500 kV line, the cost is very high for the benefits provided.

The second option is to convert the Sammamish-Lakeside and Lakeside-Talbot 2 115 kV line to 230 kV. By installing a 230 kV transformer at Lakeside, loading on the Sammamish and Talbot 230-115 kV transformers is reduced. This provides an additional benefit in the winter because currently the Sammamish transformers will exceed their emergency ratings in the winter for an outage of either one. With the Lakeside transformer addition, Sammamish and Talbot transformer overloading is resolved, overloading on the Beverly-Cottage Brook 115 kV line is reduced, and overloading is eliminated on Cottage Brook-Fall City 115 kV line for North-to-South outages.

To convert the Sammamish-Lakeside and Lakeside-Talbot 2 line, the existing conductor must be bundled or replaced. The conductor modeled was Lapwing ACSR with restricted H-frame construction. Lapwing was adequate, but a larger conductor would be preferable for future needs. It is expected that the outside pole nearest the edge of the right-of-way must be moved to become the inside pole to gain sufficient distance from the edge of the right-of-way.

**Generation Benefits to South to North Capability:**
BPA is heavily focused on Puget Sound area capability to support south to north BCH transfers. They want to achieve 1700 MW West Side south to north capability for all seasons. There are serious problems with facility overloads during south to north exports when generation in Whatcom and Skagit Counties are light. Generation in Whatcom and Skagit Counties directly offset power flowing through King and Snohomish County facilities to Canada. BPA's need for firm south to north capability would be helped if there were generation sources that they could count on running.

## Appendix A. Existing System Overloads.

### 2004 Summer, Heavy Load, North to South Limits

| West Side NI at 2850 MW<br>Facility Overload ① | SCL ②<br>Skagit | Generation Level (MW) ③<br>1896 | 1541 | 1129 | 1186 | 260 |
|---|---|---|---|---|---|---|
| | | Percent of emergency rating | | | | |
| Portal Way #1 (or #2) 230-115 tx | any | 107 | | | | 104 |
| Portal Way - Arco Central 115 | 650 | 126 | 134 | | | |
| Terrell - PSE Bellingham 115 | any | | 109 | | 107 | |
| BPA Bellingham - Tasco Ref. 115 | 100 | | 108 | | 110 | |
| BPA Bellingham 230-115 tx | 100 | 152 ④ | 157 ④ | | | |
| Sedro NT - Murray 230 | 100 | 145 | 130 | 107 | 111 | |
| Sedro - Horse Ranch Tap 230 | 100 | 114 | | | | |
| March Point - Beverly Park 115 | 100 | 126 | 117 | | 101 | |
| Beverly Park - Cottage Brook 115 | 100 | 111 | 107 | | | |
| Fall City - Cottage Brook 115 | 650 | 129 | 120 | 106 | 106 | |
| Bothell - Sammamish 230 | 650 | 121 | 116 | 108⑥ | 108⑥ | |
| Snoking - Maple Valley #1 230 | 650 | 105 | | | | |
| Snoking - Maple Valley #2 230 | 650 | 144 | 135 | 122 | 124 | |
| Horse Ranch-Tap of Mon-Snoh 230 | 100 | 148 | 132 | 105 | 110 | |
| Snohomish - Bothell #2 230 | 100 | 123 | 117 | 109 | 110 | |
| Bothell - Snoking #1 & #2 230 | 650 | 140 | 132 | 120 | 121 | |
| ⑤ Snohomish - Bothell #1 230 | 100 | 160 | 152 | 140 | 142 | 117 |
| ⑤ Snohomish - Bothell #2 230 | 100 | 122 | 118 | 110 | 111 | |
| ⑤ Bothell - Snoking #2 230 | 650 | 138 | 131 | 118 | | |

Footnotes:

① Assumes Sumas II RAS tripping for Monroe-Custer #1 & #2, Monroe-Echo Lake, or Raver-Paul 500 kV outages, and Sumas II RAS tripping connected to Bellingham for Bellingham 230 bus or 230-115 tx outage.

② SCL Skagit generation level at highest facility overload (any means that overload is insensitive to SCL Skagit generation).

③ Columns are for different combinations of Sumas and Puget generation.

| Generation levels (MW) | 1896 | 1541 | 1129 | 1186 | 260 |
|---|---|---|---|---|---|
| Sumas at BPA Bellingham 115 kV | 355 | 355 | 355 | | |
| Sumas at Portal Way & 2nd PW 230-115 tx | 355 | | | | |
| PSE CT's at Whitehorn and Fredonia | 412 | 412 | | 412 | |
| PSE cogeneration and hydro | 774 | 774 | 774 | 774 | 260 |

④ Overload is made higher by RAS tripping of Sedro-Bellingham #3 & #4 115 kV on line overload.

⑤ Overloads from SCL Bothell 230 kV bus segment outages, before new arrangement.

⑥ Overloads for only Monroe-Snoking-Sammamish 230 kV outage is mitigated by tripping PSE (and SE2) combustion turbines.

Reference: 04hsnsJun30B

## 2004 Summer, Light Load, North to South Limits

| West Side NI 2850 MW<br>Facility Overload ① | SCL ②<br>Skagit | Generation Level (summer, MW) ③<br>1896 | <br>1541 | <br>1129 | <br>1186 | <br>260 |
|---|---|---|---|---|---|---|
| | | Percent of emergency rating | | | | |
| Portal Way #1 (or #2) 230-115 tx | any | 126 | | | | |
| Portal Way - Arco Central 115 | 650 | 150 | 154 | | 129 | |
| Terrell - PSE Bellingham 115 | any | | 145 | | 154 | |
| BPA Bellingham - Tasco Ref. 115 | 100 | | 166 | | 160 | |
| BPA Bellingham 230-115 tx | 100 | 115 | 182 ④ | | | |
| Sedro NT - Murray 230 | 100 | 152 | 137 | 113 | 118 | |
| Sedro - Sedro NT 230 | 100 | 133 | 125 | | 101 | |
| Sedro - Horse Ranch Tap 230 | 100 | 115 | 103 | | | |
| March Point - Beverly Park 115 | 100 | 135 | 126 | | 110 | |
| Tolt - Cottage Brook 115 | 650 | 147 | 137 | 124 | 124 | |
| Bothell - Sammamish 230 | 650 | 109 | 104 | | | |
| Snoking - Maple Valley #2 230 | 650 | 118 | 110 | 101 | 103 | |
| Horse Ranch-Tap of Mon-Snoh 230 | 100 | 163 | 146 | 118 | 124 | |
| Snohomish - Bothell #2 230 | 100 | 116 | 110 | | 103 | |
| Bothell - Snoking #1 & #2 230 | 650 | 153 | 145 | 133 | 133 | |
| | | | | | | |
| ⑤ Sedro NT - Murray 230 | 100 | 145 | 131 | 106 | 111 | |
| ⑤ Horse R - Tap of Mon-Snoh 230 | 100 | 160 | 143 | 115 | 122 | |
| ⑤ Snohomish - Bothell #1 230 | 100 | 163 | 155 | 142 | 145 | 117 |
| ⑤ Bothell - Snoking #2 230 | 650 | 152 | 144 | 131 | 131 | |

Footnotes:

① Assumes Sumas II RAS tripping for Monroe-Custer #1 & #2, Monroe-Echo Lake, or Raver-Paul 500 kV outages, and Sumas II RAS tripping connected to Bellingham for Bellingham 230 bus or 230-115 tx outage.

② SCL Skagit generation level at highest facility overload (any means that overload is insensitive to SCL Skagit generation).

③ Columns are for different combinations of Sumas and Puget generation.

| Generation levels (MW) | 1896 | 1541 | 1129 | 1186 | 260 |
|---|---|---|---|---|---|
| Sumas at BPA Bellingham 115 kV | 355 | 355 | 355 | | |
| Sumas at Portal Way & 2nd PW 230-115 tx | 355 | | | | |
| PSE CT's at Whitehorn and Fredonia | 412 | 412 | | 412 | |
| PSE cogeneration and hydro | 774 | 774 | 774 | 774 | 260 |

④ Overload is made higher by RAS tripping of Sedro-Bellingham #3 & #4 115 kV on line overload.

⑤ Overloads from SCL Bothell 230 kV bus segment outages, before new arrangement.

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Reference: 04lsnsJul6B

# Appendix B. Improvements not related to the Northern Intertie.

The Portal Way-Arco 115 kV line needs to be upgraded from 75C to 90C minimum for an outage of Arco Central-Arco North 115 kV line or a RAS scheme to runback or trip Whitehorn and Tenaska Generation.

The March Point-Texaco East 115 kV line needs to be upgraded from 55C to 100C for an outage of the March Point-Texaco West 115 kV line when March Point cogeneration and the Fredonia CT's are running.