Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

PUBLIC AFFAIRS

January 31, 2011

In reply refer to: DK-7

Thomas Drach
Save Our Scenic Area (SOSA)
P.O. Box 41
Underwood, WA 98651

RE: FOIA #BPA-2011-00304-F

This is a final response to your request for information that you made to the Bonneville Power Administration (BPA) under the Freedom of Information Act (FOIA), 5 U.S.C. 552.

You requested the following:
Copies of reports that are claimed to exist, authored by BPA, relating to the BPA 115KV line which runs generally east to west thru southern Skamania County Washington, and which eastern terminus is located at Bald Mountain substation in Klickitat County Washington.

Response:
BPA has provided all responsive documents in their entirety. There is no charge for your request.

I appreciate the opportunity to assist you and apologize for the delay in providing your response. Please contact Laura M. Atterbury, FOIA/Privacy Act Specialist, at (503) 230-7305, with any questions about this letter.

Sincerely,

/s/ Christina J. Munro

Christina J. Munro
Freedom of Information Act/Privacy Act Officer

Enclosure(s): Responsive documents

Interconnection Feasibility Evaluation
For
Underwood Wind Power Project
Pacificorp Power Marketing

November 7, 2002

Report Prepared by:
Gordon Comegys, TOC
Stephen Enyeart, TOC
Agreement No. 02TX-11192

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Attachment: Interconnection Sketch for Wind Project

1.1 Introduction

This report is the generation interconnection feasibility evaluation (IFE) addressing local interconnection requirements in response to request No.108 in BPA's generation interconnection study queue. Pacificorp Power Marketing (PPM) submitted a generation interconnection request to the Bonneville Power Administration-Transmission (BPAT) via the Open Access Transmission Tariff (OATT) process for 70MW's of Wind Turbine Generation with the point of interconnection on the Midway-North Bonneville 230kV line. The wind project will consist of 1500 KW wind turbine units, possibly Vestas units. These WTG's are induction machines with variable pitch control and internally switched capacitors. The requested interconnection energization date is March 1, 2004, which should be sufficient time to build the interconnecting facility. A schedule will be provided with the signed agreement to proceed. Minimum time required is 15 months from a signed agreement to proceed, or a minimum of 10-12 months from permission to construction (after ROD or environmental permits signed), depending on what type of construction is required for Bonneville. The point of interconnection (POI) requested requires a new 230kV connection and substation. The Interconnection Feasibility Evaluation (IFE) is a preliminary evaluation addressing the following objectives:

a) Identify the plan of service option(s) (to be included in the NEPA process).
b) Identify facilities required for interconnection to the BPA system.
c) Provide estimated costs for BPA associated with the interconnection options.
d) Establish a schedule to meet BPA's requirements to complete the study work and construction.
e) Provide preliminary analysis of capacity limits and identify remaining study work required for the final Interconnection Facilities Study (IFS).

The IFS will not be performed until the project has met certain requirements including key environmental milestones, selection of option, and commercial arrangements. The technical studies are appended to this document. However, these studies are preliminary and intended to develop reasonable alternatives. **The studies do not address firm transmission requirements, nor do they portend to offer such to the customer. System changes and other concerns due to projects higher in the queue may alter the interconnection requirements presented here, which will be addressed in the final IFS report.**

1.2 Interconnection Options

Option 1 is a connection to the Underwood 115 kV tap line of the Bonneville – Alcoa line, creating a 3 – terminal line. This option is not contingent on the actions of other projects in the queue.
Option 2 is a ring bus substation connecting to the Midway-North Bonneville 230 kV line where it passes thru the site. This option is only valid if other wind projects requesting interconnection in the area withdraw from the request queue.

2.1 Interconnection General

The Project will be located 5 miles northwest of Underwood, WA, near Willard. The 230 kV N. Bonneville – Midway and 115 kV Underwood tap lines both cross the site. The site is mostly forest land belonging to SDS Lumber. Apparently the wind project will be on a cleared area. It is assumed that the developer will acquire all land required and necessary permits. BPA will have to perform an environmental review for NEPA compliance.

For Option 1, the 115 kV substation (Willard) will be at the same location, but on the North side of the two lines to avoid crossings. The intended plan of service is a new substation with 3 - 115 kV PCB ring bus. BPA will be the owner of the transmission station portion. The Customer will provide the 115 kV/34.5 kV transformer(s) (WyeGrd'd-Delta-WyeGrd'd) and remainder of the wind project substation including the 34.5 kV collector system.

For Option 2, the 230 kV substation (Willard) will be located adjacent to the line, near Tower 21/5 and the Cook – Underwood road. It is proposed for BPA to build the 230 kV ring bus substation on the south side of both lines, to avoid line crossing. BPA will own, operate, and maintain this substation up to the connection to the transformer. BPA will provide the intertie to the existing line. The Customer will provide the 230 kV/34.5 kV transformer(s) (WyeGrd'd-Delta-WyeGrd'd) and remainder of the wind project substation including the 34.5 kV collector system.

Metering CT's and PT's will be required on the low side of each transformer for the BPA provided metering.

Shunt Capacitors or other means to obtain unity power factor at 90% or greater of rated output may be required for the interconnecting facility. The final IFS will address the specifics of the wind project system. Communications will be required for SCADA and telemetry of the wind project.

3.1 New Substation (BPA Portion)

For option 1, BPA will provide the portion of the substation required for the interconnection. BPA will install the 3-115 kV PCB ring bus substation, with provisions for expansion and associated disconnect switches, CCVT's, buswork, grounding, etc. Line current in both sections will be used for the purpose of determining overload and initiate generation tripping.

Should BPA ask the Customer to provide the substation, all yard design for the 115 kV portion up to the tie line shall be per BPA standards, especially grounding and bus layout. The 115 kV yard design shall be subject to BPA review to assure compliance to BPA standards, as BPA will require ownership of this portion of the substation as a system facility.

For option 2, BPA will provide the portion of the substation required for the interconnection. BPA will install the 3-230 kV PCB ring bus substation, with provisions for expansion and associated disconnect switches, CCVT's, buswork, grounding, etc. Line current in both sections will be used for the purpose of determining overload and initiate generation tripping.

Should BPA ask the Customer to provide the substation, all yard design for the 230 kV portion up to the tie line shall be per BPA standards, especially grounding and bus layout. The 230 kV yard design shall be subject to BPA review to assure compliance to BPA standards, as BPA will require ownership of this portion of the substation as a system facility.

BPA will provide the transmission dead end structure, tap lines and will make all terminations to the existing line for either option. The Customer will be responsible for the obtaining the substation site and all permits.

3.2 Customer Wind Project Substation Portion

The Customer will be responsible for the substation site, permits, grading, fencing, etc; and for their portion all buswork, structures, conduit/cables, grounding, etc as well as providing the surge arresters, switches, CCVT's and Transformer(s) (WyeGrd'd-Delta-WyeGrd'd).

Customer shall be responsible for all 34.5kV equipment specifications and associated protection for WTG collection system. Metering accuracy CT's and PT's will be required on the low side of each transformer for the BPA provided metering. The customer facility shall provide reactive within the WTG units and/or the substation at the 34.5 kV bus in sufficient steps as required by BPA to minimize voltage fluctuations and to compensate for all reactive requirement at the 230 kV point of connection. The minimum requirement will be PF =1.0 at 90% of rated output. Final studies will determine the exact requirement.

The Customer substation will include room in the control building for all BPA equipment, in addition to their needs.

3.3 BPA Control, Relaying and Metering

BPA will install all control and protection associated with the transmission system. New line relays and transfer trip will be added to the each line terminal at the Wind project substation. The new line PCB's will have four CT cores, C800. The existing line relays and transfer trip at the existing line terminals may need to be replaced to accommodate the new line relays at the Wind project substation.

Each line section will include the overload detection for the local Generation Drop requirement. Generation will be tripped for predetermined current thresholds on either line section. 125VDC is the control voltage for all switching equipment.

Auto-reclosing will be provided on both line sections. For the case where the generation has been tripped, logic will be included to auto-reclose the Wind Project 115 (or 230) kV PCB's for

conditions where a temporary fault reclosed successfully and the wind turbine generation has shut down. Auto-restoration of the wind turbines will be permitted for this situation. All other outages will require permission from BPA Dispatch to resume generation operations.

The revenue metering will be on the metering accuracy CT's and PT's on the 34.5kV connection to the transformers. KWH and KVArH telemetry will be required on a separate circuit. Analog KV, KW and KVAr will be included on the SCADA system provided by BPA for Control and monitoring purposes. SCADA control of all 115/230kV PCB's is required.

The Customer will be responsible for all equipment, control, meters, and relaying of the facility not included in the BPA furnished equipment. Refer to the attached diagram for delineation of the BPA provided equipment. The substation will include room in the Customer control building for all BPA equipment, in addition to customer needs.

4.1 Communications

The existing fiber on the North Bonneville – Midway 230 kV line will be looped into the new substation for the communications requirements for either option. Digital equipment will be used for the communications system. Circuits will be added at both control centers (Dittmer and Munro) at N. Bonneville and at Midway/Alcoa. The substation will include room in the control building for this equipment and 48VDC communications batteries provided by BPA.
A detailed communications plan and estimates will be provided in the final IFS report. Interconnection to the backbone system may alter the final communications plans.

5.1 System Feasibility Analysis

Introduction

This summary addresses alternative interconnection options considered connecting 70 MW of generation from the Underwood wind project. The full report will be provided with the final IFS.

Base Cases Studied/Modified

The system study objective is to identify the approximate facility additions needed to provide interconnection capacity. Interconnection capacity is defined, for study purposes, as capability to transfer the generation unimpeded to the nearest main grid buses, assuming the facilities are in service. In the case of Underwood wind, the main grid buses are assumed as Midway 230kV and North Bonneville 230kV for option 2. North Bonneville 230kV and Ross 230kV are the assumed main grid buses for option 1.

The approach used was to model the most severe conditions prior to the addition of Underwood generation. The most severe conditions are determined by analyzing the historical flow data and superimposing recent changes or future changes that are not reflected in the historical data. The most severe condition for the Midway-North Bonneville 230kV line occurs during summer in the power flow direction from Midway to Big Eddy. For the 115 kV Underwood Tap option, the most severe case is the summer loading (winter a little less severe), which creates the highest loading (69 kV at Bald Mountain between Condit and Bingen) combined with the lowest seasonal line ratings.

Summary of Alternatives Studied

Interconnection on the Underwood Tap of the Bonneville - Alcoa 115 kV line (Option 1) - The requested 70 MW generation can be accommodated (up to 90 MW interconnection capacity exists). No voltage issues for this magnitude appear in studies. About 20% of the power goes onto the 69kV system, which causes a no contingency constraint (limit between Condit and Bingen described below).

The contingency analysis shows that contingencies overload the 69kV section between Condit and Bingen, or one of the Bonneville-Alcoa 115kV lines before any other branch The overloads only occur when the post contingency power flow from the generation interconnect towards Underwood exceeds 35MW. This leads to a proposed simple local RAS option at interconnect on the section towards Underwood and Bald Mountain. An overcurrent detector at the interconnect can be set to trip generation for flows greater than 35 MW. This is the power flow level and direction that indicates an abnormal condition is causing an overload that can be mitigated by tripping the generation.

Interconnection on the Midway-North Bonneville 230 kV line (Option 2) - The requested 70 MW generation can only be accommodated if the Maiden Wind project (request #48) or Simcoe Wind project (request #67) withdraw from the queue. Those projects use 100% of the interconnection capacity of the line.

The contingency analysis shows that all outage contingencies overload the section between the interconnect and North Bonneville before any other branch. This leads to a proposed simple local RAS option at interconnect on the section towards North Bonneville. Overcurrent detector at the interconnect can be set to trip generation when a predetermined current threshold is reached on the North Bonneville section.

5.2 System Fault Studies

System fault studies will be conducted with future proposed generators and new facilities modeled in the Final IFS study. The values shown on the sketch are present values with estimated values as indicated. Customer equipment should be sized to accommodate system growth.

6.1 Cost Estimates

Estimated Customer costs for interconnection are given below. These costs are only for the Bonneville supplied facilities. It is assumed that the Customer will be responsible for all equipment, facilities development, and site development including land acquisitions, and permitting, including environmental impact assessment.

Description of Facilities	QTY	Estimated Interconnection Costs		
		Material	Contract	Labor
Option 1 - Modify 115kV Line, Add Loop-in, 3 PCB Ring Bus (ST - 7727)				
Project Mgmt, Design			50,000	290,000
Bus, Conduit, installed(Customer developed site/fence/gr'nding)		60,000		40,000
3-PCB's, 9-Switches, 6-Arresters, 6-CCVT's	1 lot	370,000		175,000
Digital Line Relays	2 lines	46,000		25,000
Bus/PCB relays, control	1 lot	50,000		25,000
Cable/Station Service/DC System		34,000		25,000
Structures/Foundations		160,000		170,000
Misc., Travel Time, Contingency		150,000	15,000	150,000
Wood 3-Pole Structures w/Ins,Hdwr, Modify Tap	1 lot	10,000		30,000
$1,835,000		**870,000**	**65,000**	**900,000**
Willard Comm (C&C Estimate)				
Project Management, Design				70,000
Fiber Loop-in 36Fiber ADSS, Terminations, Etc	1 lot	75,000		15,000
Sonet Box, Fiber MUX, Chnl Addn, Battery/Charger	1 lot	100,000		70,000
SCADA/SER,KW/KWH TM, Metering	lot	30,000		25,000
Misc., Travel Time, Contingency		45,000		40,000
$470,000		**250,000**	**0**	**220,000**
Radio Hops, Relay Additions		Material	Design	Construction
Alcoa Chnl Addns, Transfer Trip	1 lot	14,000	7,000	12,000
Bonneville Chnl Addns, Transfer Trip	1 lot	16,000	5,000	8,000
Alcoa Relay Replacement	1 lot	35,000	24,000	25,000
Bonneville Relay Replacement	1 lot	35,000	24,000	25,000
$230,000		**100,000**	**60,000**	**70,000**
Dittmer/Munro CC Additions (SCADA, Gen Int)				
Dittmer Modem, TM Additions				5,000
Munro Comm, Modem, TM, Phone Additions				5,000
$10,000		**0**	**0**	**10,000**
Estimate Totals:		**1,220,000**	**125,000**	**1,200,000**
Estimate Totals w/Overheads:		**$1,400,000**	**$160,000**	**$1,500,000**
Project Total W/Option 1 (Reimbursable):		**$3,060,000**	-	

Description of Facilities	QTY	Estimated Interconnection Costs		
		Material	Contract	Labor
Option 2A - 230 kV, Add 3-PCB Ring Bus ref: sw-22668-1				
Project Mgmt, Design (assumes BPA develops site)			10,000	280,000
Construction/Field Support/Material Support				86,000
3-PCB's, 9-Switches, 9-SA, 9-CVT's, Grounding System	1 lot	470,000		273,000
*Control/Relaying for 3 positions/DFR		150,000		48,000
Cable/Station Service/DC System		45,000		27,000
Bus/Insulators/Conduit System - Installed		105,000		93,500
Site Work/Access Roads/Fence		50,000		32,500
Building, Structures, Foundation		250,000	80,000	150,000
Misc., Travel Time, Contingency		330,000	15,000	190,000
Xmsn Tower (Dead End)	18 ton	40,000		40,000
Wood 3-Pole Structures w/Ins,Hdwr, Wire	2 each	10,000		10,000
* Assumes some relaying for Wind Terminal				
$2,785,000		**1,450,000**	**105,000**	**1,230,000**
Option 2B - 230 kV, Add Relays, Tap (excludes Customer Provided 3-PCB Ring Bus)				
Project Mgmt, Design (assumes Customer develops site)			10,000	75,000
Construction/Field Support/Material Support				35,000
*Control/Relaying for 3 positions/DFR		150,000		50,000
Xmsn Tower (Dead End)	18 ton	40,000		40,000
Wood 3-Pole Structures w/Ins,Hdwr, Wire	2 each	10,000		10,000
Misc., Travel Time, Contingency		50,000	15,000	50,000
* Assumes some relaying for Wind Terminal				
$535,000		**250,000**	**25,000**	**260,000**
Willard Comm (C&C Estimate)				
Project Management, Design				70,000
Fiber Loop-in 36Fiber ADSS, Terminations, Etc	1 lot	75,000		15,000
Sonet Box, Fiber MUX, Chnl Addn, Battery/Charger	1 lot	100,000		70,000
SCADA/SER,KW/KWH TM, Metering	lot	30,000		25,000
Misc., Travel Time, Contingency		45,000		40,000
$470,000		**250,000**	**0**	**220,000**
Radio Hops, Relay Additions		Material	Design	Construction
Midway Chnl Addns, Transfer Trip	1 lot	14,000	7,000	12,000
N. Bonn. Chnl Addns, Transfer Trip	1 lot	16,000	5,000	8,000
Midway Relay Replacement	1 lot	35,000	24,000	25,000
N. Bonn. Relay Replacement	1 lot	35,000	24,000	25,000
$230,000		**100,000**	**60,000**	**70,000**

Dittmer/Munro CC Additions (SCADA, Gen Int)				
Dittmer Modem, TM Additions				5,000
Munro Comm, Modem, TM, Phone Additions				5,000
$10,000		**0**	**0**	**10,000**
Option 2A Estimate Totals :		**1,800,000**	**165,000**	**1,530,000**
Estimate Totals w/Overheads:		**$2,000,000**	**$230,000**	**$1,970,000**
Project Total W/Option 2A (Reimbursable):		**$4,200,000**	-	
Option 2B Estimate Totals :		**600,000**	**85,000**	**560,000**
Estimate Totals:		**$675,000**	**$110,000**	**$715,000**
Project Total W/Option 2B (Reimbursable):		**$1,500,000**	-	

Bonneville Power Administration

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For
Underwood Wind Power Project

Pacificorp Power Marketing

November 7, 2002

FORMAT REVISION
SEPTEMBER 12, 2007

Report Prepared by:
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Should BPA ask the Customer to provide the substation, all yard design for the 115 kV portion up to the tie line shall be per BPA standards, especially grounding and bus layout. The 115 kV yard design shall be subject to BPA review to assure compliance to BPA standards, as BPA will require ownership of this portion of the substation as a system facility.

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The Customer substation will include room in the control building for all BPA equipment, in addition to their needs.

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conditions where a temporary fault reclosed successfully and the wind turbine generation has shut down. Auto-restoration of the wind turbines will be permitted for this situation. All other outages will require permission from BPA Dispatch to resume generation operations.

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The system study objective is to identify the approximate facility additions needed to provide interconnection capacity. Interconnection capacity is defined, for study purposes, as capability to transfer the generation unimpeded to the nearest main grid buses, assuming the facilities are in service. In the case of Underwood wind, the main grid buses are assumed as Midway 230kV and North Bonneville 230kV for option 2. North Bonneville 230kV and Ross 230kV are the assumed main grid buses for option 1.

The approach used was to model the most severe conditions prior to the addition of Underwood generation. The most severe conditions are determined by analyzing the historical flow data and superimposing recent changes or future changes that are not reflected in the historical data. The most severe condition for the Midway-North Bonneville 230kV line occurs during summer in the

power flow direction from Midway to Big Eddy. For the 115 kV Underwood Tap option, the most severe case is the summer loading (winter a little less severe), which creates the highest loading (69 kV at Bald Mountain between Condit and Bingen) combined with the lowest seasonal line ratings.

Summary of Alternatives Studied

Interconnection on the Underwood Tap of the Bonneville - Alcoa 115 kV line (Option 1) - The requested 70 MW generation can be accommodated (up to 90 MW interconnection capacity exists). No voltage issues for this magnitude appear in studies. About 20% of the power goes onto the 69kV system, which causes a no contingency constraint (limit between Condit and Bingen described below).

The contingency analysis shows that contingencies overload the 69kV section between Condit and Bingen, or one of the Bonneville-Alcoa 115kV lines before any other branch The overloads only occur when the post contingency power flow from the generation interconnect towards Underwood exceeds 35MW. This leads to a proposed simple local RAS option at interconnect on the section towards Underwood and Bald Mountain. An overcurrent detector at the interconnect can be set to trip generation for flows greater than 35 MW. This is the power flow level and direction that indicates an abnormal condition is causing an overload that can be mitigated by tripping the generation.

Interconnection on the Midway-North Bonneville 230 kV line (Option 2) - The requested 70 MW generation can only be accommodated if the Maiden Wind project (request #48) or Simcoe Wind project (request #67) withdraw from the queue. Those projects use 100% of the interconnection capacity of the line.

The contingency analysis shows that all outage contingencies overload the section between the interconnect and North Bonneville before any other branch. This leads to a proposed simple local RAS option at interconnect on the section towards North Bonneville. Overcurrent detector at the interconnect can be set to trip generation when a predetermined current threshold is reached on the North Bonneville section.

5.2 System Fault Studies

System fault studies will be conducted with future proposed generators and new facilities modeled in the Final IFS study. The values shown on the sketch are present values with estimated values as indicated. Customer equipment should be sized to accommodate system growth.

6.1 Cost Estimates

Estimated Customer costs for interconnection are given below. These costs are only for the Bonneville supplied facilities. It is assumed that the Customer will be responsible for all equipment, facilities development, and site development including land acquisitions, and permitting, including environmental impact assessment.

Description of Facilities	QTY	Estimated Interconnection Costs		
		Material	Contract	Labor
Option 1 - Modify 115kV Line, Add Loop-in, 3 PCB Ring Bus (ST - 7727)				
Project Mgmt, Design			50,000	290,000
Bus, Conduit, installed(Customer developed site/fence/gr'nding)		60,000		40,000
3-PCB's, 9-Switches, 6-Arresters, 6-CCVT's	1 lot	370,000		175,000
Digital Line Relays	2 lines	46,000		25,000
Bus/PCB relays, control	1 lot	50,000		25,000
Cable/Station Service/DC System		34,000		25,000
Structures/Foundations		160,000		170,000
Misc., Travel Time, Contingency		150,000	15,000	150,000
Wood 3-Pole Structures w/Ins,Hdwr, Modify Tap	1 lot	10,000		30,000
$1,835,000		**870,000**	**65,000**	**900,000**
Willard Comm (C&C Estimate)				
Project Management, Design				70,000

Fiber Loop-in 36Fiber ADSS, Terminations, Etc	1 lot	75,000		15,000
Sonet Box, Fiber MUX, Chnl Addn, Battery/Charger	1 lot	100,000		70,000
SCADA/SER,KW/KWH TM, Metering	lot	30,000		25,000
Misc., Travel Time, Contingency		45,000		40,000
$470,000		**250,000**	**0**	**220,000**
Radio Hops, Relay Additions		Material	Design	Construction
Alcoa Chnl Addns, Transfer Trip	1 lot	14,000	7,000	12,000
Bonneville Chnl Addns, Transfer Trip	1 lot	16,000	5,000	8,000
Alcoa Relay Replacement	1 lot	35,000	24,000	25,000
Bonneville Relay Replacement	1 lot	35,000	24,000	25,000
$230,000		**100,000**	**60,000**	**70,000**
Dittmer/Munro CC Additions (SCADA, Gen Int)				
Dittmer Modem, TM Additions				5,000
Munro Comm, Modem, TM, Phone Additions				5,000
$10,000		**0**	**0**	**10,000**
Estimate Totals:		**1,220,000**	**125,000**	**1,200,000**
Estimate Totals w/Overheads:		**$1,400,000**	**$160,000**	**$1,500,000**
Project Total W/Option 1 (Reimbursable):		**$3,060,000**	-	

Description of Facilities	QTY	Estimated Interconnection Costs		
		Material	Contract	Labor
Option 2A - 230 kV, Add 3-PCB Ring Bus ref: sw-22668-1				
Project Mgmt, Design (assumes BPA develops site)			10,000	280,000
Construction/Field Support/Material Support				86,000
3-PCB's, 9-Switches, 9-SA, 9-CVT's, Grounding System	1 lot	470,000		273,000
*Control/Relaying for 3 positions/DFR		150,000		48,000
Cable/Station Service/DC System		45,000		27,000
Bus/Insulators/Conduit System - Installed		105,000		93,500
Site Work/Access Roads/Fence		50,000		32,500
Building, Structures, Foundation		250,000	80,000	150,000
Misc., Travel Time, Contingency		330,000	15,000	190,000
Xmsn Tower (Dead End)	18 ton	40,000		40,000
Wood 3-Pole Structures w/Ins,Hdwr, Wire	2 each	10,000		10,000
* Assumes some relaying for Wind Terminal				
$2,785,000		**1,450,000**	**105,000**	**1,230,000**
Option 2B - 230 kV, Add Relays, Tap (excludes Customer Provided 3-PCB Ring Bus)				
Project Mgmt, Design (assumes Customer develops site)			10,000	75,000

Construction/Field Support/Material Support				35,000
*Control/Relaying for 3 positions/DFR		150,000		50,000
Xmsn Tower (Dead End)	18 ton	40,000		40,000
Wood 3-Pole Structures w/Ins,Hdwr, Wire	2 each	10,000		10,000
Misc., Travel Time, Contingency		50,000	15,000	50,000
* Assumes some relaying for Wind Terminal				
$535,000		**250,000**	**25,000**	**260,000**
Willard Comm (C&C Estimate)				
Project Management, Design				70,000
Fiber Loop-in 36Fiber ADSS, Terminations, Etc	1 lot	75,000		15,000
Sonet Box, Fiber MUX, Chnl Addn, Battery/Charger	1 lot	100,000		70,000
SCADA/SER,KW/KWH TM, Metering	lot	30,000		25,000
Misc., Travel Time, Contingency		45,000		40,000
$470,000		**250,000**	**0**	**220,000**
Radio Hops, Relay Additions		Material	Design	Construction
Midway Chnl Addns, Transfer Trip	1 lot	14,000	7,000	12,000
N. Bonn. Chnl Addns, Transfer Trip	1 lot	16,000	5,000	8,000
Midway Relay Replacement	1 lot	35,000	24,000	25,000
N. Bonn. Relay Replacement	1 lot	35,000	24,000	25,000
$230,000		**100,000**	**60,000**	**70,000**

Dittmer/Munro CC Additions (SCADA, Gen Int)				
Dittmer Modem, TM Additions				5,000
Munro Comm, Modem, TM, Phone Additions				5,000
$10,000		**0**	**0**	**10,000**
Option 2A Estimate Totals :		**1,800,000**	**165,000**	**1,530,000**
Estimate Totals w/Overheads:		**$2,000,000**	**$230,000**	**$1,970,000**
Project Total W/Option 2A (Reimbursable):		**$4,200,000**	**-**	
Option 2B Estimate Totals :		**600,000**	**85,000**	**560,000**
Estimate Totals:		**$675,000**	**$110,000**	**$715,000**
Project Total W/Option 2B (Reimbursable):		**$1,500,000**	**-**	

Interconnection Facility Study
For
SaddleBack (Underwood) Wind Project
For PPM Energy (GI # 108)

July 6, 2004

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Agreement No. 02TX-11192

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APPENDICES

Preliminary Project Requirements Diagram (PRD)

1.0 INTRODUCTION

The Request: PPM Energy, Inc (PPM) requested (OASIS #108) for the Saddleback (was Underwood) Wind Project, a 70 MW wind turbine generation project connecting to the Bonneville Power Administration (Bonneville). Subsequently the request has been revised downward to 50 MW, initially with the site permitted for 86 MW. The study is based on 70 MW with the point of interconnection on the Midway-North Bonneville 230kV line. The wind project will consist of 1500 KW GE wind turbine generation (WTG) units, or possibly Vestas 1800 KW units. The requested interconnection energization date was March 1, 2004; the revised request is for December 2004, which may not provide sufficient time to build the interconnecting facility. A schedule will be provided with the signed agreement to proceed. Minimum time required is 15 months from a signed agreement to proceed, or a minimum of 10-12 months from permission to construction (after ROD or environmental permits signed), depending on what type of construction is required for Bonneville.

Project Description:
Option 1 - connecting to the Underwood 115 kV tap line of the Bonneville – Alcoa line is not the preferred alternative now due to the complexity of the local RAS requirements.
Option 2 is a ring bus substation connecting to the Midway-North Bonneville 230 kV line where it passes thru the site. PPM Energy will be responsible for the site and facilities beyond the change of ownership.

Objectives of Study:
The Interconnection Facility Study (IFS) addresses the following objectives:

a) Confirm the requested plan of service.
b) Identify facilities required for interconnection to the Bonneville system.
c) Provide documented costs estimates.
d) Establish a timeline to complete Bonneville's construction requirements.

Transient and fault duty study impacts on the preferred plan of service are not included. Once a construction agreement has been signed these issues will be addressed.

IFS Limitations: The technical study results included in this document are only for the purpose of developing the interconnection requirements. **System Impact studies (SIS) are being performed for the separate firm transmission request. Transmission service is neither implied nor guaranteed with this study and will be determined in separate studies.**

2.0 INTERCONNECTION OPTIONS

2.1 Description of Plan of Service

Option 1, the 115 kV substation (Saddleback), is not examined in detail at this time due to the RAS complexity of the interconnection and potential system expansion costs between Bonneville Powerhouse and the Vancouver area.

For Option 2, the 230kV substation (Saddleback), near Tower 22/6 and the forest service road CG 2927 on the north side of the two lines to requiring crossing of the 115kV line. Bonneville will build the 230 kV ring bus substation. Bonneville will own, operate, and maintain this substation up to the connection to the transformer. Bonneville will provide the intertie to the existing line. The Customer will provide the 230 kV/34.5 kV transformer(s) (WyeGrd-Delta-WyeGrd) and remainder of the wind project substation including the 34.5 kV collector system.

If the wind turbine generators are other than double–fed wound rotor induction machines with dynamic voltage control capability, shunt capacitors or other means to obtain unity power factor at 90% or greater of rated output will be required for the interconnecting facility. Voltage fluctuation shall be limited to less than 0.5 % at the 230kV point of interconnection per step and has to switch within 30 seconds on and off.

.

2.2 Study Results

230kV Option. The Midway-North Bonneville 230kV line interconnection provides sufficient capacity for the 70MW request. From the Saddleback substation interconnection, the power flow is 80% towards North Bonneville and 20% towards Midway. The contingency analysis indicates no overloads will occur. However, a local RAS is required to trip the generation for operational flexibility during system outages. Saddleback generation may need to be managed during outage conditions, within the operational planning process for the California-Oregon Intertie (COI), the I-5 corridor, or within the WILSWA area.

3.0 INTERCONNECTION AND SYSTEM REQUIREMENTS

3.1 Interconnecting Facilities

Bonneville will provide the transmission dead end structure(s), tap lines and make all terminations to the existing line for either option, and the portion of the substation required for the interconnection. Bonneville will install the 3 high voltage PCB's, bus work with provisions for expansion; disconnect switches, CCVT's, grounding, etc. Should Bonneville ask PPM Energy to provide the substation, all yard design for the high voltage shall be per Bonneville standards, especially grounding and bus layout. The design shall be subject to Bonneville review to assure compliance to Bonneville standards, as Bonneville will require ownership of this portion of the substation as a system facility.

The Customer will be responsible for acquiring the substation site (230kV portion for Bonneville ownership), permits, grading, fencing, etc; and for their portion all design, materials and construction including equipment specifications and protection for WTG collection system. Metering accuracy CT's and PT's will be required on each transformer for the Bonneville provided metering.

Bonneville Control, and Relaying: Bonneville will install all control and protection associated with the transmission system. New line relays and transfer trip will be added to the each line terminal at the Wind project substation. The new line PCB's will have five CT cores, C800. 125VDC is the control voltage for all switching equipment. Each line section will include the overload detection for the local Generation Drop requirement.

The existing line relays and transfer trip at the North Bonneville may need to be replaced to accommodate the new line relays at the Wind project substation. The Outlook 3-terminal relaying and transfer trip will need to be modified for this project.

Auto-reclosing will be provided for each PCB with appropriate logic for reclosing the line sections. After the generation has ceased (HLDB), logic will allow auto-reclose of the generation terminal PCB's for conditions where a temporary fault reclosed successfully. Auto-restoration of the wind turbines will be permitted for this situation. All other outages will require permission from Bonneville Dispatch to resume generation operations.

The Customer will be responsible for all equipment, control, meters, and relaying of the facility not included in the Bonneville furnished equipment. Refer to the attached diagram for delineation of the Bonneville provided equipment. The Customer control building will be required to have a secured area for all Bonneville equipment, with locked entry for security purposes, in addition to customer needs.

3.2 Synchronizing, RAS and Other System Control Requirements

Synch check relays and Dead Line Check will be required as depicted on the PRD for the existing BPA line terminals. Synchronizing of induction machines is not required.

A local Remedial Action Scheme (RAS) is required for operational flexibility. The project will need to address WECC requirements for frequency and voltage off normal operation, and fault ride through capability.

Voltage Control / VAr Requirements: The customer has indicated the use of the GE 1.5MW units, which provide sufficient voltage and VAr support. If a different WTG unit is selected, then the customer facility shall provide reactive within the WTG units and/or the substation at the 34.5 kV bus in sufficient steps and timing as required by Bonneville to minimize voltage fluctuations and to compensate for all reactive requirement. The minimum requirement will be PF =1.0 at 90% of rated output, at the point of interconnection. All external shunt capacitors will be on PF control normally within a voltage band provided by Bonneville. Voltage fluctuation shall be limited to less than 0.5 % at the 230kV point of interconnection per step and has to switch within 30 seconds on and off. Operational studies will determine the control and required

settings after the customer has provided their detailed design. No PF penalty shall be in force as long as the compensation scheme provides for voltage support and is in service.

4.0 TELECOMMUNICATIONS AND METERING

The existing fiber on the North Bonneville – Midway 230 kV line will be looped into the new substation for the communications requirements for either option. Digital equipment will be used for the communications system. Circuits will be added at both control centers (Dittmer and Munro) at N. Bonneville, AT Big Eddy and at Midway. The Customer control building will provide a separate space for this equipment and 48VDC communications batteries provided by BPA, with provisions to secure with BPA lock.

SCADA control of each 230kV PCB is required. If external shunt caps are used, then indication is required from each capacitor section and the controller.

The revenue metering will be on the metering accuracy (0.3% accuracy class) CT's and PT's on the connection to the transformer. KWH and KVArH telemetry will be required on a separate circuit. Analog KV, KW and KVAr will be included on the SCADA system provided by Bonneville for Control and monitoring purposes. A dial-up RMS link will be required for meter data. This communications plan of service assumes that the revenue metering equipment will be installed in the substation control house provided by PPM Energy.

Bonneville will provide all metering and communications equipment.

Circuits will be added at both control centers (Dittmer and Munro) to accommodate this phase. All communications equipment will be provided and installed by Bonneville, at the customer's expense. A detailed communications plan is provided in the attached PRD's.

5.0 COST ESTIMATES

Estimated Customer costs for interconnection are given below. These costs are only for the Bonneville supplied facilities. It is assumed that the Customer will be responsible for all equipment, facilities development, and site development including land acquisitions, and permitting, including environmental impact assessment.

Description of Facilities	QTY	Estimated Interconnection Costs		
		Material	Contract	Labor
230 kV, Add 3-PCB Ring Bus ref: Est SX-26749				
Project Mgmt, Design (assumes BPA develops site)			10,000	308,000
Constr T&E/Field Support/Material Support				135,000
3-PCB's, 9-Switches, 9-SA, 9-CVT's, Grounding System	1 lot	551,000		173,000
*Control/Relaying w/TT/DFR		220,000		97,000
Cable/**Station Service/**DC System		89,000		104,000
Bus/Insulators/Conduit System - Installed		97,000		96,000
Building**, Structures, Foundation		353,000	174,000	300,000
***Misc., Travel Time, Contingency		57,000	0	208,000
* Assumes some relaying for Wind Terminal				
** Assumes BPA supplied, Developer Option				
*** Assumes, Site work, Fence by Developer				
$2,972,000		**1,367,000**	**184,000**	**1,421,000**
230 kV Tower/Line Loop-in ref: Est LX-26748-1				
Project Mgmt, Design, Mapping				35,500
Land/Property Acquistion				7,500
Wood 3-Pole Structures w/Ins,Hdwr, Wire	2 each	30,000		75,000
Misc., Travel Time, Contingency		7,000		15,000
$170,000		**37,000**	**0**	**133,000**
Saddleback Comm (C&C Estimate)				
Project Management, Design				175,000
Fiber Loop-in 36Fiber, Sonet MUX, Terminations, Etc	1 lot	125,000		140,000
Chnl Bank Addn, Battery/Charger, etc	1 lot	85,000		35,000
SCADA/SER,KW/KWH TM, Metering	lot	35,000		30,000
Misc., Travel Time, Contingency		60,000		75,000
$760,000		**305,000**	**0**	**455,000**
Radio Hops, Relay Additions		Material	Design	Construction
Big Eddy Chnl Addns	1 lot	4,000	4,000	8,000
N. Bonn. Chnl Addns, Transfer Trip	1 lot	23,000	10,000	12,000
Midway Chnl Addns, Transfer Trip	1 lot	20,000	9,000	10,000
N. Bonn. Relay Replacement	1 lot	35,000	24,000	25,000
$184,000		**82,000**	**47,000**	**55,000**

Dittmer/Munro CC Additions (SCADA, Gen Int)				
Dittmer Modem, TM Additions		5,000	7,000	20,000
Munro Comm, Modem, TM, Phone Additions		2,000	6,000	15,000
$55,000		**7,000**	**13,000**	**35,000**
230kV Option Estimate Totals :		**1,798,000**	**244,000**	**2,099,000**
Estimate Totals w/OH's:		**$1,905,000**	**$310,000**	**$2,665,000**
Project Total (Direct Cost w/OH):		**$4,880,000**	-	

6.0 TECHNICAL ANALYSIS

The full documentation is contained in electronic format, available via ftp download or on a CD by request, requiring execution of a non-disclosure agreement. The detailed documentation is intended to provide sufficient supporting data for the results to be independently verified by specialized transmission system study engineers. The following brief description provides the key results.

6.1 Key Findings

No line additions or upgrades are needed for the interconnection.

6.2 Background

Interconnection Feasibility Evaluations were provided to requestors prior to commencement of the in-depth system studies. The estimated system expansion needs described in the IFE for Saddleback underestimated the local RAS requirements for an interconnection to the Underwood 115kV line, but the information was correct for the 230kV interconnection. Detailed IFS system studies were performed addressing both the 115kV and 230kV alternatives in two separate reports.

Third parties conducted most of the studies. PowerWorld Corporation developed and documented general study methods to efficiently address generator interconnections with their Simulator software. Their report is "Examination of Interconnection Limits for Potential Wind Generators on the BPA System". The PowerWorld report focused on the Columbia-Covington cluster as an example. Next, the Utility System Efficiencies, Inc performed the project specific system studies that determined system impact and system expansion alternatives. Their report is "System Studies for the Electrical Connection of the 70 MW Underwood Wind Generation project with the BPA Transmission System". The report for the 115kV interconnection alternative at Underwood was prepared by BPA and is "Underwood Wind Generation Interconnection Facility Study at Underwood 115kV". The reports and supporting data are available electronically, after execution of a non-disclosure agreement.
in the IFE's have been confirmed in the detailed IFS system studies.

6.3 Study Objectives

The system design required for the interconnection will maintain system reliability and provide access to the main grid. This is achieved by modeling a wide range of conditions with simultaneous uses (i.e. worst case) on the secondary system that shares access with other users to the main grid. The design includes a local Remedial Action Scheme to minimize the system expansion cost and schedule for the generator interconnection. The local RAS will trip the generation at a threshold measurement of power flow on local facilities, which the study shows will lead to an unreliable condition. The design is also intended to prevent the local RAS from overlapping with large generation tripping for major system events (main grid RAS) to minimize impact on frequency recovery.

Another objective is to provide information for transmission operations managers to assess the impact on grid operations staff and computer resources. The approach is to identify a list of out-of-service facilities that will need to be addressed with the generator projects. The variability of generator status and magnitude, combined with the local RAS, could increase the need for more operational planning to comply with grid reliability limits.

Transient (Swing) studies will be performed after execution of a construction agreement to evaluate the dynamic impact of this generation on the system and the response of this generation to system events.

6.4 Powerflow model

The basecase model represents summer 2005 topology. The reference load levels are summer peak. Sensitivity calculations address the impact of load assumptions. Multiple generation patterns were modeled to discover the limiting conditions that will determine system expansion requirements. The limits were determined for the system prior to completion and after completion of Schultz-Wautoma 500kV line.

6.5 Limiting Conditions and System Expansion Summary

The wind generation can reach the maximum 70 MW without a reliability limit. The limit achieves the study objective to prevent local RAS from overlapping with main grid RAS. The limiting contingency is the Coulee-Hanford-Vantage common mode outage above 70 MW.

6.6 Impact on grid operations

The interconnection design for the wind generation avoids new transmission lines by application of local RAS. The potential impact on operational planning resources was estimated to help managers address the staffing, information, and computation needs. The key finding is that the new generators and associated RAS needs to be addressed in the outage planning for the I-5 corridor and the Mid Columbia areas.

Fault Studies: System fault duties with this new generation will be included on the Preliminary PRD.

"DRAFT"
Executive Summary
Southwest Washington Northwest Oregon System Facility Study

Introduction

Transmission requests have been submitted to the Bonneville Power Administration Open Access Transmission Tariff queue for point-to-point transmission service for generators either planned or under development along the central I-5 corridor between Centralia, Washington and Portland, Oregon. The following summarizes the requests being addressed by this System Facility Study (SFS)

Name	Amount	Req. #	POR	POD	Gen. Status
Grays Harbor Phase I	500MW	237	Satsop 230	Big Eddy 500	Under const.
Longview Enron	200MW	243	Longview 230	John Day 500	Planned
	200MW	244	Longview 230	Big Eddy 500	
	200MW	245	Longview 230	Columbia 115	
Longview Mirant	124MW	257	Longview 230	John Day 500	Under const.
	124MW	258	Longview 230	Rocky Rch 230	
Grays Harbor Phase I	130MW	297-01	Satsop 230	Big Eddy 500	Under const.
Summit Westward	520MW	333	Allston 230	Harvalum 230	Planned
Grays Harbor Phase II	650MW	410	Satsop 500	Big Eddy 500	Planned

The System Impact Study (SIS) conducted for the Grays Harbor Phase I project dated March 22, 2001, concluded that the existing system is constrained and long-term transmission capacity is not available to meet their 500MW request #237. Therefore, transmission reinforcement is required on the I-5 corridor. Previous studies indicated that a new 500 kV transmission line was required from Paul to Troutdale substation.

Long-term transmission requests made for the Big Hanaford project developed at Centralia, Washington expire in 2003 and 2005 respectively. These transmission requests cannot be accommodated within the time frame of this project since they expire before a new 500 kV transmission line can be built.

Assumptions

New generation along the I-5 corridor, either planned or under construction, is being developed in three general areas, Centralia, Allston, and Longview. Studies model conditions for the summer season with north-south transfers through the system modeling all the committed obligations. This is the worst-case flow pattern for stressing the I-5 corridor. This creates stress across four local cutplanes, Paul-Allston, Longview area, South of Allston, and Portland area. Local industrial loads and new and existing generation were modeled appropriately to create the four stress patterns to determine what facilities beyond the new 500 kV line are required to provide long-term transmission capacity.

1. The following assumptions were made for firm obligations across the BPA system that affects the I-5 corridor.
   A. B.C.Hydro-Northwest Westside flow 850MW.
   B. Federal upper Columbia Hydro generation 7200MW.
   C. Other local generators with firm transmission service were modeled near their maximum including Centralia, Fredrickson at South Tacoma, Centralia at Napavine, Swift, and Mayfield and Mossy Rock.
   D. The California Oregon Intertie and Pacific DC Intertie were modeled near their historical summer operational transfer limits.
2. It was assumed that remedial action schemes (RAS) could utilize up to 2850MW of generator tripping for 500 kV N-2 outages and up to 1700 MW of generator tripping for 500 kV N-1 outages. The 2850 MW level is limited by possible frequency excursions causing under frequency load shedding of firm load. The 1700 MW level is limited by generation reserve requirements for loss of a single element.

Since the new combustion turbine generation is most effective for mitigating the overload problems based on their location, they were utilized for RAS generator tripping when needed.

3. The following infrastructure projects are assumed energized in the studies;
   A. G-1 Kangley-Echo Lake 500 kV line and Snoking 500/230 kV transformer.
   B. G-2 Shultz-Wautoma 500 kV line.
   C. G-3 McNary-John Day 500 kV line.
   D. G-6 Schultz series capacitors.
   E. G-9 Grand Coulee-Bell 500 kV line.
4. The most critical contingencies were run as required by the WECC and NERC Planning Standards. These include single line outages, credible double line outages, and breaker failure outages.

Study Results

In general the main grid transmission system along the I-5 corridor is limited by thermal overloads on the parallel underlying transmission system. With present obligations these overloads are severe enough to require the underlying 230 kV and 115 kV lines to be opened up following a disturbance. When new generation is added beyond present obligations these overloads are so severe that opening these underlying 230 kV and 115 kV lines will lead to voltage and transient instability. Therefore, a new 500 kV transmission line is needed to reinforce the existing system to accommodate these new transmission requests. In order to provide transmission service to the new generators addressed in this report, additional 230 kV and 115 kV reinforcements are also needed beyond the 500 kV line. To evaluate what lower voltage upgrades are also required studies were conducted on the four stress patterns listed in the assumptions.

The present plan of service for the new 500 kV transmission line is to develop a new 500 kV switching station in the Napavine-Allston 500 kV line approximately 12 miles north of Allston substation and build a 70 mile 500 kV transmission line from the new switching station to Troutdale. This requires and development of a 500 kV substation yard at Troutdale.

1. <u>Paul-Allston Path</u>

When the Paul-Allston path is stressed, for the existing system, the N-2 outage of the Paul-Allston #2 and Paul-Napavine-Allston #1 500 kV lines causes severe overloads requiring maximum RAS generator tripping. These lines are adjacent for 2.5 miles out of Paul substation and for 12 miles north out of Allston substation. Reconfiguring the lines 2.5 miles from Paul substation and locating the new switching station 12 miles north of Allston substation eliminates the need to assess this double line outage. Addition of the new switching station-Troutdale 500 kV line project significantly reduces the severity of N-2 outages between Paul and Allston.

After the addition of the new switching station-Troutdale 500 kV line project outages involving 500 kV lines between Paul and Allston substations overload the Chehalis-Longview 230 kV #1 and #3 lines. These outages also overload the Aberdeen-Cosmopolis 115 kV line, owned by Grays Harbor PUD, and the Raymond-Holcomb 115 kV line. The Chehalis-Longview 230 kV #1 and #3 lines are parallel to 1.6 miles north of Longview and are tied together into a single circuit for the remaining distance. One option to relieve these overloads is to reconductor the Chehalis-Longview #1 and #3 lines with approximately 33 miles of high temperature conductor. The option to relieve the overload on the Grays Harbor PUD Aberdeen-Cosmopolis 115 kV line is to reconductor approximately 11 miles of line. The option to relieve overload on the Holcomb-Raymond 115 kV line section is to resag this line to 100C operating temperature.

Outages involving the Paul-Napavine-new switching station-Allston 500 kV lines #1 overloads the Paul-Allston 500 kV line #2. The option to relieve this overload is to resag the river crossing from 90C to 100C operating temperature.

2. Longview Area

An outage of the Longview-Lexington 230 kV line overloads the Longview 230/115 kV transformer. An outage of the Longview 230/115 kV transformer also overloads the Longview-Lexington 230 kV line. In addition, outages involving the Allston-Keeler 500 kV line, the new switching station-Troutdale 500 kV line, or the double line outage of adjacent 230 kV circuits through Trojan substation overloads the Longview-Lexington 230 kV line. For the 500 kV outages maximum RAS generator tripping does not mitigate the overloads. The adjacent 230 kV lines through Trojan are owned by Portland General Electric and do not have RAS associated with them. One option to relieve overloading of the Longview-Lexington 230 kV line section is to reconductor 7.8 miles of line. Two options to relieve overloading on the Longview transformer are to either add a second 230/115 kV transformer at Longview or add a 230/115 kV transformer at Lexington.

3. South of Allston

When the South of Allston path is stressed, outages involving the Allston-Keeler 500 kV line, the new switching station-Troutdale 500 kV line, or the double line outage of adjacent 230 kV circuits through Trojan substation will overload the Lexington-Woodland Tap 230 kV line and the Woodland Tap-Ross 230 kV line. These outages also overload the Merwin-View Tap-Cherry 115 kV line owned by PacifiCorp. For the 500 kV outages maximum RAS generator tripping does not mitigate the overloads. The adjacent 230 kV lines through Trojan are owned by Portland General Electric and do not have RAS associated with them. The option to relieve overloading of the Lexington-Longview 230 kV line is to reconductor approximately 20 miles of line. One option to relieve overloading of the Woodland Tap-Ross 230 kV line section is to reconductor approximately 21 miles of line with high temperature conductor. BPA needs to work with PacifiCorp to upgrade approximately 11 miles of the Merwin-View Tap-Cherry 115 kV line.

4. Portland Area

When the Portland area is stressed, outages involving the Allston-Keeler 500 kV line, the Keeler-Pearl 500 kV line, or the new switching station-Troutdale 500 kV line overloads the Knott-Holiday-Harrison-Lincoln 115 kV line owned by PacifiCorp. For the 500 kV outages maximum RAS generator tripping does not mitigate the overloads. BPA needs to work with PacifiCorp to upgrade approximately 5.5 miles or 115 kV line.

Outages caused by breaker failures at Pearl 500 kV substation cause overloads on the Keeler 500/230 kV transformer as well as on the 230 kV and 115 kV underlying system in the Portland area. The option to eliminate this critical breaker failure includes re-terminating a 500 kV line and adding up to two additional breakers at Pearl 500 kV substation.

Outages caused by breaker failures at Pearl 230 kV substation cause overloads on the 230 kV and 115 kV underlying system in the Portland area. One option to mitigate problems caused by this breaker failure is to add a 230 kV sectionalizing breaker.

There are parallel combinations of several 500 kV outages that load Portland General Electric 230 kV lines through the Portland to their limits. These have not been fully investigated. RAS generator tripping may take care of these. An effort is underway to work with Portland General Electric to examine other upgrades needed in the Portland area.

Conclusions

With the assumed firm obligations there is no capacity available across the existing BPA system to meet the long-term transmission requests in the BPA OATT queue along the I-5 corridor. A new 500 kV transmission line along with the following upgrades on the underlying system is required to meet the long-term transmission requests addressed in this report.

1. Swap the Raver-Paul 500-kV and the Paul-Allston (Napavine) 500-kV #1 lines approximately 2.5 miles from Paul substation. This will make the Paul-Allston (Napavine) #1 500-kV Line and the Paul-Allston #2 500-kV Line on separate right of way on this 2.5 mile section.
2. Chehalis-Longview Tap 230-kV #1 and #3 lines – Reconductor approximately 33 miles of each line with high temp wire to minimum capacity of 1500A each at 30C ambient temperature.
3. Longview T-Longview 230-kV line – Upgrade 1.6 miles to minimum 3000A at 30C ambient temperature.
4. Paul-Allston 500-kV #2 – Resag river crossing from 90C to 100C conductor operating temperature.
5. Longview-Lexington 230-kV – Reconductor 7.8 mile section to minimum of 1420A at 30C ambient temperature.
6. Lexington – Woodland Tap (Swift Switching Station) 230-kV line – Reconductor approximately 20miles of 230-kV line to minimum of 1420A at 30C ambient temperature.
7. Woodland Tap-Ross 230-kV –Reconductor approximately 21 miles of 230-kV line with high temperature wire to get minimum of 1500A at 30C ambient temperature.
8. Longview 230/115-kV – Add second transformer at Longview or Lexington.
9. Aberdeen-Cosmopolis 115-kV line – **Grays Harbor PUD's** Line-Reconductor approximately 11 miles of 115-kV line to minimum of 650A at 30C ambient temperature.
10. Holcomb-Raymond 115-kV Line section. Upgrade (approx.12 miles) sag to 100C conductor operating temperature.
11. Merwin-View Tap-Cherry PPL 115-kV line – **PacifiCorp** to upgrade approximately 11 miles of 115-kV line to minimum of 1200A at 30C ambient temperature.
12. Knott-Holladay-Harrison-Lincoln 115-kV Line – Upgrade approximately 5.5 miles of **PacifiCorp's** 115-kV line to minimum of 1300 A at 30C ambient temperature.
13. Ostrander – Pearl 500-kV – Resag approximately 20 miles of 500-kV line to minimum of 1800A at 30C ambient temperature.
14. Pearl 500-kV Breaker Failure Outages: Add Breakers at Pearl 500-kV to eliminate critical breaker failure outages. This includes re-termination of 500-kV line and addition of up to 2 new breakers.
15. Pearl 230-kV Breaker Failure Outages: Add sectionalizing breaker at Pearl 230-kV substation.

Additional remedial action schemes not yet identified will require RAS generator tripping to relieve line thermal overloads. This could be a significant cost because line loss logic may be required on several 230 kV transmission lines to mitigate problems caused by N-2 outages of adjacent 500 kV and 230 kV circuits. If the assumptions used in this analysis change in the future (i.e. new generation status, changes in BPA infrastructure plans, etc.) these requirements could change significantly.

"DRAFT"
Executive Summary
Southwest Washington Northwest Oregon System Facility Study

Introduction

Transmission requests have been submitted to the Bonneville Power Administration Open Access Transmission Tariff queue for point-to-point transmission service for generators either planned or under development along the central I-5 corridor between Centralia, Washington and Portland, Oregon. The following summarizes the requests being addressed by this System Facility Study (SFS)

Name	Amount	Req. #	POR	POD	Gen. Status
Grays Harbor Phase I	500MW	237	Satsop 230	Big Eddy 500	Under const.
Longview Enron	200MW	243	Longview 230	John Day 500	Planned
	200MW	244	Longview 230	Big Eddy 500	
	200MW	245	Longview 230	Columbia 115	
Longview Mirant	124MW	257	Longview 230	John Day 500	Under const.
	124MW	258	Longview 230	Rocky Rch 230	
Grays Harbor Phase I	130MW	297-01	Satsop 230	Big Eddy 500	Under const.
Summit Westward	520MW	333	Allston 230	Harvalum 230	Planned
Grays Harbor Phase II	650MW	410	Satsop 500	Big Eddy 500	Planned

The System Impact Study (SIS) conducted for the Grays Harbor Phase I project dated March 22, 2001, concluded that the existing system is constrained and long-term transmission capacity is not available to meet their 500MW request #237. Therefore, transmission reinforcement is required on the I-5 corridor. Previous studies indicated that a new 500 kV transmission line was required from Paul to Troutdale substation.

Long-term transmission requests made for the Big Hanaford project developed at Centralia, Washington expire in 2003 and 2005 respectively. These transmission requests cannot be accommodated within the time frame of this project since they expire before a new 500 kV transmission line can be built.

Assumptions

New generation along the I-5 corridor, either planned or under construction, is being developed in three general areas, Centralia, Allston, and Longview. Studies model conditions for the summer season with north-south transfers through the system modeling all the committed obligations. This is the worst-case flow pattern for stressing the I-5 corridor. This creates stress across four local cutplanes, Paul-Allston, Longview area, South of Allston, and Portland area. Local industrial loads and new and existing generation were modeled appropriately to create the four stress patterns to determine what facilities beyond the new 500 kV line are required to provide long-term transmission capacity.

1. The following assumptions were made for firm obligations across the BPA system that affects the I-5 corridor.
   A. B.C.Hydro-Northwest Westside flow 850MW.
   B. Federal upper Columbia Hydro generation 7200MW.
   C. Other local generators with firm transmission service were modeled near their maximum including Centralia, Fredrickson at South Tacoma, Centralia at Napavine, Swift, and Mayfield and Mossy Rock.
   D. The California Oregon Intertie and Pacific DC Intertie were modeled near their historical summer operational transfer limits.
2. It was assumed that remedial action schemes (RAS) could utilize up to 2850MW of generator tripping for 500 kV N-2 outages and up to 1700 MW of generator tripping for 500 kV N-1 outages. The 2850 MW level is limited by possible frequency excursions causing under frequency load shedding of firm load. The 1700 MW level is limited by generation reserve requirements for loss of a single element.

Since the new combustion turbine generation is most effective for mitigating the overload problems based on their location, they were utilized for RAS generator tripping when needed.

3. The following infrastructure projects are assumed energized in the studies;
   A. G-1 Kangley-Echo Lake 500 kV line and Snoking 500/230 kV transformer.
   B. G-2 Shultz-Wautoma 500 kV line.
   C. G-3 McNary-John Day 500 kV line.
   D. G-6 Schultz series capacitors.
   E. G-9 Grand Coulee-Bell 500 kV line.
4. The most critical contingencies were run as required by the WECC and NERC Planning Standards. These include single line outages, credible double line outages, and breaker failure outages.

Study Results

In general the main grid transmission system along the I-5 corridor is limited by thermal overloads on the parallel underlying transmission system. With present obligations these overloads are severe enough to require the underlying 230 kV and 115 kV lines to be opened up following a disturbance. When new generation is added beyond present obligations these overloads are so severe that opening these underlying 230 kV and 115 kV lines will lead to voltage and transient instability. Therefore, a new 500 kV transmission line is needed to reinforce the existing system to accommodate these new transmission requests. In order to provide transmission service to the new generators addressed in this report, additional 230 kV and 115 kV reinforcements are also needed beyond the 500 kV line. To evaluate what lower voltage upgrades are also required studies were conducted on the four stress patterns listed in the assumptions.

The present plan of service for the new 500 kV transmission line is to develop a new 500 kV switching station in the Napavine-Allston 500 kV line approximately 12 miles north of Allston substation and build a 70 mile 500 kV transmission line from the new switching station to Troutdale. This requires and development of a 500 kV substation yard at Troutdale.

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Additional remedial action schemes not yet identified will require RAS generator tripping to relieve line thermal overloads. This could be a significant cost because line loss logic may be required on several 230 kV transmission lines to mitigate problems caused by N-2 outages of adjacent 500 kV and 230 kV circuits. If the assumptions used in this analysis change in the future (i.e. new generation status, changes in BPA infrastructure plans, etc.) these requirements could change significantly.

February 18, 2005

Underwood 115kV Wind Generation System Impact Study

Prepared by the Bonneville Power Administration Transmission Business Line

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Prepared by: Gordon Comegys
Operations and Planning

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5.10 Line out-of-service conditions
6 Conclusions

1 Introduction

1.1 Point of Receipt (POR) and Point of Delivery (POD)

This report documents power flow studies addressing Long Term Firm Point to Point requests 645, 646, 647, and 648 (http://www.transmission.bpa.gov/OASIS/BPAT/oasis_html/ltreq.htm) for the delivery of 70 MW of Underwood Wind generation from the Underwood Substation on the Alcoa-Bonneville 115kV line. The Points of Delivery are to PGE (Pearl Substation) and the Northwest Market Hub (NWH). The POD at the NWH is defined as the five BPA substations (Midway, Columbia, Vantage, Valhalla, and Sickler) interconnected with one of the three Mid Columbia control areas (Grant, Chelan, or Douglas). NWH information is posted on the OASIS at http://www.transmission.bpa.gov/OASIS/BPAT/Scheduling/NWHBP.doc

NWH rules require a coinciding schedule to take the delivered power out from the NWH (no corresponding request exists to do that with Underwood Wind). The studies assume that the future transmission service out from the NWH will use either (a) existing transmission rights or (b) a future request that will be granted because the POR/POD combination will not use a congested path.

An interconnection request does not presently exist for new generation at Underwood 115kV. This SIS assumes future generation at this location.

1.2 SIS objectives

The SIS objective is to determine whether the Long Term Firm PTP requests can be granted. If it can't be granted, then the approximate scope of system expansion is identified. If the SIS identifies system expansion is needed, BPA is required to tender a Facility Study agreement to the requestor for detailed studies to determine required facilities, schedule, and estimated cost.

1.3 Supporting data

The supporting data is contained in separate files identified in brackets [*filename.*xls] with a hyperlink to it in this document (which should link correctly if it resides in the same directory). Supporting data is only available upon request and the execution of a non-disclosure agreement at http://www2.transmission.bpa.gov/PlanProj/NonDisclosureForm.pdf. It will be made available via ftp download in electronic format. Most of the complete supporting data files are PowerWorld Simulator binary history files [*filename.*pwb] that can be accessed with the PowerWorld Simulator program version 10 or the free downloadable Simulator viewer that can be obtained at http://www.powerworld.com/products/viewer.html . For efficiency in describing results, some of the supporting data files are Excel spreadsheets. The basic intent is to provide full data access to the audience by providing the binary history files and allow navigation with the Simulator to the datafields of interest.

2 Establishment of Base Case Conditions

The potential transmission constraints are initially found with the system model representing the existing transmission system modified with future transmission commitments and associated system changes. The system conditions in the base case, developed for operating and planning the main grid, may not provide the limiting conditions for the sub grid. Therefore, the need for modifications to the budget base case generation pattern are first determined (described in sections 2.1 and 2.2) and the changes are documented (section

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2.3). The objective is to model the credible pre-contingency generation/load patterns so the contingency analysis will calculate the potential limits.

2.1 Identification of pre-contingency affected facilities

The starting basecase generation pattern is analyzed for adequacy to find the reliability limits potentially impacted by the new generation. Application of Power Transfer Distribution Factor (PTDF) calculations provide a list of candidate branches with significant incremental power flow caused by the new generation. These branches are first investigated prior to addition of new generation. The Transmission Loading Relief (TLR) calculation identifies the generation and loads that contribute to the the power flow on these lines. The TLR quantifies the sensitivity of the branch loading to generation patterns. Historical loading data is compared with the starting base case loading (section 2.2). Historical versus base case topology differences that could affect the branch loading is not investigated (e.g. historical flow data affected by outage conditions). If the historical loading is higher and the TLR shows that it will be changed by generation patterns, the starting basecase generation pattern is modified (section 2.3) to achieve a condition that can identify reliability limits. If an outage, rather than a generation pattern, is causing the historical loading to be high, the resulting severe generation pattern modeled in the modified base case provides margin.

2.1.1 Precontingency PTDF's

Incremental loading is quantified on all branches from the new generation prior to a contingency [underwood115-ptdf.xls]. The North Bonneville-North Camas 115kV line, the North-Bonneville-Alcoa 115kV line, and the 69kV line section from Condit to Bingen on the Bald Mountain-Powerdale 69kV line are candidates for investigation to develop the planning base case generation pattern.

2.1.1.1 North Bonneville-North Camas and North Bonneville-Alcoa 115kV lines

The Transmission Loading Relief (TLR) calculation identifies the generation and loads that contribute to the loading [evansclk-ncamas-tlr.xls]. Bonneville 115kV generation levels dominate the loading on these branches. The impact of 1 MW from Bonneville is similar to the impact of 1.14 MW from Underwood 115kV.

2.1.1.2 Bald Mountain-Powerdale 69kV line

The TLR shows the 69kV power flow serving the Hood River loads will be affected by the Underwood generation, because 23% of the new generation will flow on the 69kV Hood River PAC system. The impact of 1 MW from Underwood is similar to the impact of 4.8 MW from Bonneville 115kV generation [baldmountain-tlr.xls]

2.1.1.3 Bonneville-Hood River 115kV line

The TLR shows the impact of 1 MW generation from Underwood on the 115kV power flow from Bonneville to Acton on the Hood River line is similar to 1.75 MW from Bonneville 115kV generation [bonneville-acton-tlr.xls].

2.1.1.4 Big Eddy 230/115kV transformer

Previous wind generation studies for Klondike predicted future generation integrated on the 115kV system in the general area will cause the power flow to exceed the summer capacity of the Big Eddy 230/115kV transformer (power flow from the 115kV to the 230kV). The impact of Underwood was calculated. The TLR shows 17.4% of the Underwood generation will flow through the transformer (potential 12 MW total contribution to the Big Eddy 230/115kV transformer loading from 70 MW generation) [bigeddy-tlr.xls].

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2.1.2 POD issue at Pearl

Incremental flow occurs on the previously identified South of Allston flow path from either POR option to the Pearl POD. Previous System Impact and Facilities studies have identified the need for large scale mitigation such as the SW Washington – NW Oregon Transmission Project [http://www.transmission.bpa.gov/orgs/opi/system_news/SWWA_NWOR_ExecSum.doc]. This SIS report investigates system impact to deliver Underwood wind to the Northwest Hub and not to Pearl.

2.2 Historical Conditions on affected facilities

2.2.1 115kV and 69kV facilities

The Bonneville-North Camas 115kV line shows sustained peaks at 135 MW in winter and 125 MW in summer [Ncamas-Bonneville-scada.xls] measured at North Camas. Bonneville-Alcoa 115kV line shows sustained peaks at 85 MW in winter and 65 MW in summer [Alcoa-Bonneville-scada.xls]. Powerflow on the Bald Mountain-Powerdale 69kV line shows summer peaks at –10 MW [BaldMtn-Powerdale-scada.doc]. The summer conditions appear most limiting due to the reduced facility ratings.

Four generator units are connected to the Bonneville 115kV bus for a total generation peak of 248 MW (2-55MVA units and 2-69MVA units). The TLR shows the most severe conditions on the 115kV lines occur with all four units generating coinciding with low generation on the units connected to the 230kV North Bonneville bus.

2.2.2 Limiting season

The likely season to be constraining appears to be the summer season. The 2005 summer peak load basecase for network planning [a05cy04dd_working.pwb] was compared with historical levels described above. Section 2.3 describes the changes made to the basecase to achieve the historically stressed conditions caused by generation patterns.

Other conditions are studied to determine if other credible generation/load patterns could be more limiting than summer. This includes summer light load and winter heavy load.

2.3 Modifications to the model

The Simulator Optimal Power Flow (OPF) was applied to efficiently modify the generation patterns to achieve the stressed levels. The basecase started with 57 MW into North Camas from Bonneville and 23 MW into Alcoa from Bonneville. Generation shifts from Chehalis, Beaver, River Road, Bonneville 230kV, Swift, Yale, Merwin, and Mossyrock to the Bonneville 115kV, The Dalles, and John Day achieved the 135 MW flow into North Camas from Bonneville [underwood115-basecase-genshift.xls]. The large changes that increased generation into the 115kV buses at Bonneville and The Dalles caused the new basecase to overload the Big Eddy 230/115kV transformer [underwood115-basecase-genshift-atc.xls]. To mitigate, The Dalles unit #4 connected to the 115kV bus was taken off. The resulting North Camas flow from Bonneville was 131 MW [underwood115-basecase-genshift.pwb]

3 Key Assumptions

3.1 Sufficient information from powerflow studies

The decision on the scope of interconnection facilities and system expansion are primarily determined by steady state and post-transient calculations performed with the powerflow simulations. The transient stability simulations will be performed after a construction agreement is executed.

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3.2 Sufficient Operational Planning resources

Changes to the transmission system (e.g. new generation sites) will impact operational planning. Implementing an interconnection plan for new generation assumes the resources for the operations function are appropriated.

3.3 Local RAS alternative

The system design to include tripping wind generators to mitigate problems caused by contingencies, referred to as “local RAS”, is assumed as an alternative to system expansion that would increase the system robustness. The wind generator characteristics (size, machine type, diversity, intermittent generation, load rejection capability) appear to technically support the local RAS alternative. The operational resources need to be higher than the system expansion alternative.

3.4 Unity powerfactor with no AVR on the generator terminal

Voltage regulation is investigated. Other assumptions are (a) interconnection design to accommodate the highest loading, which occurs during summer or winter, will provide for adequate design during other time-of-day conditions the other seasons, and (b) unity power factor at the point of interconnection with no dynamic reactive capability.

4 Study Method Description

The study is performed in a series of sequential steps. These steps are described below.

4.1 No contingency limit

The maximum generation is modeled to determine whether precontingency conditions will cause loading beyond facility limits. If limits are exceeded, mitigation alternatives are identified.

4.2 Contingency analysis

A contingency analysis is performed with the proposed resource at the maximum generation that complies with the pre-contingency limit. Contingencies that cause thermal limit violations in the model, but have no contribution from wind, are filtered out and assumed mitigated by other means to make a case compliant with reliability criteria. The Simulator ATC tool is applied to analyze contingencies affected by the wind generation. The ATC tool efficiently lists the contingency limits in ascending order of severity.

4.3 Contingency mitigation

Potential mitigation plans for contingency violations contributed by the resource are identified. The objective is to identify a possible plan that is a simple local RAS. This minimizes the system expansion schedule. The results show that local RAS is can’t be planned at this time, due to existing reliability criteria violations that need mitigation.

4.4 Voltage performance

Proximity to voltage stability limits on the local lines are assessed by QV calculations on the most severe contingency loading the line, and PV calculations that monitor voltage and sensitivity trends for a series of incremental system load conditions. The objective is to determine the potential need for fast RAS. The potential for voltage fluctuations with variable wind loading on the lines was investigated by fixing slow voltage control devices and ramping the generation from zero to maximum.

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4.5 Loss assessment

Loading long lines near thermal limits has the potential to result in high losses. The sensitivity of system losses to the wind interconnection location are compared to other generator locations on the grid. The model is modified to cut the Northwest network from the WECC loop and Canada [nwcut.pwb]. The cut system essentially replicates the optimal operation of WECC phase shifters to mitigate inadvertent flow. The objective is to ensure that the calculated loss sensitivities will not include potential error due to base case generation/load patterns outside the Northwest. The results are shown in a table with incremental losses referenced to the Grand Coulee generator. Superposition applies, so the loss sensitivity can be calculated for any incremental increase at a generator displacing an increment at a different generator. The final results show that losses should not be a major factor in the selection of a system expansion alternative.

5 Study Results

5.1 No Contingency Limit

With the maximum 70 MW generator size, the system prior to a contingency is within facility limits. The first facility limit reached would be the Evansclk-N Camas section of the Bonneville-North Camas 115kV line if the generator size reached 80 MW [underwood115-nocontingency-atc.xls].

5.2 No Contingency Limit Mitigation

No mitigation is needed.

5.3 Contingency Analysis

The severe generation pattern to achieve the stressed Bonneville to Vancouver area powerflow appear to violate reliability criteria for four contingencies prior to Underwood wind generation demonstrated by the negative reliable wind generation level [atc-linear-no-ras-selected contingencies-underwood115.xls]. These contingencies are, in approximate order of severity: (1) Bonneville-Alcoa 115kV overloading North Camas-Sifton 115kV, (2) common mode outage of Ross-Rivergate and Ross-St Johns 230kV lines overloading Ross-Hazel Dell CC 115kV, (3) Sifton 115kV breaker failure overloading Ross-Hazel Dell CC 115kV, and (4) North Camas to Camas 115kV overloading North Camas-Sifton 115kV.

5.4 Analysis of contingency violations prior to Underwood wind

The OPF tool was applied to calculate the minimum shift from the severe generation pattern to reduce loading on the overloaded branches within the summer limits. The results are not used to modify the basecase. Instead, the information is intended to ensure the modeled conditions are sufficiently severe to provide some margin in the design for interconnection of new generation (partially accommodate unforecasted changes in the future such as line rating changes and future Bonneville RAS). The results in section 5.3 shows that Bonneville 115kV generation exceeds the reliable level before Underwood wind by about 100 MW.

5.4.1 Ross-Hzldcc 115kV branch overload

The Ross-Rivergate/Ross-St Johns common mode outage requires a generation shift of about 70 MW from Bonneville 115kV to River Road [opf-ross-hzdlcc-rating-commonmode-outage-ross-rvgt-stjohns.pwb]. The TLR calculations show the loading is primarily driven by load levels [ross-hzldcc-tlr-ross-rvrgat-stjohns-commonmode-outage.xls].

5.4.2 N Camas-Sifton 115kV branch overload

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The Bonneville-Stevens TP section outage requires a generation shift of about 100 MW from Bonneville 115kV generation to Yale [gen-shift-to-mitigate-contingency-overload-ncamas-sifton.xls].

5.5 Analysis of contingency violations after Underwood wind

The new Underwood generation impacts the contingency effects involving the local single and common mode outages of the Bonneville-North Camas 115kv, Bonneville-Alcoa 115kV, and the Bald Mountain connection with PAC's Hood River 69kV system [atc-linear-no-ras-selected contingencies-underwood115.xls]. Four main grid contingencies are impacted by the new generation. These are Wautoma-Ostrander-Troutdale 500kv, the Big Eddy-Ostrander-Troutdale 500kV, the Wautoma-Ostrander 500kV/McNary-Ross 345kV, and the Wautoma-Ostrander 500kV/Midway-North Bonneville 230kV.

5.6 Contingency Mitigation

5.6.1 Local RAS alternative

RAS was not investigated as an alternative because the existing system and generation appears to violate reliability criteria. If the existing criteria violations are mitigated (such as RAS to trip Bonneville generation), the Underwood generation on the 115kV will need further extensive RAS to mitigate contingencies that overload facilities. This will include the measurement of the power flow on the Bonneville-North Camas 115kV, Bonneville-Alcoa 115kV, and the Bald Mountain 115/69kV transformer to be inputs for the design of a RAS. This will require communications from the measurement sites to the new generation. The new generation can potentially be tripped based on a threshold loading that indicates an impending reliability problem.

5.6.2 System Expansion alternatives

An option with more certainty of success to provide the transmission service is a third 115kV line to the Vancouver area, likely to Sifton.

5.7 Voltage Performance

5.7.1 Voltage regulation

The variable wind generation without dynamic voltage regulation has the potential to cause voltage regulation issues. The study strategy is to apply the PV tool. The new generation is ramped up with unity powerfactor on the low side of the step up transformer and no AVR. PV calculations are performed for the two extremes of Bonneville 115kV generation. The first extreme is with all four units off line. The second extreme is with all four units on at Pmax with little reactive reserve remaining. If no problems are found with the extremes, then voltage regulation is eliminated from further investigation.

5.7.2 Voltage limits after contingencies

The potential for low voltage appears during peak winter loads following contingencies. The addition of the new generation does not appear to significantly impact it.

5.8 Loss Assessment

The loss sensitivity feature is applied for generation between 0 and 70 MW in 10 MW increments. For an interconnection design that relies on local RAS as an alternative to more lines, the potential for high losses associated with high precontingency loading could be a decision factor. However, the results show that the location is efficient relative to most other existing generation from a loss standpoint, due to proximity to Portland area loads.

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5.9 Sensitivity to future changes

The sensitivity of two changes that could create more severe conditions are assessed. These conditions are (a) the addition of the Schultz-Wautoma 500kV line, and (b) future load growth.

5.9.1 Schultz-Wautoma 500kV line

This Line Outage Distribution Factor (LODF) calculation is applied to determine incremental effects on the base case branches of adding the Schultz-Wautoma line. This line addition appears to cause a very small increase (0.14% increase) in line flow on base case limiting branches [schultz-wautoma-lodf.xls]

5.9.2 Load growth

The TLR calculations provide data that is used to estimate the impact of load growth. For the pre-contingency condition, load growth causes a net positive impact [underwood115-ncamas-tlr.xls].

5.10 Line out-of-service conditions

Contingencies that show No-RAS limits below 70MW Underwood generation, or contingencies that cause local RAS generator tripping, provide an initial list of planned outages requiring investigation. The Underwood generation needs to be off until operational studies are performed . These lines are Big Eddy-Ostrander 500kv, Wautoma-Ostrander 500kV, Ostrander-Troutdale 500kV, Midway-North Bonneville 230kV, Ross-Rivergate 230kV, Ross-St Johns 230kV, Bonneville-Alcoa 115kV, Bonneville-North Camas 115kV, North Camas-Sifton 115kV, Sifton-Ross 115kV, Bonneville-Hood River 115kV, Hood River-The Dalles 115kV, and Big Eddy-Chenoweth 230kV.

6 Conclusions

A key finding in this SIS is that the existing conditions prior to additional generation at Underwood 115kV can cause reliability criteria violations. The 645, 646, 647, and 648 transmission requests end August 1, 2007. System expansion needs to be in place by August 1, 2006 to provide long term firm service. It is possible that extensive communications, remote power flow measurements, and local Remedial Action Schemes could mitigate the planning contingencies. However, an additional 115kV line from Bonneville to Sifton could ultimately be the only feasible scope of system expansion that will mitigate both the existing reliability criteria violations and the additional violations caused by the Underwood 115kV generation.

A System Facilities Study agreement needs to be tendered for these transmission service requests.

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gen-shift-to-mitigate-contingency-overload-ncamas-sifton.xls

Participation Groups

Name	Gen MW T	Gen MW T	Change
Aberdeen (	0	0	0
Adair Gen	4.8	4.8	0
Albeni Falls	31.32	31.32	0
Alder Gen	21.39	21.39	0
American F	71.97	71.97	0
Anderson F	31.99	31.99	0
Ashe Gen	1189.31	1189.31	0
Beaver Ge	0	0	0
Big Hanafo	258.63	258.63	0
Bliss Gen	47.98	47.98	0
Boardman	540	540	0
Boise Benc	-0.28	-0.28	0
Bonneville	199.77	248	-48.23
Bonneville	0	0	0
Bonneville	199.77	248	-48.23
Boundary (	803.85	803.85	0
Box Canyo	57.86	57.86	0
Boyle Gen	41.4	41.4	0
Brady Gen	-0.2	-0.2	0
BRD Gen	146.5	146.5	0
Bridge Rive	416.15	416.15	0
Bridger, Jir	2209.2	2209.2	0
Broad Stre	1	1	0
Brownlee (	602.5	602.5	0
Bull Run G	0	0	0
Burrard Ge	293.07	293.07	0
Cabinet Gc	218.2	218.2	0
Carmen Ge	42.1	42.1	0
Cedar Falls	2	2	0
Centralia G	1180	1180	0
Cheakamu	136.92	136.92	0
Chehalis G	0	0	0
Chelan Ge	52	52	0
Chief Jose	1142.28	1142.28	0
Chief Jose	1130.68	1130.68	0
Chief Jose	2272.96	2272.96	0
Colstrip 23	662.34	662.34	0
Colstrip 50	1524.54	1524.54	0
Colstrip Ge	2186.88	2186.88	0
Condit Ger	7	7	0
Condit Win	50	50	0
Convanta (	12.43	12.43	0
Copco Ger	40.13	40.13	0
Cougar Ge	12.87	12.87	0
Coulee, Gr	1130.68	1130.68	0
Coulee, Gr	4050.8	4050.8	0
Coulee, Gr	5181.48	5181.48	0
Cowlitz Fal	0	0	0
Coyote Spr	459.81	459.81	0
Creswell G	4.14	4.14	0

Cushman (	46.32	46.32	0
Dale Gen	15.99	15.99	0
Dalles, The	1064.4	1064.4	0
Dalles, The	1020.8	1020.8	0
Dalles, The	2085.2	2085.2	0
Days Creel	7	7	0
Detroit Ger	100.55	100.55	0
Dexter Ger	5.42	5.42	0
Diablo Ger	147.72	147.72	0
Don Plant (	14.99	14.99	0
Dworshak (	334.1	334.1	0
Electron G	12.68	12.68	0
Emmett Ge	19.98	19.98	0
Enserch G	157.27	157.27	0
Faraday G	0	0	0
Foster Ger	4.29	4.29	0
Fredericks	148.8	148.8	0
Fredericks	259.13	259.13	0
Fredonia G	315.6	315.6	0
G.M. Shrur	2408.36	2408.36	0
Goldendale	303	303	0
Gorge Gen	61.67	61.67	0
Green Pete	10.79	10.79	0
Hells Cany	269.9	269.9	0
Hermiston	0	0	0
Hermiston	579.92	579.92	0
Hills Creek	9.88	9.88	0
Hungry Ho	202.28	202.28	0
Ice Harbor	309.03	309.03	0
Jackson G	82.95	82.95	0
John Day (	2576	2576	0
Kemano G	699.56	699.56	0
Kerr Gen	140.73	140.73	0
Kettle Falls	44.49	44.49	0
Klamath Fa	501.91	501.91	0
Klondike W	25	25	0
Kootenay (	366.51	366.51	0
Lancaster (	258.63	258.63	0
Libby Gen	234.17	234.17	0
Little Goos	585.85	585.85	0
Long Lake	47.82	47.82	0
Lookout Ge	26.18	26.18	0
Lost Creek	31.44	31.44	0
Lower Colu	5475.86	5475.86	0
Lower Grai	585.86	585.86	0
Lower Mala	10.99	10.99	0
Lower Mon	585.86	585.86	0
Lower Saln	31.99	31.99	0
Lower Sna	2400.7	2400.7	0
Lucky Peal	79.97	79.97	0
March Poir	138.65	138.65	0
Mayfield G	0	0	0

McCall Ge	16.99	16.99	0
McNary 11	77.06	77.06	0
McNary 23	737.61	737.61	0
McNary Ge	814.66	814.66	0
Merwin Ge	0	0	0
Meyers Fal	1.33	1.33	0
Mica Gen	1093.59	1093.59	0
Mid-Colum	1863.69	1863.69	0
Milner Gen	7.98	7.98	0
Minidoka G	27.98	27.98	0
Morrow Ge	0	0	0
Mossyrock	0	0	0
Moyie Spri	2	2	0
Murder Cre	40	40	0
Nine Cany	26.1	26.1	0
Nine Mile F	16.59	16.59	0
North Fork	0	0	0
Northeast (	0	0	0
Noxon Ger	121.85	121.85	0
Oak Grove	0	0	0
Oxbow Ge	199.88	199.88	0
Palisades (	167.61	167.61	0
Peace Can	585.82	585.82	0
Pelton Ger	108	108	0
Port Angel	0	0	0
Post Falls (	12.32	12.32	0
Priest Rive	614.52	614.52	0
Rathdrum (	0	0	0
Revelstoke	1562.64	1562.64	0
River Mill G	0	0	0
River Roac	0	0	0
Rock Islan	43.28	43.28	0
Rocky Rea	701.42	701.42	0
Ross Gen	135.58	135.58	0
Round Butt	285	285	0
S Slocan G	36	36	0
SCL & SP[	427.92	427.92	0
SCL Skagi	344.97	344.97	0
Seven Mile	361.62	361.62	0
Snoqualmi	31.34	31.34	0
Stateline W	75	75	0
Strike, C.J.	55.98	55.98	0
Sumas Ge	117.53	117.53	0
Swan Falls	14.99	14.99	0
Tenaska G	249.23	249.23	0
Thomson (	70.31	70.31	0
Troutdale (	0	0	0
Twin Falls	11.98	11.98	0
Upper Bak	66.63	66.63	0
Upper Colu	7454.45	7454.45	0
Upper Salr	33.99	33.99	0
Upriver Ge	18	18	0

Vancouver	0	0	0
Vansycle F	25	25	0
Wanapum	665	665	0
Waneta Ge	0	0	0
Wauna Ge	0	0	0
Wells Gen	401.37	401.37	0
Western M	776.5	776.5	0
Weyerhaus	41.64	41.64	0
Whatcom (	672.83	672.83	0
White Rive	25.98	25.98	0
Whitehorn	148.8	148.8	0
Wynooche	4.34	4.34	0
Yale Gen	50.55	0	50.55

Underwood115-ptdf.xls

Line PTDF Records

From Num	From Nam	From Nom	To Numbe	To Name	To Nom kV	Circuit	From % PTDF
40074	BALD M T	115	41103	UNDRWO	115	1	-100
40183	CARSON	115	41037	STEVNSO	115	1	76.9
41035	STEVN TP	115	41037	STEVNSO	115	1	-76.9
40074	BALD M T	115	40183	CARSON	115	1	76.9
40139	BONNVILE	115	41035	STEVN TP	115	1	-50.39
40541	HOOD RVI	115	41071	THE DALS	115	1	39.34
40173	CAPEHOR	115	47043	EVANSCLI	115	1	34.16
40173	CAPEHOR	115	41259	STEVN T2	115	1	-34.16
47276	N CAMAS	115	40979	SIFTON	115	1	34.16
47043	EVANSCLI	115	47276	N CAMAS	115	1	34.16
40139	BONNVILE	115	41259	STEVN T2	115	1	34.16
49946	CAPOLI13	500	49945	CAPOLI14	500	1	30.89
49948	CAPOLI11	500	49947	CAPOLI12	500	1	30.89
49947	CAPOLI12	500	49946	CAPOLI13	500	1	30.89
45035	CAPTJACK	500	49948	CAPOLI11	500	1	30.89
49945	CAPOLI14	500	30020	OLINDA	500	1	30.89
49874	MALROU2	500	49873	MALROU2	500	2	29.13
40687	MALIN	500	49875	MALROU2	500	2	29.13
49873	MALROU2	500	30005	ROUND M	500	2	29.13
49875	MALROU2	500	49874	MALROU2	500	2	29.13
40687	MALIN	500	49878	MALROU1	500	1	27.84
49878	MALROU1	500	49877	MALROU1	500	1	27.84
49877	MALROU1	500	49876	MALROU1	500	1	27.84
49876	MALROU1	500	30005	ROUND M	500	1	27.84
40217	CHENOW	115	41071	THE DALS	115	1	-27.17
40031	ALCOA	115	41035	STEVN TP	115	1	-26.51
41341	BIGEDDY1	230	41342	BIGEDDY2	230	1	24.16
40699	MARION	500	40827	PEARL	500	1	-23.45
41185	BALD MT	69	45057	CONDITPH	69	1	23.1
41185	BALD MT	69	41184	BALD MT	115	1	-23.1
40115	BINGEN	69	45251	POWERDL	69	1	23.1
40074	BALD M T	115	41184	BALD MT	115	1	23.1
40115	BINGEN	69	45057	CONDITPH	69	1	-23.1
40837	PONDROS	500	49853	PONSUM1	500	1	22.94
49853	PONSUM1	500	49852	PONSUM1	500	1	22.94
49821	PONSUM1	500	41043	SUMMER I	500	1	22.94
49852	PONSUM1	500	49822	PONSUM1	500	1	22.94
49958	BUCGRI11	500	40489	GRIZZLY	500	1	22.55
40155	BUCKLEY	500	49958	BUCGRI11	500	1	22.55
49950	CAPGRI15	500	49949	CAPGRI16	500	1	-22.13
49952	CAPGRI12	500	49951	CAPGRI13	500	1	-22.13
45035	CAPTJACK	500	49953	CAPGRI11	500	1	-22.13
49824	CAPGRI14	500	49950	CAPGRI15	500	1	-22.13
49953	CAPGRI11	500	49952	CAPGRI12	500	1	-22.13
49949	CAPGRI16	500	40489	GRIZZLY	500	1	-22.13
40111	BIG EDDY	500	40585	JOHN DAY	500	2	21.91
49871	MALSUM1	500	41043	SUMMER I	500	1	-21.69
49872	MALSUM1	500	49871	MALSUM1	500	1	-21.69
40687	MALIN	500	49872	MALSUM1	500	1	-21.69
41341	BIGEDDY1	230	40219	CHENOW	230	2	-21.68

40219	CHENOW	230	40217	CHENOW	115	1	-21.68
49893	GRIMAL26	500	40687	MALIN	500	2	21.39
49897	GRIMAL21	500	49896	GRIMAL22	500	2	21.39
49823	GRIMAL24	500	49894	GRIMAL25	500	2	21.39
49896	GRIMAL22	500	49895	GRIMAL23	500	2	21.39
40489	GRIZZLY	500	49897	GRIMAL21	500	2	21.39
49894	GRIMAL25	500	49893	GRIMAL26	500	2	21.39
40489	GRIZZLY	500	40837	PONDROS	500	1	20.31
45095	DIXONVLE	500	49918	DIXMER11	500	1	19.95
49918	DIXMER11	500	45197	MERIDINP	500	1	19.95
45035	CAPTJACK	500	45262	KFALLS	500	1	-19.87
45262	KFALLS	500	45197	MERIDINP	500	1	-19.87
41342	BIGEDDY2	230	41343	BIGEDDY3	230	1	19.6
49899	GRIJOH11	500	40585	JOHN DAY	500	1	-19.29
40489	GRIZZLY	500	49899	GRIJOH11	500	1	-19.29
49898	GRIJOH21	500	40585	JOHN DAY	500	2	-19.26
40489	GRIZZLY	500	49898	GRIJOH21	500	2	-19.26
40051	ALVEY	500	49994	ALVDIX11	500	1	19.19
49994	ALVDIX11	500	45095	DIXONVLE	500	1	19.19
40111	BIG EDDY	500	41343	BIGEDDY3	230	5	-18.64
40111	BIG EDDY	500	40585	JOHN DAY	500	1	18.46
43459	RIVRGATE	230	40899	ROSS	230	1	-17.76
41341	BIGEDDY1	230	40107	BIG EDDY	115	1	-17.41
40187	CASCD LK	115	40541	HOOD RVI	115	1	16.23
40013	ACTON	115	40187	CASCD LK	115	1	16.23
40013	ACTON	115	40139	BONNVILE	115	1	-16.23
40051	ALVEY	500	49993	ALVMAR1	500	1	-15.92
49993	ALVMAR1	500	40699	MARION	500	1	-15.92
40111	BIG EDDY	500	41341	BIGEDDY1	230	2	-15.45
40155	BUCKLEY	500	49956	BUCSLA11	500	1	-15
49956	BUCSLA11	500	40989	SLATT	500	1	-15
45145	HOOD RVI	69	45307	TUCKER1	69	1	14.68
40541	HOOD RVI	115	45307	TUCKER1	69	1	-14.68
45145	HOOD RVI	69	45251	POWERDL	69	1	-14.68
41251	ROSALC1	115	40897	ROSS	115	1	14.49
40031	ALCOA	115	41252	ROSALC4	115	1	14.49
40599	KEELER	230	43459	RIVRGATE	230	1	-13.44
47001	2ND ST	115	47003	3MILE TP	115	1	12.16
47001	2ND ST	115	41071	THE DALS	115	1	-12.16
47003	3MILE TP	115	47019	CHEIGHTS	115	1	12.16
47019	CHEIGHTS	115	47083	SEUFERT	115	1	12.16
40107	BIG EDDY	115	47083	SEUFERT	115	1	-12.16
40601	KEELER	500	40827	PEARL	500	1	12.01
41095	TROUTDA	500	41093	TROUTDA	230	1	-11.06
40809	OSTRNDE	500	41095	TROUTDA	500	1	-11.06
40601	KEELER	500	40599	KEELER	230	1	-10.39
40033	ALCOA	230	40031	ALCOA	115	1	-10.38
40033	ALCOA	230	40899	ROSS	230	1	10.38
47214	RUNYAN	115	45299	TROUTDA	115	1	9.79
40983	SIFTON 2	230	40979	SIFTON	115	1	-9.5
40977	SIFT TP2	230	40983	SIFTON 2	230	1	-9.5
40975	SIFT TP1	230	40981	SIFTON 1	230	1	-9.34

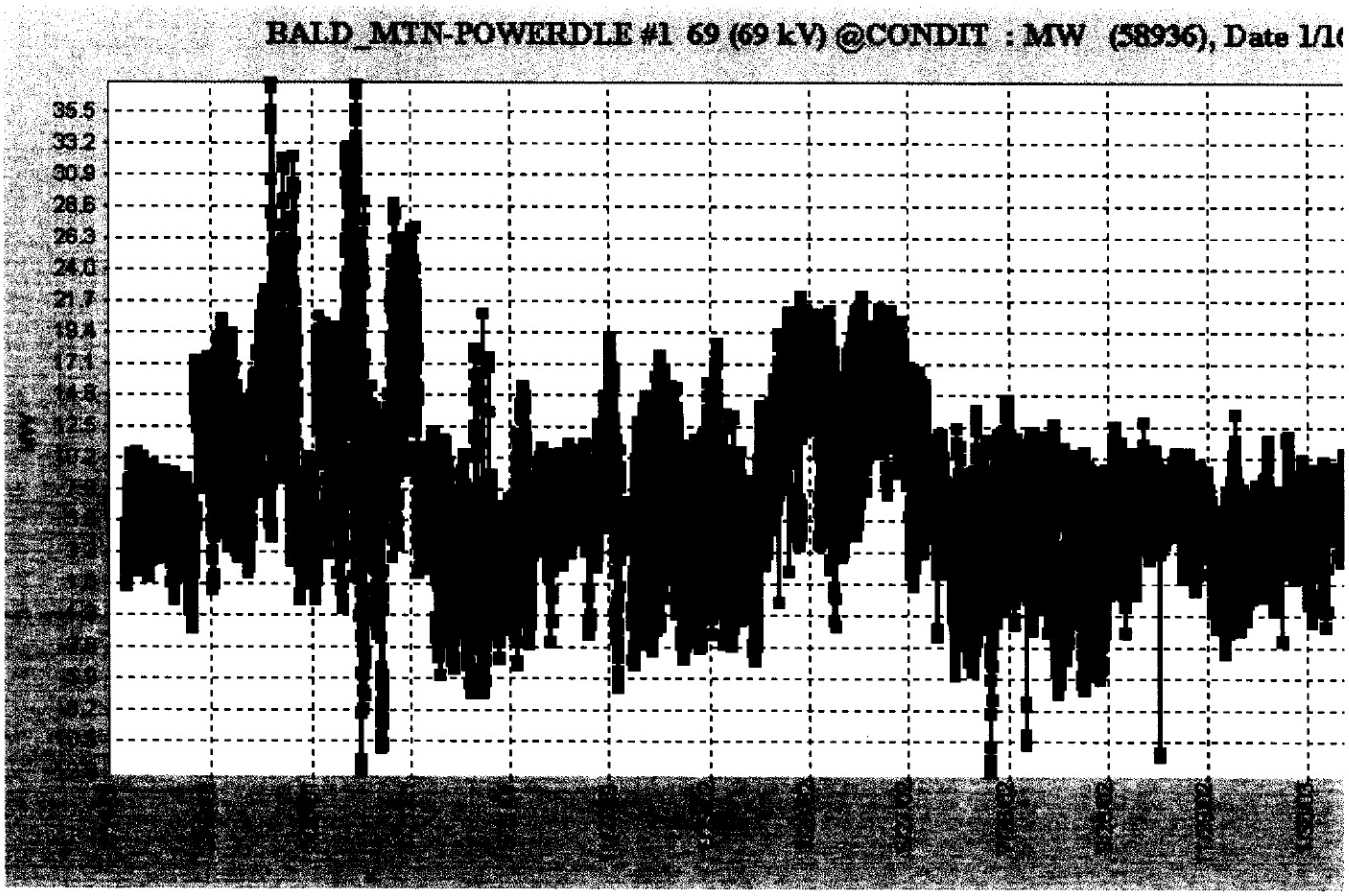
40981	SIFTON 1	230	40979	SIFTON	115	1	-9.34
45251	POWERDL	69	41163	WOODYG	69	1	8.43
45083	DEE TAP	69	41163	WOODYG	69	1	-8.43
40541	HOOD RVI	115	45309	TUCKER2	69	1	-8.43
45157	KENWOOI	69	45309	TUCKER2	69	1	8.43
45083	DEE TAP	69	45157	KENWOOI	69	1	8.43
45299	TROUTDA	115	45303	TROUTPP	230	1	8.25
41251	ROSALC1	115	49847	ROSROS2	115	2	-7.84
49847	ROSROS2	115	49846	ROSROS2	115	2	-7.84
49846	ROSROS2	115	41252	ROSALC4	115	2	-7.84
49957	BUCMAR1	500	40699	MARION	500	1	-7.56
40155	BUCKLEY	500	49957	BUCMAR1	500	1	-7.56
41251	ROSALC1	115	41252	ROSALC4	115	4	-6.64
40821	PAUL	500	40869	RAVER	500	1	6.56
40899	ROSS	230	40897	ROSS	115	2	-6.5
40111	BIG EDDY	500	40809	OSTRNDE	500	1	-6.27
45390	F.VALLEY	115	45399	HZLDLPPL	115	1	-6.27
45390	F.VALLEY	115	45281	ST JOHNT	115	1	6.27
40899	ROSS	230	40897	ROSS	115	1	-6.12
40061	ASHE	500	40499	HANFORD	500	1	-6.06
43089	CARVER	230	43313	MCLOUGL	230	1	6.01
41093	TROUTDA	230	45303	TROUTPP	230	1	-5.96
45035	CAPTJACI	500	40687	MALIN	500	2	5.92
40651	LEXINGTN	230	40671	LONGVIEV	230	2	5.69
43348	MURRAY I	230	43527	SHERWOO	230	1	5.62
40141	BONNVILE	230	40977	SIFT TP2	230	2	-5.51
40107	BIG EDDY	115	40217	CHENOW	115	1	-5.49
40141	BONNVILE	230	40975	SIFT TP1	230	1	-5.48
47171	HZLDL CC	115	45399	HZLDLPPL	115	1	5.41
47171	HZLDL CC	115	40897	ROSS	115	1	-5.41
43089	CARVER	230	43215	GRESHAM	230	1	-5.38
40045	ALLSTON	500	40043	ALLSTON	230	2	-5.32
41352	MCNRY S2	230	41353	MCNRY S3	230	1	-5.23
40585	JOHN DAY	500	40989	SLATT	500	1	5.22
40827	PEARL	500	40825	PEARL	230	1	-5.21
45035	CAPTJACI	500	40687	MALIN	500	1	5.19
41351	MCNRY S	230	41352	MCNRY S2	230	1	-5.13
40899	ROSS	230	40901	ROSS	345	1	5.07
49864	MCNROS1	345	40901	ROSS	345	1	-5.07
49865	MCNROS1	345	49864	MCNROS1	345	1	-5.07
40721	MCNARY	345	49865	MCNROS1	345	1	-5.07
40721	MCNARY	345	41353	MCNRY S3	230	1	5.07
40899	ROSS	230	41161	WOODLAN	230	1	5.05
40651	LEXINGTN	230	41161	WOODLAN	230	1	-5.05
43348	MURRAY I	230	43541	ST MARYS	230	1	-4.96
40061	ASHE	500	40989	SLATT	500	1	4.92
40979	SIFTON	115	49836	SIFWAF11	115	1	4.91
49836	SIFWAF11	115	47258	WAFERTE	115	1	4.91
47214	RUNYAN	115	47258	WAFERTE	115	1	-4.91
41205	FISHERS	115	47176	JOE AST	115	1	4.88
41205	FISHERS	115	40979	SIFTON	115	1	-4.88
47176	JOE AST	115	47214	RUNYAN	115	1	4.88

43123	COYOTE	500	40989	SLATT	500	1	4.87
43123	COYOTE	500	40723	MCNARY	500	1	-4.87
40599	KEELER	230	43541	ST MARYS	230	1	4.82
40499	HANFORD	500	41113	VANTAGE	500	1	-4.76
45127	HARRISOI	115	45141	HOLLADA'	115	1	-4.71
45141	HOLLADA'	115	45167	KNOTT	115	1	-4.71
40825	PEARL	230	43773	PEARL #	230	1	-4.71
49797	OSTWAU1	500	49796	OSTWAU1	500	1	4.67
49795	OSTWAU1	500	41138	WAUTOM/	500	1	4.67
49796	OSTWAU1	500	49795	OSTWAU1	500	1	4.67
40809	OSTRNDE	500	49797	OSTWAU1	500	1	4.67
40141	BONNVILE	230	41093	TROUTDA	230	2	4.36
40141	BONNVILE	230	41093	TROUTDA	230	1	4.36
49784	BELTAF12	500	41057	TAFT	500	1	4.34
40091	BELL BPA	500	49982	BELTAF11	500	1	4.34
49982	BELTAF11	500	49784	BELTAF12	500	1	4.34
40597	KEELER	115	41019	ST JOHNS	115	2	-4.22
43039	BETHEL	230	43329	MONITOR	230	1	-4.2
40045	ALLSTON	500	40043	ALLSTON	230	1	-4.07
43313	MCLOUGL	230	43329	MONITOR	230	1	4.03
40045	ALLSTON	500	40821	PAUL	500	2	4.01
40899	ROSS	230	40977	SIFT TP2	230	2	-3.98
43229	HARBORT	230	43601	TROJAN 2	230	1	3.93
43229	HARBORT	230	43459	RIVRGATE	230	1	-3.93
40709	MAUPIN	230	40875	REDMONI	230	1	3.87
40899	ROSS	230	40975	SIFT TP1	230	1	-3.86
40045	ALLSTON	500	40774	NAPAVINE	500	1	3.77
40774	NAPAVINE	500	40821	PAUL	500	1	3.77
43773	PEARL #	230	43527	SHERWO(	230	1	-3.7
45053	COLUM P(	115	45193	MALLORY	115	1	3.67
45378	BLOSS	115	45053	COLUM P(	115	1	3.67
45378	BLOSS	115	45281	ST JOHNT	115	1	-3.67
45167	KNOTT	115	45193	MALLORY	115	1	-3.67
47136	CHERYCC	115	45383	CHERYPP	115	1	3.63
41342	BIGEDDY2	230	40709	MAUPIN	230	1	3.63
40723	MCNARY	500	41351	MCNRY S'	230	1	-3.6
40897	ROSS	115	40979	SIFTON	115	1	-3.54
40827	PEARL	500	40825	PEARL	230	2	-3.54
40091	BELL BPA	500	40287	COULEE	500	6	-3.47
45127	HARRISOI	115	45173	LINCOLN	115	1	3.28
45173	LINCOLN	115	43621	URBAN	115	1	3.28
40051	ALVEY	500	40049	ALVEY	230	5	-3.27
49806	JOHWAU1	500	41138	WAUTOM/	500	1	-3.26
40585	JOHN DAY	500	49807	JOHWAU1	500	1	-3.26
49807	JOHWAU1	500	49806	JOHWAU1	500	1	-3.26
40957	SCHULTZ	500	41113	VANTAGE	500	1	3.23
45239	PILOT BU	230	40875	REDMONI	230	1	-3.03
40869	RAVER	500	49851	RAVSCH1	500	1	2.97
49850	RAVSCH1:	500	40957	SCHULTZ	500	1	2.97
49851	RAVSCH1	500	49850	RAVSCH1:	500	1	2.97
41021	ST JOHNS	230	41019	ST JOHNS	115	1	2.96
40899	ROSS	230	41021	ST JOHNS	230	1	2.96

43215	GRESHAM	230	43291	LINNEMAN	230	1	-2.8
47117	ARIEL	115	40175	CARDWEL	115	1	2.78
45383	CHERYPP	115	47095	VIEW TAP	115	1	2.78
47117	ARIEL	115	45201	MERWIN	115	1	-2.78
45201	MERWIN	115	47095	VIEW TAP	115	1	-2.78
40687	MALIN	500	45189	MALIN	230	1	-2.77
40489	GRIZZLY	500	43485	ROUND BU	500	1	-2.73
43483	ROUND BU	230	43485	ROUND BU	500	1	2.73
40809	OSTRNDE	500	40827	PEARL	500	1	2.69
40837	PONDROS	500	45249	PONDROS	230	1	-2.64
49903	GARTAF1	500	41057	TAFT	500	1	-2.63
49901	GARTAF2	500	41057	TAFT	500	2	-2.63
49902	GARTAF2	500	49901	GARTAF2	500	2	-2.63
40459	GARRISOI	500	49904	GARTAF1	500	1	-2.63
40459	GARRISOI	500	49902	GARTAF2	500	2	-2.63
49904	GARTAF1	500	49903	GARTAF1	500	1	-2.63
49907	ENTWAL1	230	45327	WALAWAL	230	1	-2.62
45103	ENTERPR	230	60150	HELLSCYN	230	1	2.62
45103	ENTERPR	230	49907	ENTWAL1	230	1	-2.62
45161	KLAFALLS	230	45189	MALIN	230	1	2.61
41019	ST JOHNS	115	45281	ST JOHNT	115	1	-2.59
40671	LONGVIEV	230	40673	LONGVW	230	1	2.59
40711	MCLOUGL	500	43313	MCLOUGL	230	1	-2.57
40711	MCLOUGL	500	40809	OSTRNDE	500	1	2.57
43039	BETHEL	230	43483	ROUND BU	230	1	2.53
40671	LONGVIEV	230	40669	LONGVIEV	115	1	-2.47
43215	GRESHAM	230	45303	TROUTPP	230	1	-2.46
40381	ECHOLAK	500	40869	RAVER	500	1	-2.33
43291	LINNEMAN	230	45301	TROUTPP	230	1	-2.29
49997	ALFBON11	230	40141	BONNVILE	230	1	-2.27
40039	ALFALFA	230	49997	ALFBON11	230	1	-2.27
40039	ALFALFA	230	45229	OUTLOOK	230	1	2.27
41093	TROUTDA	230	45301	TROUTPP	230	1	2.1
40825	PEARL	230	43527	SHERWOO	230	2	-2.02
40825	PEARL	230	43527	SHERWOO	230	1	-2.02
45239	PILOT BU	230	45249	PONDROS	230	1	2.01
47225	SIFT TP	115	40979	SIFTON	115	1	-1.99
47317	119TH ST	115	47241	SW51	115	1	-1.99
47168	HEYE MYF	115	47170	HOKINSN	115	1	-1.99
47119	AXFORD	115	47136	CHERYCC	115	1	1.99
47110	4TH PLN	115	47241	SW51	115	1	1.99
47110	4TH PLN	115	47225	SIFT TP	115	1	-1.99
47317	119TH ST	115	47170	HOKINSN	115	1	1.99
47119	AXFORD	115	47168	HEYE MYF	115	1	-1.99
41346	MIDWAYB	230	45229	OUTLOOK	230	1	-1.97
43597	TROJAN	230	43601	TROJAN 2	230	1	-1.97
43597	TROJAN	230	43599	TROJAN 1	230	1	1.97
40499	HANFORD	500	40683	LOW MON	500	1	1.95
49908	ECHSCH2	500	40957	SCHULTZ	500	2	1.95
49909	ECHSCH2	500	49908	ECHSCH2	500	2	1.95
49910	ECHSCH2	500	49909	ECHSCH2	500	2	1.95
40381	ECHOLAK	500	49910	ECHSCH2	500	2	1.95

40043	ALLSTON	230	43601	TROJAN 2	230	1	-1.95
40629	LANE	500	40699	MARION	500	1	-1.92
40629	LANE	500	40627	LANE	230	1	1.92
43621	URBAN	115	43790	URBAN #	115	1	1.92
40043	ALLSTON	230	40671	LONGVIEV	230	1	-1.89
40043	ALLSTON	230	40672	LONGVAN	230	3	-1.89
40671	LONGVIEV	230	40672	LONGVAN	230	1	1.89
40049	ALVEY	230	40375	E SPRING	230	1	-1.88
40937	SANT TAP	230	40939	SANTIAM	230	1	-1.88
49931	COUHAN1	500	40499	HANFORD	500	1	1.85
40287	COULEE	500	49931	COUHAN1	500	1	1.85
40043	ALLSTON	230	43599	TROJAN 1	230	1	-1.83
60192	LADD	230	40621	LAGRAND	230	1	-1.81
40621	LAGRAND	230	40905	ROUNDUF	230	1	-1.81
49929	COUSCH1	500	40957	SCHULTZ	500	1	-1.81
49927	COUSCH2	500	40957	SCHULTZ	500	2	-1.81
49930	COUSCH1	500	49929	COUSCH1	500	1	-1.81
49928	COUSCH2	500	49927	COUSCH2	500	2	-1.81
40287	COULEE	500	49930	COUSCH1	500	1	-1.81
40287	COULEE	500	49928	COUSCH2	500	2	-1.81
40043	ALLSTON	230	40671	LONGVIEV	230	2	-1.8
49941	CHESAN1	230	40939	SANTIAM	230	1	1.79
40213	CHEMAW/	230	49941	CHESAN1	230	1	1.79
40453	GAR2EAS	500	49781	GARTOW2	500	2	1.77
49780	GARTOW	500	62013	TOWN1	500	1	1.77
49782	GARTOW	500	49780	GARTOW	500	1	1.77
49779	GARTOW2	500	62012	TOWN2	500	2	1.77
49781	GARTOW2	500	49779	GARTOW2	500	2	1.77
40453	GAR2EAS	500	40459	GARRISOI	500	1	-1.77
40451	GAR1EAS	500	49782	GARTOW	500	1	1.77
40451	GAR1EAS	500	40459	GARRISOI	500	1	-1.77
45025	BOYLE	230	45161	KLAFALLS	230	1	1.75
45025	BOYLE	230	45063	COPCO	230	1	-1.75
40459	GARRISOI	500	40457	GARRISOI	230	1	1.72
41351	MCNRY S	230	40905	ROUNDUF	230	1	1.69
47243	SW6	115	47245	SW7	115	1	-1.65
47159	FELIDA	115	47221	SARA	115	1	1.65
47138	CLARK	115	47245	SW7	115	1	1.65
47138	CLARK	115	47221	SARA	115	1	-1.65
47121	BATLGRD	115	47243	SW6	115	1	-1.65
47121	BATLGRD	115	47136	CHERYCC	115	1	1.65
47115	ALCO TI	115	47239	SW48	115	1	1.65
47115	ALCO TI	115	40031	ALCOA	115	1	-1.65
47159	FELIDA	115	47239	SW48	115	1	-1.65
40175	CARDWEL	115	40309	COWL CC	115	1	1.62
40309	COWL CC	115	40669	LONGVIEV	115	1	1.62
40045	ALLSTON	500	40601	KEELER	500	1	1.61
40049	ALVEY	230	45093	DIXONVLE	230	1	1.6
45043	CENTR SS	230	41053	TACOMA I	230	1	1.58
40233	CHIEF JO	500	40287	COULEE	500	1	1.58
45043	CENTR SS	230	40207	CHEHALIS	230	1	-1.58
40521	HATWAI	500	40679	LOW GRA	500	1	-1.55

45143	HOLLYWC	115	45167	KNOTT	115	1	1.54
45073	CULLY	115	45299	TROUTDA	115	1	-1.54
45073	CULLY	115	45143	HOLLYWC	115	1	1.54
45089	DIA HILL	230	46291	MCKEN TF	230	1	1.53
45031	CALAPOY/	230	45111	FRY	230	1	-1.53
45031	CALAPOY/	230	45089	DIA HILL	230	1	1.53
41346	MIDWAYB	230	41347	MIDWAYB	230	1	1.52
40049	ALVEY	230	40627	LANE	230	1	-1.5
43039	BETHEL	230	49976	BETSAN11	230	1	1.46
49976	BETSAN11	230	40939	SANTIAM	230	1	1.46
45063	COPCO	230	45183	LONEPINE	230	1	-1.44
45127	HARRISOI	115	43237	HARSNPG	115	1	1.43
43201	GLENCOE	115	43761	GLENCOE	115	1	1.43
43007	ALDERCR	115	43237	HARSNPG	115	1	-1.43
43007	ALDERCR	115	43201	GLENCOE	115	1	1.43
43761	GLENCOE	115	43581	TABOR	115	1	1.43
40049	ALVEY	230	46291	MCKEN TF	230	1	-1.39
45113	GLENDL	230	40503	HANNA	230	1	-1.39
45093	DIXONVLE	230	40503	HANNA	230	1	1.39
40941	SANTIAM	500	40939	SANTIAM	230	1	-1.39
45113	GLENDL	230	45123	GRANT PS	230	1	1.39
40699	MARION	500	40941	SANTIAM	500	1	-1.39
43085	CANYON	115	43621	URBAN	115	1	-1.36
40869	RAVER	500	40957	SCHULTZ	500	4	1.36
40207	CHEHALIS	230	40673	LONGVW	230	2	-1.34
41341	BIGEDDY1	230	40813	PARKDALI	230	1	-1.33
40813	PARKDALI	230	41093	TROUTDA	230	1	-1.33
40549	HORSE H\	230	41351	MCNRY S	230	1	1.31
49809	DWOTAF1	500	41057	TAFT	500	1	1.31
41343	BIGEDDY3	230	40511	HARVALUI	230	1	1.31
40511	HARVALUI	230	40549	HORSE H\	230	1	1.31
49915	DWOTAF1	500	49809	DWOTAF1	500	1	1.31
40369	DWORSH/	500	49915	DWOTAF1	500	1	1.31
40369	DWORSH/	500	40521	HATWAI	500	1	-1.31
40793	OLYMPIA	230	41055	TACOMA S	230	1	1.27
40723	MCNARY	500	40917	SACJWA T	500	1	-1.26
49955	BURSUM1	500	41043	SUMMER I	500	1	-1.25
61986	BURMID11	500	60240	MIDPOINT	500	1	1.25
45029	BURNS	500	61986	BURMID11	500	1	1.25
45029	BURNS	500	49955	BURSUM1	500	1	-1.25
40207	CHEHALIS	230	40673	LONGVW	230	1	-1.25
40597	KEELER	115	40805	ORE CITY	115	2	1.18
46609	COWLITZ	230	41049	TACOMA	230	1	1.17
40869	RAVER	500	40957	SCHULTZ	500	3	1.17
40649	LEXINGTN	115	47224	SHAWN C	115	1	-1.16
40175	CARDWEL	115	47015	CARROLL	115	1	1.16
47035	E KELSO	115	47224	SHAWN C	115	1	1.16
47035	E KELSO	115	47219	S KELSO	115	1	-1.16
47015	CARROLL	115	47219	S KELSO	115	1	1.16
43195	FARGO	115	40805	ORE CITY	115	1	-1.15
40211	CHEMAW/	115	43195	FARGO	115	1	-1.15
45051	COLD SPF	230	41351	MCNRY S	230	1	-1.14

43770	MULTNMA	115	43816	WSTPRT	115	1	1.14
43770	MULTNMA	115	43790	URBAN #	115	1	-1.14
43039	BETHEL	230	45111	FRY	230	1	1.13
45327	WALAWAL	230	45331	WALLULA	230	1	-1.11
45129	HATROCK	230	45331	WALLULA	230	1	1.11
45123	GRANT PS	230	45195	MERIDINP	230	1	1.11
45051	COLD SPF	230	45129	HATROCK	230	1	1.11
43695	DURHAM :	115	43816	WSTPRT	115	1	-1.11
43695	DURHAM :	115	43589	TIGARD 1	115	1	1.11
43279	KINGCITY	115	43589	TIGARD 1	115	1	-1.11
43279	KINGCITY	115	43525	SHERWD	115	1	1.11
62004	ANACOND	230	40457	GARRISOI	230	2	-1.1
40749	MONROE	500	41001	SNOK TAF	500	1	-1.05
62004	ANACOND	230	40457	GARRISOI	230	1	-1.03
40207	CHEHALIS	230	40793	OLYMPIA	230	1	1.03
49937	CHILAP11	230	40635	LAPINE	230	1	-1.02
40635	LAPINE	230	45239	PILOT BU	230	1	-1.02
45047	CHILQUIN	230	49937	CHILAP11	230	1	-1.02
43005	ABRNTHY	115	43309	MCLGHLN	115	1	1.01
43005	ABRNTHY	115	43273	JENGSLD:	115	1	-1.01
46609	COWLITZ	230	41053	TACOMA I	230	1	-1.01
43527	SHERWO(	230	43525	SHERWD	115	1	-1.01
43313	MCLOUGL	230	43773	PEARL #	230	1	1.01
43267	ISLAND	115	43519	SELLWOC	115	1	-1.01
43267	ISLAND	115	43273	JENGSLD:	115	1	1.01

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