Alaska Energy Authority
Kenai Transmission Study
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Summary of Changes

Revision	Revision Date	Revision Description
0	June 4, 2012	Initial release to AEA
1	March 7, 2014	Final release to AEA

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Executive Summary

Electric Power Systems ("EPS") has completed the technical studies to determine the impacts to the central and southern utilities due to changes in the Kenai generation and transmission system since the completion of the 2010 Regional Integrated Resource Plan ("RIRP") administered by the Alaska Energy Authority ("AEA"). The studies and analysis included in the RIRP required updating to reflect these generation changes and to analyze the impact these changes would have on the transmission system recommendations included in the RIRP. The studies included power flow contingency analysis, loss analysis, and transient stability contingency analysis.

The focus of the study was to provide unconstrained access to Bradley Lake power and energy with its current capacity as well as the future possibility of a third turbine at the Bradley Lake plant. For purposes of this study, the current capacity of the plant is assumed to be 115 MW. The expanded capacity is assumed to be 135 MW.

Prior to the 2015 addition of Kenai area generation, the Kenai export limit was defined as 71 MW in the summer and 82-99 MW in the winter. Following the addition of the 2015 Kenai area generation and other changes in northern Railbelt generation, the export limit will vary from 29 – 104 MW, depending on the Kenai generation configuration. To eliminate the wide variations in Kenai export limits and provide a predictable export limit that allows all Bradley Lake and Cooper Lake generation to be unconstrained, improvements will be required to the Kenai transmission system. .

EPS identified various transmission improvements that could alleviate the capacity and energy constraints of the Anchorage-Kenai system to allow unconstrained use of Bradley Lake and Cooper Lake hydro energy and capacity. These improvements include the construction of new transmission facilities, the reconstruction of existing facilities, and the installation of additional transmission compensation.

Preliminary analysis indicates that a 100 kV DC intertie between Beluga and Bernice Lake may be the most economical and expeditious method of alleviating the Bradley Lake constraints. The DC tie would utilize submarine cable for the entire length of the route and would be capable of 100 MW of transfer between the Anchorage and Kenai systems. However, this routing and option has only recently been identified and further investigation and cost analysis is required before we can recommend this alternative.

The recommended construction projects for the Kenai transmission system include the following two recommendations:

<u>DC tie and Soldotna – Quartz Line</u>

- Add new 100 kV HVDC Intertie from Beluga to Bernice Lake
- Add new 115 kV transmission line from Bradley Lake to Soldotna
- Add new 115 kV transmission line from Soldotna to Quartz Creek

<u>DC tie and Kenai Tie 230 kV upgrade</u>

- Add new 100 kV HVDC Intertie from Beluga to Bernice Lake
- Add new 115 kV transmission line from Bradley Lake to Soldotna
- Add new Dave's Creek – University 230 kV upgrade

In addition to the projects required for relief of the transmission constraint, analysis of the Kenai Static VAR Compensator ("SVC") controls should be included due to the age of equipment and consequences of its outage. These controls are almost 20 years old and are no longer readily supported by the manufacturer. The Power Oscillation Dampening ("POD") function originally installed on the SVC has negative impacts on system operations during certain conditions. Also, the POD has not been modified to account for the relocation of the Soldotna unit to Nikiski or the construction of additional Kenai generation. Consideration should be given to replacing these controls with the same controls utilized on the Anchorage-Fairbanks Intertie to provide common maintenance and training.

Loss analysis show that adding the DC intertie, a 2nd Bradley Lake – Soldotna, and a 2^{nd} Soldotna – Quartz Creek 115 kV transmission line result in large decreases in the losses during high Kenai export periods. Losses are decreased over 60% following the proposed improvements. The decreases in losses are also achieved with the DC intertie, a 2nd Bradley Lake – Soldotna 115 kV line, and the Kenai Tie upgraded to 230 kV.

A summary of the transmission improvements and their estimated costs are presented in the tables below:

Table I. Description – Recommendations, 115 kV Kenai Tie

Project Description	Cost Range (1000's)	
100 kV HVDC Bernice - Beluga Tie Alternative, 115 kV Kenai Tie	Low	High
Beluga - Bernice Lake 100 kV DC Line	$134,550	$195,756
Bradley - Soldotna 115 kV line	$62,665	
Soldotna - Quartz Creek 115 kV line	$49,000	
Total Range	$246,215	$307,421

Table II. Description – Recommendations, 230 kV Kenai Tie

Project Description	Cost Range (1000's)	
100 kV HVDC Bernice - Beluga Tie Alternative, 230 kV Kenai Tie	Low	High
Beluga - Bernice Lake 100 kV DC Line	$134,550	$195,756
Bradley - Soldotna 115 kV line	$62,665	
Upgrade Kenai Tie to 230 kV	$85,525	
Total Range	$282,740	$343,946

1 Introduction

Electric Power Systems ("EPS") has conducted a study to determine the impacts to the central and southern utilities due to changes in the Kenai generation and transmission system since the completion of the 2010 Regional Integrated Resource Plan ("RIRP") administered by the Alaska Energy Authority ("AEA").

Since the completion of the 2010 RIRP, plans for new thermal generation additions on the Kenai and some non-dispatchable generation in the Anchorage were finalized. The studies and analysis included in the RIRP required updating to reflect these generation changes and to analyze the impact these changes would have on the transmission system recommendations included in the RIRP.

The purpose of this study is to identify potential changes to the RIRP to mitigate impacts of any generation changes to the Railbelt and evaluate the cost of the mitigation efforts against the benefit realized by the same improvements.

The impacts that were evaluated in this RIRP update include the following:

1) Transmission Contingency Analysis
2) Transfer Capacity Analysis
3) Energy and Capacity Loss Analysis
4) Generation Capacity Loss Analysis
5) Penalty Costs for Loss of Hydro-Thermal Coordination Flexibility

The study used the three seasonal power flow cases, summer valley, summer peak, and winter peak, using the IOC approved 2020 base cases and utilize version 32.1.1 of Power Systems Simulator Engineer ("PSS/E") for power flow and transient contingency analysis.

It should be noted that the year 2020 IOC base case corresponds to approximately a year 2040-45 load as represented in the 2010 RIRP. The differences in loads between the 2020 IOC cases and the 2010 RIRP for each of the winter peak, summer peak and summer valley cases are outlined by utility in the tables in Appendix A.

The discrepancies between the 2020 IOC base cases and the 2010 RIRP were not resolved. However, the loads utilized for long-term transmission and resource planning should be evaluated and reconciled with the loads used by the IOC.

2 Kenai Export and Constraints

Exports from the Kenai are currently limited by both thermal and stability limitations. The Soldotna – Quartz Creek and Quartz Creek – Dave's Creek sections with have thermal ratings of 96 MVA in the summer, with a Kenai export limit of 71-99 MW limited by stability depending upon the system dispatch.

Following the planned Kenai generation and northern utility generation changes, the thermal limits remain the same, however the stability limit for various Kenai exports varies from 29 MW to 104 MW depending on the Kenai system dispatch. In addition to the changes in Kenai export limits, the losses experienced on the Bradley Lake energy will approach 25% under peak operating conditions.

Without improvements to the transmission system, the energy and capacity of Bradley Lake will be constrained during most of the year, with increased losses and stranded capacity experienced by the central and northern Railbelt utilities. These constraints will impact the efficiency of the hydro-thermal coordination and access to spinning reserve by the northern utilities. The combination of all these factors has significant economic impacts to the central and northern Railbelt utilities.

3 Generation Configuration

The 2020 bases cases were modified to include new generation on the Kenai, the MEA system, and the Watana large hydro project. Without the Watana project, there are significant voltage issues in the Railbelt in the summer valley cases. Prior to assessing the impacts of the Kenai transmission system, voltage correction measures were required in the South Central Railbelt. Planned changes to the MEA transmission system that included a new Hospital-Reed transmission line and a new Herning-Hospital-Reed transmission line were included with the new generation. The Watana large hydro project assumes that significant amounts of new transmission will be required between Healy and the Douglas substations.

Generation additions to the 2020 database to evaluate long-term transmission requirements include the following:

1) 3rd Bradley Lake unit, with total Bradley Lake output of 135 MW (45 MW each unit)
2) Watana hydro plant consisting of 3 – 200 MW generators
3) Eklutna 2 (Reed) generation plant consisting of ten, 17 MW reciprocating engines (170 MW total plant output)
4) These generation additions are in addition to the 84 MW of generation added to the Kenai from the 2009 existing system to the 2020 IOC Base Case

These generation additions will be dispatched with the generators currently in the 2020 database to create base cases designed to stress the Railbelt grid. Note that it was assumed that the Eklutna 2 generation would not be built if the Watana hydro plant was built.

The generation additions were configured into 8 different configurations to be used for each of the 3 seasonal base cases. Generation Case A was configured to be similar to the present day system. Generation Case B utilizes transmission upgrades listed in the next section to achieve high Kenai export conditions. Generation Case C includes the 3rd Bradley Lake unit to achieve even higher Kenai export conditions than Case B. Generation Case C was used for two sensitivity cases. Generation Case C1 was configured with the Nikiski units offline and Generation Case C2 was configured with Nikiski, Bernice Lake, and Cooper Lake units all offline. Additional cases CA and C1A were created by adjusting the spin to the minimum requirements for use in analysis of the DC transmission line option.

Cases with Watana online (Generation Cases D and E) were configured with two different Railbelt spin amounts (100 or 200 MW). Configurations of different combinations of Watana and the expanded Bradley Lake plant (Generation cases F-H) were created based on total plant output. The cases were setup with either plant online at their full amount with the other plant at a reduced output. As with the previous Watana case configurations (D and E), Railbelt spin amounts of 100 and 200 MW were used.

A list of the different generation configurations is shown below. Summary tables of the different generation dispatches are listed in Appendix B.

A) Base case, no transmission or generation additions, similar to 2009 generation dispatch

B) No Generation Additions from 2020 IOC Base Case (includes 2015 Kenai generation additions – Nikiski 18 MW HSRG, 17 MW Duct Firing, 49 MW-LM 6000)

C) 3rd Bradley Lake addition

CA) 3rd Bradley Lake addition, minimum spin case

C1) 3rd Bradley Lake addition, with Nikiski offline

C1A) 3rd Bradley Lake addition, with Nikiski offline, minimum spin case

C2) 3rd Bradley Lake addition, with Nikiski, Bernice Lake, and Cooper Lake offline

D) Watana generation at 600 MW with 100 MW of spin on Railbelt*

E) Watana generation at 600 MW with 200 MW of spin on Railbelt*

F) 3rd Bradley Lake added, 135 MW, Watana generation reduced

G) 3rd Bradley Lake with Bradley Lake plant output reduced, Watana generation at 600 MW with 100 MW of spin*

H) 3rd Bradley Lake with Bradley Lake plant output reduced, Watana generation at 600 MW with 200 MW of spin*

* Except for summer valley cases were low spin values are not possible

4 Transmission Options

The two main areas of focus to relieving the generation constraints are to improve the existing transmission system between Bradley Lake and Anchorage without a new intertie or construct a new transmission system between the Kenai and Anchorage in addition to improvements to the existing transmission system. The specifics for the interties as well as other Kenai transmission upgrades are listed below.

4.1 Upgrade Dave's Creek – University Tie to 230 kV

This project includes upgrading the existing 115 kV transmission line to 230 kV construction and operation. On the northern end, the upgraded line would terminate in Anchorage at the 230 kV University substation bus. On the southern end, the line would terminate at Dave's Creek and would include a single 230 kV to 115 kV 150 MVA transformer to interconnect into the 115 kV bus sections. A 30 MVAR fixed reactor would be required at the Dave's Creek substation. The reactor would allow load to be served from the Kenai with the University substation end opened without units on the Kenai being operated in the "buck" condition. It was assumed that the Kenai tie transmission upgrades would be wooden H-Frames utilizing 795 ACSR "Drake" conductor.

Further switching studies will be required to confirm if a switched reactor can be utilized in conjunction with the existing SVC or if the existing SVC will require upgrading.

4.2 New HVAC Kenai Intertie

A new Kenai Intertie option was studied at two voltage levels, 138 kV and 230 kV. The Kenai Intertie termination point in Anchorage would be at Point Woronzof substation. The 138 kV option would assume a direct termination into the 138 kV bus at Point Woronzof. The 230 kV option was modeled with a single 230/138 kV 150 MVA transformer connection to the 138 kV bus. The termination point on the Kenai was at Bernice substation. The 138 kV option was modeled with a single 138/115 kV 150 MVA transformer connection to the 115 kV bus. The 230 kV option was modeled with a single 230/115 kV 150 MVA transformer connection to the 115 kV bus.

The Kenai Intertie utilized the Tesoro route as listed in the Southern Intertie Final Environmental Impact Study (FEIS). There are three different underground cable sections due to two airports and crossing the Captain Cook State Recreational Area (SRA). The remainder of the route is overhead until crossing the Cook Inlet with submarine cable. Table 4.2 lists the distances and conductors for the Tesoro preferred route option.

Table 4.2 Proposed Tesoro route per Southern Intertie FEIS

Route Option	Details	Distance (mi)	Conductor type		
			type	size	name
A	Bernice Lake to Private Airstrip 1	3	overhead	795	Drake
	Underground for Airstrip 1	1	underground	1000	copper
	Overhead to Airstrip 2	1	overhead	795	Drake
	Underground for Airstrip 2	0.5	underground	1000	copper
	Overhead to Captain Cook SRA	11.2	overhead	795	Drake
	Underground for Captian Cook SRA	3.4	underground	1000	copper
	Follow Tesoro pipeline	27.4	overhead	795	Drake
N	Submarine Cable under Cook Inlet	18.1	undersea	1000	copper

The 138 kV intertie required a total of 120 MVAr of compensation in order to control the voltages created by the submarine cable charging. The 230 kV option required approximately 270 MVAr of compensation, with at least 65 MVAr of that compensation being a SVC. The values assumed an additional 40 MVAr of compensation already added to the Railbelt system in the base case.

4.3 100 kV HVDC Intertie Beluga – Bernice Lake

An HVDC alternative was analyzed due to the complexities found in the HVAC Kenai Intertie above. With HVDC, the length of the submarine cable becomes a cost consideration, but does not present a technical challenge. Therefore in order to minimize the overall cost of the project, a direct tie between Beluga and Bernice Lake was investigated. The direct tie would eliminate the environmentally sensitive areas along the overhead route and avoid the multiple land cables and their associated terminations along the overhead route. The submarine cable would also make entrance into and out of the Beluga and Bernice stations easier than an overhead alternative.

The size of the HVDC cable was chosen to carry sufficient load such that during the maximum Anchorage import of 130 MW from Kenai hydro resources, the loss of the existing Anchorage-Dave's Creek 115 kV line would not result in load shedding in the Anchorage/Mat-Su/Fairbanks areas. We also assumed that the HVDC terminals would be mono-pole terminals as opposed to bi-pole terminals. A mono-pole terminal is similar to an AC transmission line in that a fault on either the single cable or either of the HVDC terminals would result in the loss of the line.

This sizing and methodology is considerably different than previous analysis which evaluated bi-pole systems of 125 MW or more capacity. Our studies used a capacity of 100 MW for the mono-pole converters.

Due to the length of outage delay for a submarine cable failure, we did include two submarine cables in the project. The route of the cables would result in the majority of the cables being parallel to the Cook Inlet current flow which should make them less susceptible to damage caused by high currents than the Pt. Woronzof- Pt. Possession cables. A failure of either cable would result in the loss of the intertie until the faulted cable was removed from service. The capacity of the intertie would remain at 100 MW following the loss of the first cable.

4.4 Kenai Transmission Upgrades

The transmission upgrades for the Kenai system that were evaluated include the following options:

- Reconductor existing Diamond Ridge – Soldotna to 556 MCM
- Add new 115 kV line from Bradley Lake to Quartz Creek
- Add new 115 kV line from Bradley Lake to Soldotna
- Add new 115 kV line from Soldotna to Quartz Creek
- Add new 115 kV line from Quartz Creek to Dave's Creek

4.5 Transmission Configurations

The Kenai Tie, Southern Intertie, DC tie, and other HEA transmission upgrades were organized into groups of transmission configurations to be studied. The different configurations are listed below in Table 4.1 and were used for the power flow, transient contingency, and loss analysis parts of the study.

Table 4.1 Transmission Configurations

Trans Config	Kenai Tie		Southern Intertie			Kenai Transmission Upgrades				
	115 kV	230 kV	138 kV	230 kV	DC	add 2nd Bradley - Quartz	add 2nd Quartz - Daves	add 2nd Bradley - Soldotna	upgrade Soldotna - Diamond	add 2nd Soldotna - Quartz
1	x		x					x		
2	x		x					x		x
3	x			x				x		
4	x			x				x		x
5		x	x			x	x			
6		x		x		x	x			
7		x				x	x			
8		x					x	x		x
9	x		x						x	
10	x		x						x	x
11	x			x					x	
12	x			x					x	x
13		x					x		x	x
14	x				x			x		
15	x				x				x	
16	x				x			x		x
17		x			x		x	x		x
18		x	x				x	x		x
19		x		x			x	x		x
20		x	x					x		
21		x			x			x		

5 Power flow Analysis

Power flow analysis was run on all of the cases listed above. The contingencies consist of all 115 kV branches and associated transformers in the Kenai area as well as the ties connecting the Kenai to Anchorage. The ratings used for the power flow contingency analysis are shown in Table 5.1 below.

Table 5.1 Conductor Ratings

Conductor		Rating (MVA)	
Size	Name	Winter	Summer
4/0	*Penguin*	88	50
556 ACSR	*Dove*	173	96
795 ACSR	*Drake*	220	120

The power flow contingency analysis was completed on only two of the generation cases for each load season. Generation Cases using the 2020 IOC generation capacity (Case B) and the 2020 IOC base case plus the 3rd Bradley Lake unit addition (Case C) were chosen due to the high Kenai export amounts and represent the worst case scenarios during power flow contingency analysis.

No branch thermal overloads were found for the winter peak load season for either generation case and for all transmission configurations.

Many branch thermal overloads for the summer peak and summer valley load seasons were found for both generation cases (Case B and Case C). Many contingencies for the different transmission configurations create thermal overloads due to the restricted summer ratings used for the conductors. Severe contingencies include loss of the ties between the Kenai and Anchorage and a loss of the transmission line between Bradley Lake and Soldotna.

An outage of the new proposed ties from the Kenai to Anchorage (DC, Southern Intertie) will overload the existing Kenai tie. Upgrading the Kenai tie to 230 kV and adding new 115 kV transmission lines between Soldotna – Quartz Creek – Dave's Creek eliminates the overload condition. Another severe contingency is an outage of the Soldotna – Bradley Lake line when Bradley Lake is at peak output. This outage will overload the remaining line sections, even if reconductored to 556 ACSR or if a 115 kV Bradley Lake – Quartz Creek line is added. A second Bradley Lake – Soldotna line is required to eliminate the overload condition. Detailed power flow results for the summer peak and summer valley cases are shown in Appendix C.

Table 5.2 shows the summary of the power flow results. Transmission configurations highlighted in orange have thermal overloads for contingencies during the summer peak and summer valley load seasons. Note that an x in a cell denotes what upgrades are applicable for each different transmission configuration.

Table 5.2 Power Flow Results Summary

Trans Config	Kenai Tie		Southern Intertie			Kenai Transmission Upgrades				
	115 kV	230 kV	138 kV	230 kV	DC	add 2nd Bradley - Quartz	add 2nd Quartz - Daves	add 2nd Bradley - Soldotna	upgrade Soldotna -	add 2nd Soldotna - Quartz
1	x		x					x		
2	x		x					x		x
3	x			x				x		
4	x			x				x		x
5		x	x			x	x			
6		x		x		x	x			
7		x				x	x			
8		x					x	x		x
9	x		x						x	
10	x		x						x	x
11	x			x					x	
12	x			x					x	x
13		x					x		x	x
14	x				x			x		
15	x				x				x	
16	x				x			x		x
17		x			x		x	x		x
18		x	x				x	x		x
19		x		x			x	x		x
20		x	x					x		
21		x			x			x		

x denotes equipment upgrades / options

(shaded) transmission configurations with thermal overloads

There are only 3 transmission configurations that produce no overloads for the summer peak and summer valley load seasons. This configurations are the Kenai Tie upgraded to 230 kV, with either the DC tie (transmission configuration 17) or the Southern Intertie operated at 138 kV or 230 kV (transmission configuration 18 or 19, respectively). These configurations assume that the Kenai transmission system includes new 115 kV transmission lines from Bradley Lake – Soldotna – Quartz Creek – Dave's Creek.

The results for the power flow analysis show no overloads for the winter peak load season. Since the thermal overloads are only for the summer peak and summer valley load seasons, redispatching generation to alleviate the overloads (reducing Kenai exports) is deemed an acceptable mitigation measure.

6 Loss Analysis

Loss analysis was performed comparing the existing system to improved systems with Kenai Transmission upgrades and additions. Comparisons between the different cases were made by combining the losses for the line sections between Bradley Lake, University, and Pt. Woronzof (for the Southern Intertie cases). The winter peak cases were used for the loss analysis study. It is important to note that it is difficult to accurately determine losses of a DC line / system due to its complexity. Losses of 4% of power transfer were used to model the losses on the DC line. Table 6.1 shows the results from the loss analysis for Kenai export levels of 99 MW.

The results show that a large reduction in losses for transferring energy from the Kenai is found with the addition of the Southern Intertie (at 138 kV or at 230 kV) or a DC tie. The transmission configuration with the least amount of losses is with the existing tie operated at 230 kV, the Southern Intertie operated at 230 kV, a second Bradley – Soldotna line, a second Soldotna – Quartz Creek line, and a second Quartz Creek – Dave's Creek line section (transmission configuration 4 and 19). These configurations have 6.6 and 6.3 MW of total losses, respectively.

A comparison of cases with a second 115 kV Bradley Lake – Soldotna line versus reconductoring the Soldotna – Diamond Ridge line to 556 ACSR conductor can be made with the results. Adding the second Bradley Lake – Soldotna line reduces losses by about 2 MW in all cases compared to reconductoring the Soldotna – Diamond Ridge line.

Table 6.1 Loss Analysis Results – 99 MW Export Comparisons

Kenai Export Levels	Trans Config	Kenai Tie		Southern Intertie			Kenai Transmission Upgrades					Total Losses (MW)	Reduction in Losses	
		115 kV	230 kV	138 kV	230 kV	DC	New Brad - Qrtz	2nd Qrtz - Daves	2nd Brad - Sold	Recd Sold - Dmnd	2nd Sold - Qrtz		%	MW
Current Limits (99 MW) at Daves Creek - Hope 115 kV line	base	x										25.0	0%	0.0
	1	x		x					x			7.6	-69%	17.3
	2	x		x					x		x	7.5	-70%	17.5
	3	x			x				x			6.7	-73%	18.3
	4	x			x				x		x	6.6	-73%	18.3
	5		x	x			x	x				6.9	-72%	18.0
	6		x		x		x	x				6.7	-73%	18.3
	7		x				x	x				9.9	-60%	15.1
	8		x					x	x		x	9.9	-60%	15.1
	9	x		x						x		9.6	-62%	15.4
	10	x		x						x	x	9.4	-62%	15.5
	11	x			x					x		8.7	-65%	16.3
	12	x			x					x	x	8.6	-65%	16.3
	13		x					x		x	x	11.8	-53%	13.2
	14	x				x			x			8.4	-66%	16.6
	15	x				x				x		10.4	-58%	14.6
	16	x				x			x		x	8.3	-67%	16.7
	17		x			x		x	x		x	7.9	-68%	17.0
	18		x	x				x	x		x	6.7	-73%	18.3
	19		x		x			x	x		x	6.3	-75%	18.7
	20		x	x					x			7.2	-71%	17.8
	21		x			x			x			8.1	-67%	16.8

The loss analysis was also completed with a Kenai export level of 125 MW, with results shown in Table 6.2. Note that the table shows the results sorted by losses, with transmission configurations with the least amount of losses located at the top. The results show a wide range of possible losses for the different transmission configurations (8.9 – 17.5 MW). To reduce the losses to a high degree requires a minimum of another tie to the Kenai (AC or DC), adding a second Soldotna – Bradley Lake 115 kV line, and adding a second Soldotna – Quartz Creek 115 kV line.

Table 6.2 Loss Analysis Results – 125 MW Export Comparisons

Trans Config	Kenai Tie		Southern Intertie			Kenai Transmission Upgrades					Total Losses (MW)
	115 kV	230 kV	138 kV	230 kV	DC	New Brad - Qrtz	2nd Qrtz - Daves	2nd Brad - Sold	Recd Sold - Dmnd	2nd Sold - Qrtz	
19		x		x			x	x		x	8.9
6		x		x		x	x				9.5
4	x			x				x		x	9.6
3	x			x				x			9.6
18		x	x				x	x		x	9.8
5		x	x			x	x				10.1
20		x	x					x			10.6
17		x			x		x	x		x	10.7
2	x		x					x		x	11.2
1	x		x					x			11.4
21		x			x			x			11.5
16	x				x			x		x	12.3
12	x			x					x	x	12.4
11	x			x					x		12.4
14	x				x			x			13.0
10	x		x						x	x	13.9
9	x		x						x		14.1
8		x					x	x		x	14.8
7		x				x	x				15.0
15	x				x				x		15.5
13		x					x		x	x	17.5

7 Stability Analysis

Dynamic stability simulations were run to assess the transient impact of the proposed system improvements. Simulations of unit trip events and line fault and trip events were conducted. The simulations were used to evaluate the transfer limits of various system configurations as well as evaluate any impact of spinning reserve amounts and locations. A complete list of the disturbances used for stability analysis is shown in Appendix D.

The stability results for all three seasonal cases show that when the Kenai tie is upgraded to 230 kV along with a second Dave's Creek to Quartz Creek line and a Bradley Lake to Quartz Creek line section (transmission configuration 7), the system will go out of step for contingencies on the Soldotna - Sterling – Quartz line sections. Replacing the Bradley Lake to Quartz Creek line with a second line from Bradley Lake to Soldotna and a second line from Soldotna to Quartz Creek removes the unstable condition. The Bradley Lake – Quartz Creek line is not a recommended upgrade.

The results for all three seasonal cases also show that reconductoring the Soldotna to Diamond Ridge transmission line to 556 ACSR *"Dove"* conductor results in unstable conditions for a fault and trip of the Bradley Lake – Soldotna line section. Reconductoring the line section is not a recommended upgraded. Adding a second Soldotna – Bradley Lake line section is the preferred alternative.

The results also show that a second 115 kV line from Soldotna – Quartz Creek is required to eliminate instabilities due to contingencies of the Southern Intertie or the DC tie.

Detailed stability results for the winter peak, summer peak, and summer valley cases are shown Appendix E, F, and G, respectively.

There are 7 transmission configurations that produce no instabilities for contingencies with the three seasonal cases. These configurations include a 2nd Bradley Lake – Soldotna line, a 2nd Soldotna – Quartz Creek line section, and either the Southern Intertie (138 kV or 230 kV) or the DC tie. Only transmission configuration case 8 has no other tie besides the Kenai tie upgraded to 230 kV. It is important to note that since transmission configuration 8 has only one tie between Anchorage and the Kenai, it is susceptible to islanding for single contingencies between Dave's Creek and University. Table 7.1 shows the summary of the transient stability results. Transmission configurations highlighted in green exhibit instabilities during dynamic contingencies. Note that an x in a cell denotes what upgrades are applicable for each different transmission configuration.

Table 7.1 Transient Stability Results Summary

Trans Config	Kenai Tie		Southern Intertie			Kenai Transmission Upgrades				
	115 kV	230 kV	138 kV	230 kV	DC	add 2nd Bradley - Quartz	add 2nd Quartz - Daves	add 2nd Bradley - Soldotna	upgrade Soldotna - Diamond	add 2nd Soldotna - Quartz
1	x		x					x		
2	x		x					x		x
3	x			x				x		
4	x			x				x		x
5		x	x			x	x			
6		x		x		x	x			
7		x				x	x			
8		x					x	x		x
9	x		x						x	
10	x		x						x	x
11	x			x					x	
12	x			x					x	x
13		x					x		x	x
14	x				x			x		
15	x				x				x	
16	x				x			x		x
17		x			x		x	x		x
18		x	x				x	x		x
19		x		x			x	x		x
20		x	x					x		
21		x			x			x		

x	denotes equipment upgrades / options
(green)	transmission configurations with stability issues
(blue)	single contingency results in islanding

7.1 DC Size Analysis – Kenai Tie Trip

The addition of the DC tie between Bernice and Beluga adds additional complexity to the Railbelt system. With the AC Southern Intertie options, a fault and trip of the Kenai Tie would result in all available Kenai export energy flowing through the remaining AC Southern Intertie. Since the DC tie flows must be set and would be scheduled, the size of the DC line including overload capability was examined. This analysis was completed by scheduling the DC tie with an initial flow of 75 MW, then tripping the Kenai Tie open. The DC line flow was then increased until the Anchorage area did not load shed. The Kenai Tie was opened between the Dave's Creek and Quartz Creek substations, which was deemed the worst case outage due to the load at Seward remaining connected to the Anchorage system and the generation at Cooper Lake remaining connected to the Kenai system.

The results show that the DC line should have the capability of operating at 100 MW. Increasing the DC schedule from 75 MW to 100 MW eliminates load shedding that can occur if the DC schedule is not increased for a loss of the Kenai Tie with total Kenai Exports of around 127 MW. Detailed results are shown in Appendix H.

7.2 Kenai Tie Analysis – DC / Southern Intertie Trip

The loss of the DC Tie or Southern Intertie is a severe outage on the Kenai system. The outage results in all exports off of the Kenai flowing through the Kenai Tie and can result in instabilities or unacceptable voltages on the Kenai Tie.

7.2.1 Kenai Tie Analysis – Transient Stability

Transmission configurations with the existing Kenai Tie upgraded to 230 kV show no instability problems with the loss of the DC or Southern Intertie. The Kenai Tie upgrade to 230 kV was analyzed with 115 kV line additions from Soldotna – Quartz and Quartz – Dave's Creek and without the 115 kV line additions. Analysis of the existing Kenai Tie (115 kV) was completed to determine what upgrades are required to survive the loss of the DC or Southern Intertie.

The results show that in addition to the 2nd Bradley Lake – Soldotna 115 kV transmission line, the 2nd Soldotna – Quartz Creek 115 kV transmission line is also required. These transmission additions allow the export of energy off of the Kenai without problems during DC tie or Southern Intertie trip events. Detailed results are shown in Appendix I.

7.2.2 Kenai Tie Analysis – Power flow / Voltage

The high transfer levels on the existing Kenai Tie (115 kV) due to an outage of the DC tie or the Southern Intertie were shown to be stable with the addition of the 2nd Bradley Lake – Soldotna and 2nd Soldotna – Quartz Creek 115 kV transmission lines. Further analysis was completed to determine if unacceptable voltages were found on the Kenai Tie and if the SVC's at Dave's Creek and Soldotna were not operating at their limits.

The criteria used for unacceptable voltages were below 1.02 pu for the 24.9 kV buses at Portage or Girdwood. Load Tap Changer transformers (LTC) were modeled between the 115 kV and 24.9 kV bus locations to determine if the LTC would have enough steps to keep the 24.9 kV voltages acceptable (above 1.02 pu). A 10 MVAR reduction was placed on the SVC limits to model an appropriate operating margin for the Soldotna and Dave's Creek SVC's.

The results show acceptable voltage performance for the 115 kV Kenai Tie with the addition of the 2nd Bradley Lake – Soldotna 115 kV line and the 2nd Soldotna – Quartz Creek 115 kV line. The results also show acceptable voltage performance when the Kenai Tie is upgraded to 230 kV with and without line additions to the Soldotna – Quartz – Dave's Creek substations. The 230 kV Kenai Tie cases include the 2nd Bradley – Soldotna 115 kV line addition.

8 Cost Analysis

Cost estimates for each of the proposed transmission upgrades are found in Appendix J. The possible transmission configurations were chosen based on the previous stability results as well as the costs associated with the individual projects. Comparing the costs of the Southern Intertie at 138 kV and 230 kV, the 230 kV option is a lot more expensive while providing nominal increases in transfer capability / reduction in losses. Therefore, the Southern Intertie option at 230 kV is not considered a viable option. Transmission configurations with the Soldotna – Diamond Ridge line upgraded or with the Bradley Lake – Quartz Creek line are not viable options due to instabilities that can occur with those transmission configurations. Upgrading the Kenai Tie to 230 kV without adding a Southern Intertie or a DC tie was deemed not feasible due to single contingencies on the Kenai Tie resulting in islanding of the Kenai from Anchorage.

The possible transmission configurations include the addition of the 2nd 115 kV Bradley Lake – Soldotna line for all cases with possible upgrades to the existing Kenai Tie and additional ties into Anchorage (Southern Intertie and DC Intertie). Table 8.1 shows the possible transmission configuration specifics and the total costs.

Table 8.1 Possible Transmission Configurations

Trans Config	Kenai Tie		Southern Intertie		Kenai Transmission Upgrades			Total Costs Range (1000's)	
	115 kV	230 kV	138 kV	DC	add 2nd Bradley - Soldotna	add 2nd Soldotna - Quartz	add 2nd Quartz - Daves	Low	High
2	x		x		x	x		$321,665	$388,455
16	x			x	x	x		$241,415	$302,621
18		x	x		x	x	x	$423,430	$490,220
20		x	x		x			$362,990	$429,780
21		x		x	x			$282,740	$343,946
17		x		x	x	x	x	$343,180	$404,386

x denotes upgrades / options for transmission configuration

The cost totals show a significant increase in costs for the 138 kV Southern Intertie options compared to the DC intertie option. The complex switching and energization requirements of both the 138 kV Kenai Intertie has increased the cost estimates considerably above prior studies. For purposes of budgetary estimates, we assumed 25% of the compensation requirements in the 138 kV option was fixed compensation. The ratio of fixed vs. variable compensation must be determined by detailed switching studies. These switching studies should consider the switching surges encountered during energizing/de-energization of the cables and reactors, the possibility of subsynchronous resonance, and the different methods of energization.

Although feasible, the technical complexities of energizing a 120 MVAr submarine cable/reactor/SVC combination in an isolated electrical system would require specialized studies and would be considerably more complex than the existing system's operation. The complexities of the switching and energization should be more fully developed prior to embarking on this technology in a limited system such as the Railbelt.

The DC is the preferred intertie due to the technical challenges in operating and constructing the AC intertie and the associated high costs.

9 Recommendations

The stability results and the cost analysis were used to create a list of more probable transmission configurations for the Kenai Transmission system. These cases are shown below in Table 9.1 with a cost comparison shown in Table 9.2.

Table 9.1 Preferred Transmission Configurations

Trans Config	Kenai Tie		DC Intertie	Kenai Transmission Upgrades		
	115 kV	230 kV		add 2nd Bradley - Soldotna	add 2nd Soldotna - Quartz	add 2nd Quartz - Daves
16	x		x	x	x	
21		x	x	x		
17		x	x	x	x	x
x	denotes upgrades / options for transmission configuration					

Table 9.2 Preferred Transmission Configurations - Costs

Trans Config	Kenai Tie (1000's)		DC Intertie		Transmission Upgrades (1000's)			Total Costs Range (1000's)	
	115 kV	230 kV	Low	High	Add 2nd Bradley - Soldotna	Add 2nd Soldotna - Quartz	Add 2nd Quartz - Dave's	Low	High
16	0		$134,550	$195,756	$57,865	$49,000		$241,415	$302,621
21		$85,525	$134,550	$195,756	$62,665			$282,740	$343,946
17		$85,525	$134,550	$195,756	$57,865	$49,000	$16,240	$343,180	$404,386

Loss analysis was completed with varying Kenai export levels of 55 MW to 100 MW for the remaining transmission configurations, comparing the losses to the current 2020 year transmission system. Table 9.3 shows the results in tabular form while Figure 9.1 shows the results graphically. Note that the DC Intertie was assumed to schedule all exports up to a maximum value of 75 MW. The export value is the flow measured at the Dave's Creek – Hope transmission line, from the Dave's Creek end. The loss value includes the losses of all of the Kenai Transmission lines from Bradley Lake to University, as well as the transmission lines to the DC Intertie. It is assumed that the DC Intertie has losses that are equal to 4% of the energy flowing on the line.

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Table 9.3 Preferred Transmission Configurations – Loss Comparisons

Transmission Configuration							
Base		#16		#21		#17	
Export (MW)	Loss (MW)	Export (MW)	Loss (MW)	Export (MW)	Loss (MW)	Export (MW)	Loss (MW)
59.3	8.6	55.5	3.8	55.5	3.8	55.5	3.8
63.3	9.8	58.3	4.0	58.3	4.0	58.4	4.0
67.4	11.1	63.2	4.5	63.2	4.5	63.2	4.5
71.5	12.6	67.7	5.0	67.7	5.0	67.7	5.0
75.3	14.0	72.4	5.5	72.4	5.5	72.4	5.5
79.2	15.7	77.1	6.0	77.1	6.0	77.1	6.0
83.1	17.4	81.6	6.3	81.6	6.3	81.6	6.3
86.7	19.2	86.3	6.7	86.3	6.7	86.4	6.7
90.5	21.2	91.0	7.2	91.0	7.1	91.1	7.0
94.8	23.7	95.4	7.7	95.3	7.6	95.4	7.5
99.8	27.0	100.0	8.3	99.8	8.1	100.1	7.9

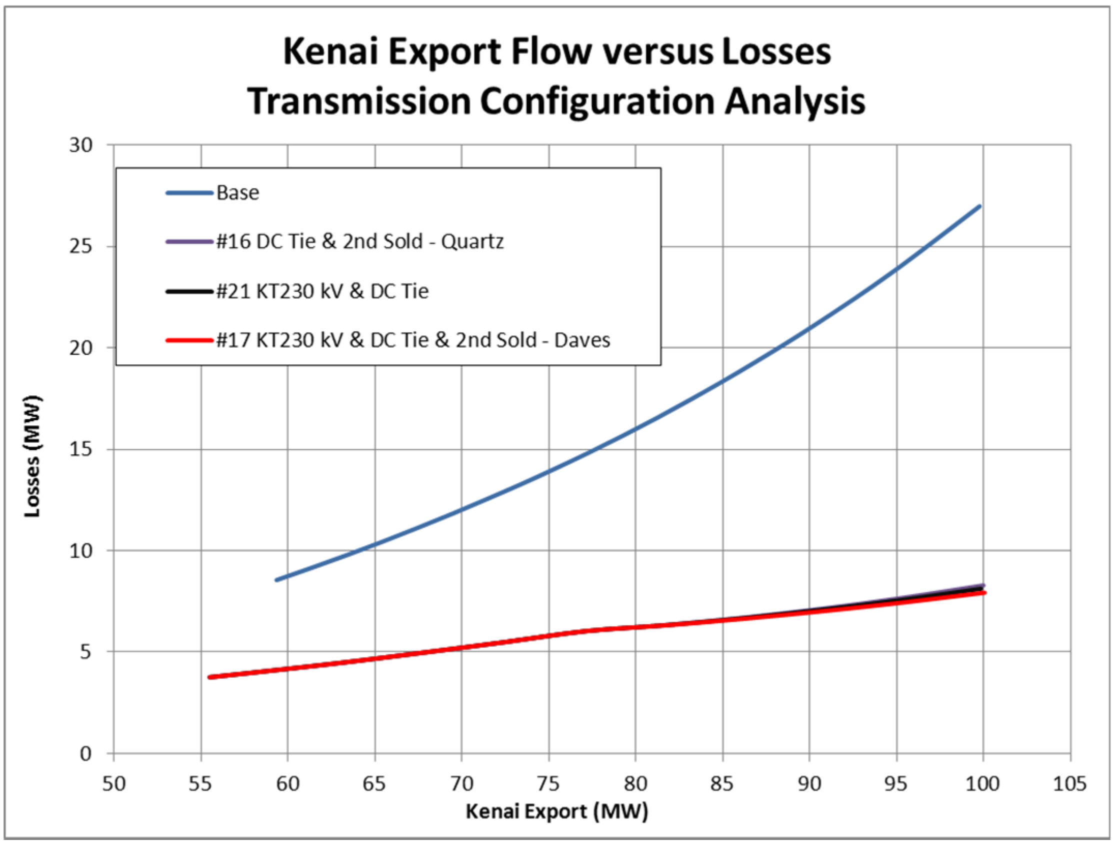

Figure 9.1 Kenai Export Loss Analysis

The results show a significant reduction in losses with the addition of the DC intertie and / or the Kenai Tie upgraded to 230 kV. The results also show minimal increased reduction in losses with the Kenai Tie upgraded to 230 kV and the DC tie added (transmission configuration 17) compared to the other upgraded configurations. Configuration 17 is not recommended since the cost is approximately $100 million more than the DC line addition (transmission configuration 16).

The two recommended transmission configurations are the as follows:

#16 - DC intertie with 2nd Bradley – Soldotna and 2nd Soldotna – Quartz Creek 115 kV line

#21 - DC intertie with 2nd Bradley – Soldotna 115 kV line and Kenai Tie upgraded to 230 kV

9.1 N-1-1 Analysis – Recommended Transmission Configurations

Double contingency analysis (N-1-1) was completed on the two recommended transmission configurations to determine the transfer capability limit of the Kenai system with the loss of the DC Intertie. Fault and trips of the Soldotna SVC transformer and the Soldotna – Diamond Ridge 115 kV line were used to determine the Kenai response due to contingencies and the associated transfer limits for the different cases. Four different generation dispatches were used to test the two recommended transmission configurations for each of the three load seasons (summer peak, summer valley, and winter peak). The dispatches are listed below:

- B – Full Cooper Lake and Bradley Lake export
- C – Full Cooper Lake and Bradley Lake (with 3rd unit) export
- C1 - Full Cooper Lake and Bradley Lake (with 3rd unit), Nikiski offline
- C2 - Full Bradley Lake (with 3rd unit), Nikiski offline, Bernice offline, Cooper Lake offline

Bradley Lake generation plant output was reduced in 5 MW increments for cases that resulted in transient instabilities till a stable response was found.

The N-1-1 Kenai Export limits are listed in Tables 9.4 for transmission configurations 16 and 21. Note that the green shaded cells are cases that have Kenai Export limits due to Bradley Lake and Cooper Lake maximum output. Cells with red text are cases that must be restricted due to contingencies. The amount of Bradley Lake excess capacity due to the restriction is also listed in the table.

The results show that the two recommended transmission configurations have similar (+/- 5 MW) Kenai Export limits due to contingencies with the DC line out of service. The results also show that turning off Nikiski and Bernice generation and increasing Soldotna generation reduces the Kenai Export limits by about 20 MW.

Table 9.4 N-1-1 Kenai Export Limits - Recommend Transmission Configurations

Trans Config	Gen Case	Summer Valley Kenai Export (MW)	Summer Valley Excess Brad (MW)	Summer Peak Kenai Export (MW)	Summer Peak Excess Brad (MW)	Winter Peak Kenai Export (MW)	Winter Peak Excess Brad (MW)
16	b	108		106		103	
	c	123		120		114	-5
	c1	111	-15	113	-10	102	-20
	c2	98	-20	92	-5	75	
21	b	104		102		100	
	c	118		115		113	
	c1	115	-5	112	-5	106	-10
	c2	94	-20	88	-5	68	-5

(green cell) Kenia Export limited by generation

red values - Kenai Export limited by stability

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10 Conclusions

The northern utilities will be adversely impacted following the addition of Kenai area and northern generation additions in 2015. Losses for Bradley Lake energy will increase significantly over historic levels. Portions of Bradley Lake's capacity will be unavailable to northern utilities during much of the year and increases in Bradley Lake capacity will not be possible.

A project to reconstruct the 115 kV Diamond Ridge – Soldotna transmission line from 4/0 was evaluated against the construction of a new 115 kV Bradley Lake – Soldotna transmission line but is not recommended due to its higher costs. The Diamond Ridge reconstruction is a significantly longer project at a higher cost/mile due to distribution underbuild, shorter spans, and working around energized facilities. In addition to the higher costs, simulations indicate that the reconductored Diamond Ridge – Soldotna line cannot provide unconstrained operation of the Bradley Lake project. Operation of Bradley Lake at high generation levels or the installation of a 3rd turbine with the new generation requires a new 115 kV Bradley Lake – Soldotna transmission line in addition to the two existing 115 kV lines.

A newly identified alternative of constructing a 100 kV HVDC tie between Beluga and Bernice Lake in conjunction with a new 115 kV Bradley Lake-Soldotna line and new 115 kV Soldotna – Quartz Creek line appears to be the most economical and technically feasible solution. We recommend the 100 kV HVDC Beluga – Bernice alternative be fully evaluated and if substantiated, it coupled with the construction of a new Bradley Lake – Soldotna 115 kV line. Additional Kenai transmission upgrades recommended are either a new Soldotna – Quartz Creek 115 kV line or upgrading the Kenai Tie to 230 kV.

Appendix A – Load Analysis (MW) IOC versus RIRP

Table A.1 2020 Seasonal Base Case Load from IOC

Season	CEA	GVEA	HEA	MEA	ML&P	SES	Total
WP	229	283.3	98.7	186	219.9	11.9	1028.8
SP	159.3	224.6	67.4	116.2	210.4	10.3	788.2
SV	98.3	127.4	45.7	67.5	113.1	7.7	459.7

Table A.2 RIRP Winter Peak Loads

Year	CEA	GVEA	HEA	MEA	ML&P	SES	GRETC
2011	234	238	87	146	188	10	869
2015	235	218	89	157	192	10	868
2020	238	226	92	167	197	10	896
2025	242	234	96	178	202	10	928
2030	247	243	100	188	207	10	959
2035	252	252	104	199	212	10	991
2040	256	260	108	210	217	10	1024
2045	261	269	112	222	223	10	1058
2050	266	278	117	234	228	10	1092
2055	271	288	121	247	233	10	1127
2060	276	297	125	260	239	10	1163

Table A.3 RIRP Summer Peak Loads

Year	CEA	GVEA	HEA	MEA	ML&P	SES	GRETC
2011	161	191	75	91	167	10	668
2015	161	175	77	96	171	11	667
2020	163	182	79	95	175	11	689
2025	166	188	83	100	180	11	713
2030	170	195	86	106	184	11	737
2035	173	202	90	113	189	11	762
2040	176	209	93	119	193	11	787
2045	180	216	97	126	198	12	813
2050	183	224	101	134	203	12	839
2055	186	231	104	141	207	12	866
2060	190	239	108	149	212	13	894

Table A.4 RIRP Summer Valley Loads

Year	CEA	GVEA	HEA	MEA	ML&P	SES	GRETC
2011	95	89	44	53	91	4	414
2015	96	81	46	57	93	5	414
2020	97	84	47	61	95	5	427
2025	99	87	49	65	98	5	441
2030	101	90	51	69	100	5	456
2035	103	94	53	73	103	5	471
2040	105	97	55	77	105	5	486
2045	107	100	57	81	108	5	502
2050	109	104	60	85	110	5	518
2055	111	107	62	90	113	5	534
2060	113	111	64	95	115	5	551

Appendix B – Generation Dispatches

The specifics of the different generation configuration dispatches for the three seasonal cases are shown in the tables below. Table B.1 shows the generation dispatches for the base cases and for cases with the 3rd Bradley Lake unit online. Table B.2 shows the generation dispatches for the cases the 3rd Bradley Lake unit online, as well as the sensitivity cases based off of the original case. Table B.3 shows the generation dispatches for the cases with Watana online and no other generation additions. Table B.4 shows the generation dispatches for the cases with Watana and the 3rd Bradley Lake unit online.

Table B.1 Generation Dispatch – Base, Upgrades, and 3rd Bradley Lake

Generator Name	ID	A			B			C		
		Base Case With Current Limits			Trans upgrades, No gen upgrades			3rd Bradley Lake		
		sv	sp	wp	sv	sp	wp	sv	sp	wp
WILSON	B	0	0	0	0	0	0	0	0	0
Soldotna G2	2						17			14
BRADLY 1G	1	45	45	45	60	60	60	47	47	47
BRADLY 2G	2	45	45	45	60	60	60	47	47	47
BRADLY 3G	3							47	47	47
TESORO1G	1	1	4	4	1	4	4	1	4	4
TESORO1G	2	1	4	4	1	4	4	1	4	4
NIKI GEN	1	39	36	43	30	34	43	20	32	43
Nikiski ST	2					14	18	8	13	18
PLNT1-2G	2		28	32		28	30		28	25
PLNT1-3G	3			32		28	30		28	25
Plant 2 9G	9		36	45		36	45		36	45
Plant 2 10G	10		36	45		36	45	40	36	45
Plant 2 11G	11		20	25		20	25	11	20	25
SPP G1	1	51	45	57	30	39	59		42	59
SPP G2	2	51	45	57	47	46	59	45	42	59
SPP G3	3	38	45	47	43	36	57	47	42	51
SPP G4	4	22	21	25	14	18	27	14	19	27
COOP1&2G	1	10	10	10	10	10	10	10	10	10
COOP1&2G	2	10	10	10	10	10	10	10	10	10
EKLUT 1G	1	18	18	19	18	19	19	19	19	19
EKLUT 2G	2	18	18	19	18	19	19	19	19	19
Eklutna #1	1			17			17			17
Eklutna #1	2			17			17			17
Eklutna #2	3			17		10	17			17
Eklutna #2	4		10	17		17	17			17
Eklutna #2	5		17	17		17	17		17	17
Eklutna #3	6		17	17		17	17		17	17
Eklutna #3	7	17	17	17		17	17		17	17
Eklutna #3	8	17	17	17	17	17	17		17	17
Eklutna #4	9	17	17	17	17	17	17	17	17	17
Eklutna #4	10	17	17	17	13	17	17	17	17	17
HCCP#2-G	2		61	60		60	60		61	61
HLP#1-G	1		26	28	28	26				
NPOLESUB	1		39	64			64		39	64
NPOLESUB	2		40	64		40	64		40	64
NPCC 1	3	40	33	53	40	33	53	43	33	53
NPCC 2	4	10	7	12	10	7	12	10	7	12
Kenai Transfer		99	99	96	111	109	108	126	125	122
Total Load		450	786	1035	450	786	1035	450	786	1035
Total Losses		32	35	36	18	29	28	23	26	31
Total Generation		482	821	1076	468	814	1063	472	825	1065
Total Spin		110	74	91	91	80	85	92	68	102

Table B.2 Generation Dispatch - 3rd Bradley Lake - Sensitivity

Generator Name	ID	C			C1			C2		
		3rd Bradley Lake			3rd Bradley Lake, Nikiski offline			3rd Brad; Nikiski,Cooper, Bernice offline		
		sv	sp	wp	sv	sp	wp	sv	sp	wp
WILSON	B	0	0	0	0	0	0	0	0	0
Soldotna G2	2			14	28	40	49	40	40	49
BRADLY 1G	1	47	47	47	47	47	47	47	47	47
BRADLY 2G	2	47	47	47	47	47	47	47	47	47
BRADLY 3G	3	47	47	47	47	47	47	47	47	47
TESORO1G	1	1	4	4	1	4	4	1	4	4
TESORO1G	2	1	4	4	1	4	4	1	4	4
NIKI GEN	1	20	32	43						
Nikiski ST	2	8	13	18						
Bernice 2	2					7				
Bernice 3	3						27			
PLNT1-2G	2		28	25		28	25		28	32
PLNT1-3G	3		28	25		28	25		28	32
PLNT2-5G	5								20	37
Plant 2 9G	9		36	45		36	45		36	45
Plant 2 10G	10	40	36	45	40	36	45	40	36	45
Plant 2 11G	11	11	20	25	11	20	25	11	21	25
SPP G1	1		42	59		42	59		45	59
SPP G2	2	45	42	59	45	42	59	45	45	59
SPP G3	3	47	42	51	47	42	51	51	20	44
SPP G4	4	14	19	27	14	19	27	14	24	27
COOP1&2G	1	10	10	10	10	10	10			
COOP1&2G	2	10	10	10	10	10	10			
EKLUT 1G	1	19	19	19	19	19	19	19	19	19
EKLUT 2G	2	19	19	19	19	19	19	19	19	19
Eklutna #1	1			17			17			17
Eklutna #1	2			17			17			17
Eklutna #2	3			17			17			17
Eklutna #2	4			17			17			17
Eklutna #2	5		17	17		17	17		17	17
Eklutna #3	6		17	17		17	17		17	17
Eklutna #3	7		17	17		17	17		17	17
Eklutna #3	8		17	17		17	17		17	17
Eklutna #4	9	17	17	17	17	17	17	17	17	17
Eklutna #4	10	17	17	17	17	17	17	17	17	17
HCCP#2-G	2		61	61		61	61		61	61
NPOLESUB	1		39	64		39	64		39	64
NPOLESUB	2		40	64		40	64		40	64
NPCC 1	3	43	33	53	43	33	53	43	33	53
NPCC 2	4	10	7	12	10	7	12	10	7	12
Kenai Transfer		126	125	122	127	124	123	118	99	77
Total Load		450	786	1035	450	786	1035	450	786	1035
Total Losses		23	26	31	23	26	31	23	26	31
Total Generation		472	825	1065	472	826	1066	469	810	1064
Total Spin		92	68	102	45	52	53	41	72	44

Table B.3 Generation Dispatch - Watana and no 3rd Bradley Lake

Generator Name	ID	D			E			F		
		Watana			Watana			3rd Bradley Full, Watana Reduced		
		sv	sp	wp	sv	sp	wp	sv	sp	wp
WILSON	B	0	0	0	0	0	0	0	0	0
BRADLY 1G	1	60	60	60	60	60	60	47	47	47
BRADLY 2G	2	60	60	60	60	60	60	47	47	47
BRADLY 3G	3							47	47	47
TESORO1G	1	1	4	4	1	4	4	1	4	4
TESORO1G	2	1	4	4	1	4	4	1	4	4
NIKI GEN	1					5	7		10	0
PLNT1-2G	2		8	20			20			31
PLNT1-3G	3									30
Plant 2 9G	9								35	44
Plant 2 10G	10			40					35	44
Plant 2 11G	11			11					19	24
SPP G1	1						37			40
SPP G2	2			50		12	37		40	57
SPP G3	3		14	28		6	25	31	26	37
SPP G4	4		5	15		6	15	6	12	24
COOP1&2G	1	10	10	10	10	10	10	10	10	10
COOP1&2G	2	10	10	10	10	10	10	10	10	10
EKLUT 1G	1	2	2	8	2	1	1	18	12	8
EKLUT 2G	2	3	2	4	3	1	1	18	12	4
Susitna 1	1	100	200	200	100	200	200	67	100	100
Susitna 2	2	100	200	200	100	200	200	67	100	100
Susitna 3	3	100	200	200	100	200	200	67	100	100
HCCP#2-G	2						60		60	60
HLP#1-G	1			28						
NPOLESUB	1									60
NPOLESUB	2			50		15	55		40	64
NPCC 1	3	16	30	53	15	15	53	25	33	53
NPCC 2	4	4	7	12	4	7	12	6	7	12
Kenai Transfer		81	61	30	81	67	37	99	89	49
Total Load		450	786	1035	450	786	1035	450	786	1035
Total Losses		15	29	33	15	29	35	16	22	25
Total Generation		467	815	1067	466	815	1070	467	808	1060
Total Spin		393	117	128	395	218	212	473	399	410

Table B.4 Generation Dispatch - Watana and the 3rd Bradley Lake

Generator Name	ID	G 3rd Bradley Reduced, Watana			H 3rd Bradley Reduced, Watana		
		sv	sp	wp	sv	sp	wp
WILSON	B	0	0	0	0	0	0
BRADLY 1G	1	20	20	20	20	20	20
BRADLY 2G	2	20	20	20	20	20	20
BRADLY 3G	3	20	20	20	20	20	20
TESORO1G	1	1	4	4	1	4	4
TESORO1G	2	1	4	4	1	4	4
NIKI GEN	1			13		10	32
Nikiski ST	2						13
PLNT1-2G	2						27
Plant 2 10G	10			40			35
Plant 2 11G	11			11			10
SPP G1	1						37
SPP G2	2		42	56		33	37
SPP G3	3	20	24	40	15	22	29
SPP G4	4	3	13	17	5	10	17
COOP1&2G	1	10	10	10	10	7	10
COOP1&2G	2	10	10	10	10	7	10
EKLUT 1G	1	8	2	8	2	2	12
EKLUT 2G	2	8	2	4	2	2	12
Susitna 1	1	100	200	200	100	200	200
Susitna 2	2	100	200	200	100	200	200
Susitna 3	3	100	200	200	100	200	200
HCCP#2-G	2			60		24	50
NPOLESUB	2			64			
NPCC 1	3	30	33	53	43	20	53
NPCC 2	4	8	7	12	10	7	12
Kenai Transfer		26	6	-13	26	11	19
Total Load		450	786	1035	450	786	1035
Total Losses		8	24	31	9	24	29
Total Generation		459	810	1066	458	811	1064
Total Spin		428	114	141	429	211	213

Appendix C – Power Flow Results

Table C.1 Power flow – Summer Peak – Case B – Bradley and Cooper Export

gen disp	trans config	outage from bus	outage to bus	outage id	overload (s) from bus	overload (s) to bus	overload (s) id	overload %
B - Cooper and Bradley Lake at full export (109 MW)	1	Southern Tie 138 kV			University-Soldotna(max 124%,Daves-Quartz)			
	2	Southern Tie 138 kV			University-Quartz(max 124%,Daves-Quartz)			
	3	Southern Tie 230 kV			University-Soldotna(max 124%,Daves-Quartz)			
	3	Soldotna	Tesoro	1	Nikiski	Bernice	1	108
	3	Tesoro	Bernice	1	Nikiski	Bernice	1	103
	3	Nikiski	Bernice	1	Soldotna	Tesoro	1	101
	4	Southern Tie 230 kV			University-Quartz(max 124%,Daves-Quartz)			
	4	Soldotna	Tesoro	1	Nikiski	Bernice	1	104
	4	Tesoro	Bernice	1	Nikiski	Bernice	1	100
	5	no branch overloads						
	6	no branch overloads						
	7	Soldotna	Sterling	1	Bradley	Quartz	1	113
	7	Sterling	Quartz	1	Bradley	Quartz	1	111
	7	Bradley	Quartz	1	Soldotna-Quartz(max 104%,Soldotna-Sterling)			
	7	Daves	Quartz	1	Daves	Quartz	2	125
	8	Soldotna	Sterling	1	Soldotna	Quartz	1	108
	8	Sterling	Quartz	1	Soldotna	Quartz	1	106
	8	Soldotna	Quartz	1	Solodtna-Ster-Quartz (108%, Soldotna-Sterling			
	8	Daves	Quartz	1	Daves	Quartz	2	125
	9	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(124% Brad-Fritz)			
	9	Soldotna-Diamond-Fritz			Bradley-Soldotna max, 121%			
	9	Southern Tie 138 kV			University-Soldotna(max 121%,Daves-Quartz)			
	10	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(124% Brad-Fritz)			
	10	Soldotna-Diamond-Fritz			Bradley-Soldotna max, 121%			
	10	Southern Tie 138 kV			University-Quartz(max 122%,Daves-Quartz)			
	11	Southern Tie 230 kV			University-Soldotna(max 121%,Daves-Quartz)			
	11	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(124% Brad-Fritz)			
	11	Soldotna-Diamond-Fritz			Bradley-Soldotna max, 124%			
	11	Soldotna	Tesoro	1	Nikiski	Bernice	1	107
	11	Nikiski	Bernice	1	Soldotna	Tesoro	1	102
	12	Southern Tie 230 kV			University-Quartz(max 123%,Daves-Quartz)			
	12	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(124% Brad-Fritz)			
	12	Soldotna-Diamond-Fritz			Bradley-Soldotna max, 124%			
	12	Soldotna	Tesoro	1	Nikiski	Bernice	1	103
	13	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(124% Brad-Fritz)			
	13	Soldotna-Diamond-Fritz			Bradley-Soldotna max, 121%			
	13	Soldotna	Sterling	1	Soldotna	Quartz	1	106
	13	Soldotna	Quartz	1	Solodtna-Ster-Quartz (106%, Soldotna-Sterling			
	13	Daves	Quartz	1	Daves	Quartz	2	122
	14	DC Tie			University-Soldotna(max 124%,Daves-Quartz)			
	15	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(141% Brad-Fritz)			
	15	DC Tie			University-Soldotna(max 121%,Daves-Quartz)			
	16	DC Tie			University-Quartz(max 124%,Daves-Quartz)			
	17	no branch overloads						
	18	no branch overloads						
	19	no branch overloads						
	20	Southern Tie 138 kV			Soldotna - Daves (max 124%, Daves - Quartz)			
	21	DC Tie			Soldotna - Daves (max 124%, Daves - Quartz)			

Legend:
- (green shading) outage of line produces overload on remaining line
- (blue shading) cases with minimal or no branch overloads

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Table C.2 Power flow – Summer Peak – Case C – 3rd Bradley Lake Unit added

gen disp	trans config	outage from bus	outage to bus	outage id	overload (s) from bus	overload (s) to bus	overload (s) id	overload %
C- Cooper and Bradley Lake with 3rd Bradley unit at full export (125 MW)	1	Southern Tie 138 kV			University-Soldotna(max 140%,Daves-Quartz)			
		Soldotna	Tesoro	1	Nikiski	Bernice	1	103
		Daves Cr	Quartz	1	Nikiski	Bernice	1	100
	2	Southern Tie 138 kV			University-Quartz(max 141%,Daves-Quartz)			
		Daves Cr	Quartz	1	Nikiski	Bernice	1	100
	3	Southern Tie 230 kV			University-Soldotna(max 140%,Daves-Quartz)			
		Soldotna	Tesoro	1	Nikiski	Bernice	1	118
		Tesoro	Bernice	1	Nikiski	Bernice	1	113
		Nikiski	Bernice	1	Soldotna-Bernice(max 111%,Soldotna-Tesoro)			
		Daves Cr	Quartz	1	Nikiski	Bernice	1	103
	4	Southern Tie 230 kV			University-Quartz(max 141%,Daves-Quartz)			
		Soldotna	Tesoro	1	Nikiski	Bernice	1	114
		Tesoro	Bernice	1	Nikiski	Bernice	1	109
		Nikiski	Bernice	1	Soldotna-Bernice(max 106%,Soldotna-Tesoro)			
		Daves Cr	Quartz	1	Nikiski	Bernice	1	103
	5	Soldotna	Bradley	1	Thompson-Diamond(max 114%,Anchor-Diamond)			
	6	Soldotna	Bradley	1	Thompson-Diamond(max 117%,Anchor-Diamond)			
	7	Soldotna	Sterling	1	Bradley	Quartz	1	137
		Sterling	Quartz	1	Bradley	Quartz	1	134
		Bradley	Quartz	1	Soldotna-Quartz(max 119%,Soldotna-Sterling)			
		Daves	Quartz	1	Daves	Quartz	2	141
	8	Soldotna	Sterling	1	Soldotna	Quartz	1	124
		Sterling	Quartz	1	Soldotna	Quartz	1	122
		Soldotna	Quartz	1	Solodtna-Ster-Quartz (123%, Soldotna-Sterling			
		Daves	Quartz	1	Daves	Quartz	2	141
	9	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(149% Brad-Fritz)			
		Soldotna-Diamond-Fritz			Bradley-Soldotna max, 141%			
		Soldotna	Tesoro	1	Nikiski	Bernice	1	101
		Southern Tie 138 kV			University-Soldotna(max 137%,Daves-Quartz)			
	10	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(148% Brad-Fritz)			
		Soldotna-Diamond-Fritz			Bradley-Soldotna max, 141%			
		Southern Tie 138 kV			University-Quartz(max 138%,Daves-Quartz)			
	11	Southern Tie 230 kV			University-Soldotna(max 137%,Daves-Quartz)			
		Soldotna	Bradley	1	Soldotna-Diamond-Fritz(147% Brad-Fritz)			
		Soldotna-Diamond-Fritz			Bradley-Soldotna max, 148%			
		Soldotna	Tesoro	1	Nikiski	Bernice	1	116
		Nikiski	Bernice	1	Soldotna	Tesoro	1	109
		Nikiski	Bernice	1	Tesoro	Bernice	1	104
		Daves	Quartz	1	Nikiski	Bernice	1	102
	12	Southern Tie 230 kV			University-Quartz(max 138%,Daves-Quartz)			
		Soldotna	Bradley	1	Soldotna-Diamond-Fritz(148% Brad-Fritz)			
		Soldotna-Diamond-Fritz			Bradley-Soldotna max, 141%			
		Soldotna	Tesoro	1	Nikiski	Bernice	1	112
		Tesoro	Bernice	1	Nikiski	Bernice	1	107
		Nikiski	Bernice	1	Soldotna	Tesoro	1	104
	13	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(149% Brad-Fritz)			
		Soldotna-Diamond-Fritz			Bradley-Soldotna max, 141%			
		Soldotna	Sterling	1	Soldotna	Quartz	1	121
		Soldotna	Quartz	1	Solodtna-Ster-Quartz (121%, Soldotna-Sterling			
		Daves	Quartz	1	Daves	Quartz	2	138
	14	DC Tie			University-Soldotna(max 140%,Daves-Quartz)			
	15	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(141% Brad-Fritz)			
		Soldotna	Tesoro	1	Nikiski	Bernice	1	100
		DC Tie			University-Soldotna(max 137%,Daves-Quartz)			
	16	DC Tie			University-Quartz(max 141%,Daves-Quartz)			
	17	no branch overloads						
	18	no branch overloads						
	19	Nikiski	Bernice	1	Soldotna	Tesoro	1	102
	20	Nikiski	Bernice	1	Soldotna	Tesoro	1	100
		Southern Tie			Soldotna - Daves (max 140%, Daves - Quartz)			
	21	DC Tie			Soldotna - Daves (max 140%, Daves - Quartz)			

Legend:
- line with 50 MVA rating
- outage of line produces overload on remaining line
- cases with minimal or no branch overloads

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Table C.3 Power flow – Summer Valley – Case B – Bradley and Cooper Export

gen disp	trans config	outage from bus	outage to bus	outage id	overload (s) from bus	overload (s) to bus	overload (s) id	overload %
B - Cooper and Bradley Lake at full export (111 MW)	1	Southern Tie 138 kV			University-Soldotna(max 124%,Daves-Quartz)			
	2	Southern Tie 138 kV			University-Quartz(max 124%,Daves-Quartz)			
	3	Southern Tie 230 kV			University-Soldotna(max 123%,Daves-Quartz)			
	3	Nikiski	Bernice	1	Soldotna	Tesoro	1	103
	3	Soldotna	Tesoro	1	Nikiski	Bernice	1	105
	4	Southern Tie 230 kV			University-Quartz(max 124%,Daves-Quartz)			
	4	Soldotna	Tesoro	1	Nikiski	Bernice	1	100
	5	Soldotna	Bradley	1	Anchor Pt.	Diamond	1	101
	6	Soldotna	Bradley	1	Anchor Pt.	Diamond	1	103
	7	Soldotna	Sterling	1	Bradley	Quartz	1	112
	7	Sterling	Quartz	1	Bradley	Quartz	1	110
	7	Bradley	Quartz	1	Soldotna-Quartz(max 103%,Soldotna-Sterling)			
	7	Daves	Quartz	1	Daves	Quartz	2	124
	8	Soldotna	Sterling	1	Soldotna	Quartz	1	112
	8	Sterling	Quartz	1	Soldotna	Quartz	1	110
	8	Soldotna	Quartz	1	Solodtna-Ster-Quartz (107%, Soldotna-Sterling			
	8	Daves	Quartz	1	Daves	Quartz	2	124
	9	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(124% Brad-Fritz)			
	9	Soldotna-Diamond-Fritz			Bradley-Soldotna max, 120%			
	9	Southern Tie 138 kV			University-Soldotna(max 120%,Daves-Quartz)			
	10	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(124% Brad-Fritz)			
	10	Soldotna-Diamond-Fritz			Bradley-Soldotna max, 121%			
	10	Southern Tie 138 kV			University-Quartz(max 122%,Daves-Quartz)			
	11	Southern Tie 230 kV			University-Soldotna(max 120%,Daves-Quartz)			
	11	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(124% Brad-Fritz)			
	11	Soldotna-Diamond-Fritz			Bradley-Soldotna max, 121%			
	11	Soldotna	Tesoro	1	Nikiski	Bernice	1	107
	11	Nikiski	Bernice	1	Soldotna	Tesoro	1	104
	12	Southern Tie 230 kV			University-Quartz(max 122%,Daves-Quartz)			
	12	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(124% Brad-Fritz)			
	12	Soldotna-Diamond-Fritz			Bradley-Soldotna max, 121%			
	12	Soldotna	Tesoro	1	Nikiski	Bernice	1	102
	13	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(124% Brad-Fritz)			
	13	Soldotna-Diamond-Fritz			Bradley-Soldotna max, 121%			
	13	Soldotna	Sterling	1	Soldotna	Quartz	1	105
	13	Soldotna	Quartz	1	Solodtna-Ster-Quartz (105%, Soldotna-Sterling			
	13	Soldotna	Tesoro	1	Nikiski	Bernice	1	103
	13	Daves	Quartz	1	Daves	Quartz	2	122
	14	DC Tie			University-Soldotna(max 124%,Daves-Quartz)			
	15	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(121% Brad-Fritz)			
	15	DC Tie			University-Soldotna(max 120%,Daves-Quartz)			
	16	DC Tie			University-Quartz(max 124%,Daves-Quartz)			
	17	no branch overloads						
	18	no branch overloads						
	19	no branch overloads						
	20	Southern Tie 138 kV			Soldotna - Daves (max 123%, Daves - Quartz)			
	21	DC Tie			Soldotna - Daves (max 123%, Daves - Quartz)			

Legend:
- (grey shading) line with 50 MVA rating
- (green shading) outage of line produces overload on remaining line
- (blue shading) cases with minimal or no branch overloads

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Table C.4 Power flow – Summer Valley – Case C – 3rd Bradley Lake Unit added

gen disp	trans config	outage from bus	outage to bus	outage id	overload (s) from bus	overload (s) to bus	overload (s) id	overload %
C - Cooper and Bradley Lake with 3rd Bradley unit at full export (126 MW)	1	Southern Tie 138 kV			University-Soldotna(max 140% ,Daves-Quartz)			
		Soldotna	Tesoro	1	Nikiski	Bernice	1	103
	2	Southern Tie 138 kV			University-Quartz(max 140%,Daves-Quartz)			
	3	Southern Tie 230 kV			University-Soldotna(max 139%,Daves-Quartz)			
		Soldotna	Tesoro	1	Nikiski	Bernice	1	122
		Tesoro	Bernice	1	Nikiski	Bernice	1	115
		Nikiski	Bernice	1	Soldotna-Bernice(max 115%,Soldotna-Tesoro)			
	4	Southern Tie			University-Quartz(max 140%,Daves -Quartz)			
		Soldotna	Tesoro	1	Nikiski	Bernice	1	117
		Tesoro	Bernice	1	Nikiski	Bernice	1	110
		Nikiski	Bernice	1	Soldotna-Bernice(max 110%,Soldotna-Tesoro)			
	5	Soldotna	Bradley	1	Thompson-Diamond(max 119%,Anchor-Diamond)			
	6	Soldotna	Bradley	1	Soldotna-Diamond(max 121%,Anchor-Diamond)			
	7	Soldotna	Sterling	1	Bradley	Quartz	1	135
		Soldotna	Bradley	1	Anchor Pt	Diamond	1	103
		Sterling	Quartz	1	Bradley	Quartz	1	133
		Bradley	Quartz	1	Soldotna-Quartz(max 118%,Soldotna-Sterling)			
		Daves	Quartz	1	Daves	Quartz	2	140
	8	Soldotna	Sterling	1	Soldotna	Quartz	1	123
		Sterling	Quartz	1	Soldotna	Quartz	1	121
		Soldotna	Quartz	1	Solodtna-Ster-Quartz (123%, Soldotna-Sterling			
		Daves	Quartz	1	Daves	Quartz	2	140
	9	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(148% Brad-Fritz)			
		Soldotna-Diamond-Fritz			Bradley-Soldotna max, 141%			
		Soldotna	Tesoro	1	Nikiski	Bernice	1	101
		Southern Tie 138 kV			University-Soldotna(max 136%,Daves-Quartz)			
	10	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(148% Brad-Fritz)			
		Soldotna-Diamond-Fritz			Bradley-Soldotna max, 141%			
		Southern Tie 138 kV			University-Quartz(max 137%,Daves-Quartz)			
	11	Southern Tie 230 kV			University-Soldotna(max 136%,Daves-Quartz)			
		Soldotna	Bradley	1	Soldotna-Diamond-Fritz(148% Brad-Fritz)			
		Soldotna-Diamond-Fritz			Bradley-Soldotna max, 141%			
		Soldotna	Tesoro	1	Nikiski	Bernice	1	120
		Nikiski	Bernice	1	Soldotna	Tesoro	1	114
		Nikiski	Bernice	1	Tesoro	Bernice	1	107
	12	Southern Tie 230 kV			University-Quartz(max 140%,Daves-Quartz)			
		Soldotna	Bradley	1	Soldotna-Diamond-Fritz(148% Brad-Fritz)			
		Soldotna-Diamond-Fritz			Bradley-Soldotna max, 141%			
		Soldotna	Tesoro	1	Nikiski	Bernice	1	116
		Tesoro	Bernice	1	Nikiski	Bernice	1	110
		Nikiski	Bernice	1	Soldotna	Tesoro	1	110
		Nikiski	Bernice	1	Tesoro	Bernice	1	103
	13	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(149% Brad-Fritz)			
		Soldotna-Diamond-Fritz			Bradley-Soldotna max, 141%			
		Soldotna	Sterling	1	Soldotna	Quartz	1	120
		Soldotna	Quartz	1	Solodtna-Ster-Quartz (120%, Soldotna-Sterling			
		Soldotna	Tesoro	1	Nikiski	Bernice	1	118
		Daves	Quartz	1	Daves	Quartz	2	137
	14	DC Tie			University-Soldotna(max 140% ,Daves-Quartz)			
	15	Soldotna	Bradley	1	Soldotna-Diamond-Fritz(141% Brad-Fritz)			
		DC Tie			University-Soldotna(max 136%,Daves-Quartz)			
	16	DC Tie			University-Quartz(max 140%,Daves-Quartz)			
	17	no branch overloads						
	18	no branch overloads						
	19	Nikiski	Bernice	1	Soldotna	Tesoro	1	102
	20	Southern Tie 138 kV			Soldotna - Daves (max 139%, Daves - Quartz)			
	21	DC Tie			Soldotna - Daves (max 139%, Daves - Quartz)			

line with 50 MVA rating
outage of line produces overload on remaining line
cases with minimal or no branch overloads

Appendix D – Transient Analysis Contingency List

Table D.1 Stability Contingency List

Dist Name	Name	From Bus	To Bus	Volt (kV)	Fault Location	Clearing Time (cycles) Near	Far
a1	Bradley-Soldotna	Soldotna	Bradley Lake	115	Soldotna	5	5
a2	Bradley-Soldotna			115	Brad_Lk	5	5
a3	Soldotna-Sterling	Soldotna	Sterling	115	Soldotna	5	5
a4	Soldotna-Sterling			115	Sterling	5	5
a5	Sterling-Quartz	Sterling	Quartz Creek	115	Sterling	5	5
a6	Sterling-Quartz			115	Quartz	5	5
a7	Quartz-Daves	Quartz Creek	Daves Creek	115	Quartz	5	5
a8	Quartz-Daves			115	Daves_Ck	5	5
a9	University-Plant_2	University	Plant 2	230	University	5	5
a10	University-Plant_2			230	Plant_2	5	5
a11	Soldotna_SVC	Soldotna SVC		115	Soldotna	5	5
a12	Daves_SVC	Dave's Creek SVC		115	Quartz	5	5
a13	230_Cable	Pt. MacKenzie	Plant 2	230	Plant_2	5	5
b1	230_Cable	Pt. MacKenzie	Plant 2	230	Pt_Mack	5	5
b2	Pt.Mack-Teeland	Pt. MacKenzie	Teeland	230	Pt_Mack	5	5
b3	Pt.Mack-Teeland			230	Teeland	5	5
w1	Pt.Mack-Douglas	Pt. MacKenzie	Douglas	230	Pt_Mack	5	5
w2	Pt.Mack-Douglas			230	Douglas	5	5
w3	Pt.Mack-Lorraine	Pt. MacKenzie	Lorraine	230	Pt_Mack	5	5
w4	Pt.Mack-Lorraine			230	Lorraine	5	5
w5	Watana-Gold Creek	Watana	Gold Creek	115	Watana	5	5
w6	Watana-Gold Creek			115	Gold_Ck	5	5
c1	Kenai_Tie	Dave's Creek	University	115	University	5	5
c2	Kenai_Tie			115	Daves_Ck	5	5
c3	Kenai_Tie	Dave's Creek	University	230	University	5	5
c4	Kenai_Tie			230	Daves_Ck	5	5
c5	South_Tie	Bernice	International	138	ITSS	5	5
c6	South_Tie			138	Bernice	5	5
c7	South_Tie	Bernice	International	230	ITSS	5	5
c8	South_Tie			230	Bernice	5	5
c9	Bradley-Quartz	Quartz Creek	Bradley Lake	115	Brad_Lk	5	5
c10	Bradley-Quartz			115	Quartz	5	5
c11	DC_tie	Beluga	Bernice	100	Bernice	5	5
c12	DC_tie			100	Beluga	5	5
g1	ITSS_Unit_Trip	ITSS Unit #3 Trip		n/a			
g2	Bradley_Unit_Trip	Bradley Lake Unit #2 Trip		n/a			
g3	Watana_Unit_Trip	Watana Unit Trip		n/a			

Appendix E – Transient Analysis – Winter Peak

Table E.1 Stability Results – Winter Peak – Cases A, B, and C

Gen Case	Trans Config	Kenai Export (MW)	Bradley-Soldotna_115@Soldotna a1	Bradley-Soldotna_115@Brad_Lk a2	Soldotna-Sterling_115@Soldotna a3	Soldotna-Sterling_115@Sterling a4	Sterling-Quartz_115@Sterling a5	Sterling-Quartz_115@Quartz a6	Quartz-Daves_115@Quartz a7	Quartz-Daves_115@Daves_Ck a8	University-Plant_2_230@University a9	University-Plant_2_230@Plant_2 a10	Soldotna_SVC_115@Soldotna a11	Daves_SVC_115@Quartz a12	230_Cable_230@Plant_2 a13	230_Cable_230@Pt_Mack b1	Pt.Mack-Teeland_230@Pt_Mack b2	Pt.Mack-Teeland_230@Teeland b3	Kenai_Tie_115@University c1	Kenai_Tie_115@Daves_Ck c2	Kenai_Tie_230@University c3	Kenai_Tie_230@Daves_Ck c4	South_Tie_138@ITSS c5	South_Tie_138@Bernice c6	South_Tie_230@ITSS c7	South_Tie_230@Bernice c8	Bradley-Quartz_115@Brad_Lk c9	Bradley-Quartz_115@Quartz c10	'DC_tie_100@Bernice' c11	'DC_tie_100@Beluga' c12	ITSS_Unit_Trip g1	Bradley_Unit_Trip g2	Watana_Unit_Trip g3
A	base	96	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x											x	x	
B	1	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
B	2	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
B	3	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
B	4	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
B	5	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	
B	6	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	
B	7	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	
B	8	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
B	9	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
B	10	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
B	11	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
B	12	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
B	13	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
B	14	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
B	15	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
B	16	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
B	17	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	
B	18	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	
B	19	108	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	
C	1	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C	2	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C	3	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C	4	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C	5	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	
C	6	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	
C	7	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	
C	8	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
C	9	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C	10	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C	11	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C	12	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C	13	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
C	14	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C	15	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C	16	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C	17	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	
C	18	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	
C	19	122	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	

out of step on Soldotna - Diamond local line

out of step on Quartz - Bradley Lake line

out of step on Dave's Creek - Hope

Table E.2 Stability Results – Winter Peak –Cases C1 and C2

Gen Case	Trans Config	Kenai Export (MW)	Bradley-Soldotna_115@Soldotna	Bradley-Soldotna_115@Brad_Lk	Soldotna-Sterling_115@Soldotna	Soldotna-Sterling_115@Sterling	Sterling-Quartz_115@Sterling	Sterling-Quartz_115@Quartz	Quartz-Daves_115@Quartz	Quartz-Daves_115@Daves_Ck	University-Plant_2_230@University	University-Plant_2_230@Plant_2	Soldotna_SVC_115@Soldotna	Daves_SVC_115@Quartz	230_Cable_230@Plant_2	230_Cable_230@Pt_Mack	Pt.Mack-Teeland_230@Pt_Mack	Pt.Mack-Teeland_230@Teeland	Kenai_Tie_115@University	Kenai_Tie_115@Daves_Ck	Kenai_Tie_230@University	Kenai_Tie_230@Daves_Ck	South_Tie_138@ITSS	South_Tie_138@Bernice	South_Tie_230@ITSS	South_Tie_230@Bernice	Bradley-Quartz_115@Brad_Lk	Bradley-Quartz_115@Quartz	'DC_tie_100@Bernice'	'DC_tie_100@Beluga'	ITSS_Unit_Trip	Bradley_Unit_Trip	Watana_Unit_Trip
			a1	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	b1	b2	b3	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	c12	g1	g2	g3
C1	1	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C1	2	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C1	3	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C1	4	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C1	5	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	
C1	6	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	
C1	7	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	
C1	8	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
C1	9	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C1	10	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C1	11	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C1	12	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C1	13	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
C1	14	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C1	15	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C1	16	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C1	17	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	
C1	18	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	
C1	19	123	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	
C2	1	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C2	2	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C2	3	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C2	4	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C2	5	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	
C2	6	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	
C2	7	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	
C2	8	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
C2	9	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C2	10	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C2	11	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C2	12	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C2	13	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
C2	14	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C2	15	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C2	16	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C2	17	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	
C2	18	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	
C2	19	77	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	

- (green) out of step on Soldotna - Diamond local line
- (yellow) out of step on Quartz - Bradley Lake line
- (olive) out of step on Dave's Creek - Hope
- (pink) out of step on Soldotna - Quartz Creek
- (peach) out of step on Quartz - Sterling

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Table E.3 Stability Results – Winter Peak – Cases D and E

Gen Case	Trans Config	Kenai Export (MW)	Bradley-Soldotna_115@Soldotna a1	Bradley-Soldotna_115@Brad_Lk a2	Soldotna-Sterling_115@Soldotna a3	Soldotna-Sterling_115@Sterling a4	Sterling-Quartz_115@Sterling a5	Sterling-Quartz_115@Quartz a6	Quartz-Daves_115@Quartz a7	Quartz-Daves_115@Daves_Ck a8	University-Plant_2_230@University a9	University-Plant_2_230@Plant_2 a10	Soldotna_SVC_115@Soldotna a11	Daves_SVC_115@Quartz a12	230_Cable_230@Plant_2 a13	Pt.Mack-Douglas_230@Pt_Mack w1	Pt.Mack-Douglas_230@Douglas w2	Pt.Mack-Lorraine_230@Pt_Mack w3	Pt.Mack-Lorraine_230@Lorraine w4	Watana-Gold Creek_115@Watana w5	Watana-Gold Creek_115@Gold_Ck w6	Kenai_Tie_115@University c1	Kenai_Tie_115@Daves_Ck c2	Kenai_Tie_230@University c3	Kenai_Tie_230@Daves_Ck c4	South_Tie_138@ITSS c5	South_Tie_138@Bernice c6	South_Tie_230@ITSS c7	South_Tie_230@Bernice c8	Bradley-Quartz_115@Brad_Lk c9	Bradley-Quartz_115@Quartz c10	'DC_tie_100@Bernice' c11	'DC_tie_100@Beluga' c12	ITSS_Unit_Trip g1	Bradley_Unit_Trip g2	Watana_Unit_Trip g3
D	1	30	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
D	2	30	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
D	3	30	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
D	4	30	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
D	5	30	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	x
D	6	30	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	x
D	7	30	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	x
D	8	30	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
D	9	30	x*	x*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
D	10	30	x*	x*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
D	11	30	x*	x*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
D	12	30	x*	x*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
D	13	30	x*	x*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
D	14	30	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
D	15	30	x*	x*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
D	16	30	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
D	17	30	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	x
D	18	30	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	x
D	19	30	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	x
E	1	37	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
E	2	37	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
E	3	37	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
E	4	37	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
E	5	37	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	x
E	6	37	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	x
E	7	37	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	x
E	8	37	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
E	9	37	x*	x*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
E	10	37	x*	x*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
E	11	37	x*	x*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
E	12	37	x*	x*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
E	13	37	x*	x*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
E	14	37	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
E	15	37	x*	x*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
E	16	37	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
E	17	37	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	x
E	18	37	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	x
E	19	37	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	x

x* (green shading): out of step on Soldotna - Diamond local line

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Table E.4 Stability Results – Winter Peak – Cases F, G, and H

Gen Case	Trans Config	Kenai Export (MW)	Bradley-Soldotna_115@Soldotna a1	Bradley-Soldotna_115@Brad_Lk a2	Soldotna-Sterling_115@Soldotna a3	Soldotna-Sterling_115@Sterling a4	Sterling-Quartz_115@Sterling a5	Sterling-Quartz_115@Quartz a6	Quartz-Daves_115@Quartz a7	Quartz-Daves_115@Daves_Ck a8	University-Plant_2_230@University a9	University-Plant_2_230@Plant_2 a10	Soldotna_SVC_115@Soldotna a11	Daves_SVC_115@Quartz a12	230_Cable_230@Plant_2 a13	Pt.Mack-Douglas_230@Pt_Mack w1	Pt.Mack-Douglas_230@Douglas w2	Pt.Mack-Lorraine_230@Pt_Mack w3	Pt.Mack-Lorraine_230@Lorraine w4	Watana-Gold Creek_115@Watana w5	Watana-Gold Creek_115@Gold_Ck w6	Kenai_Tie_115@University c1	Kenai_Tie_115@Daves_Ck c2	Kenai_Tie_230@University c3	Kenai_Tie_230@Daves_Ck c4	South_Tie_138@ITSS c5	South_Tie_138@Bernice c6	South_Tie_230@ITSS c7	South_Tie_230@Bernice c8	Bradley-Quartz_115@Brad_Lk c9	Bradley-Quartz_115@Quartz c10	'DC_tie_100@Bernice' c11	'DC_tie_100@Beluga' c12	ITSS_Unit_Trip g1	Bradley_Unit_Trip g2	Watana_Unit_Trip g3
F	1	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
F	2	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
F	3	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
F	4	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
F	5	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	x
F	6	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	x
F	7	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	x
F	8	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
F	9	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
F	10	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
F	11	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
F	12	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
F	13	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
F	14	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
F	15	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
F	16	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
F	17	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	x
F	18	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	x
F	19	49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	x
G	1	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
G	2	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
G	3	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
G	4	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
G	5	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	x
G	6	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	x
G	7	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	x
G	8	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
G	9	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
G	10	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
G	11	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
G	12	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
G	13	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
G	14	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
G	15	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
G	16	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
G	17	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	x
G	18	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	x
G	19	-13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	x
H	1	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
H	2	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
H	3	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
H	4	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
H	5	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	x
H	6	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	x
H	7	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	x
H	8	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
H	9	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
H	10	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
H	11	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
H	12	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
H	13	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
H	14	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
H	15	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
H	16	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
H	17	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	x
H	18	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	x
H	19	19	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	x

(green) out of step on Soldotna - Diamond local line

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Appendix F – Transient Analysis – Summer Peak

Table F.1 Stability Results – Summer Peak – Cases A, B, and C

Gen Case	Trans Config	Kenai Export (MW)	Bradley-Soldotna_115@Soldotna	Bradley-Soldotna_115@Brad_Lk	Soldotna-Sterling_115@Soldotna	Soldotna-Sterling_115@Sterling	Sterling-Quartz_115@Sterling	Sterling-Quartz_115@Quartz	Quartz-Daves_115@Quartz	Quartz-Daves_115@Daves_Ck	University-Plant_2_230@University	University-Plant_2_230@Plant_2	Soldotna_SVC_115@Soldotna	Daves_SVC_115@Quartz	230_Cable_230@Plant_2	230_Cable_230@Pt_Mack	Pt.Mack-Teeland_230@Pt_Mack	Pt.Mack-Teeland_230@Teeland	Kenai_Tie_115@University	Kenai_Tie_115@Daves_Ck	Kenai_Tie_230@University	Kenai_Tie_230@Daves_Ck	South_Tie_138@ITSS	South_Tie_138@Bernice	South_Tie_230@ITSS	South_Tie_230@Bernice	Bradley-Quartz_115@Brad_Lk	Bradley-Quartz_115@Quartz	'DC_tie_100@Bernice'	'DC_tie_100@Beluga'	ITSS_Unit_Trip	Bradley_Unit_Trip	Watana_Unit_Trip
			a1	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	b1	b2	b3	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	c12	g1	g2	g3
A	base	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x											x	x	
B	1	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
B	2	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
B	3	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
B	4	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
B	5	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	
B	6	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	
B	7	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	
B	8	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
B	9	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
B	10	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
B	11	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
B	12	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
B	13	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
B	14	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
B	15	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
B	16	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
B	17	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	
B	18	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	
B	19	109	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	
C	1	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C	2	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C	3	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C	4	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C	5	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	
C	6	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	
C	7	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	
C	8	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
C	9	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C	10	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C	11	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C	12	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C	13	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
C	14	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C	15	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C	16	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C	17	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	
C	18	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	
C	19	125	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	

(green) out of step on Soldotna - Diamond local line

(orange) out of step on Quartz - Bradley Lake line

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Table F.2 Stability Results – Summer Peak – Cases C1 and C2

Gen Case	Trans Config	Kenai Export (MW)	Bradley-Soldotna_115@Soldotna	Bradley-Soldotna_115@Brad_Lk	Soldotna-Sterling_115@Soldotna	Soldotna-Sterling_115@Sterling	Sterling-Quartz_115@Sterling	Sterling-Quartz_115@Quartz	Quartz-Daves_115@Quartz	Quartz-Daves_115@Daves_Ck	University-Plant_2_230@University	University-Plant_2_230@Plant_2	Soldotna_SVC_115@Soldotna	Daves_SVC_115@Quartz	230_Cable_230@Plant_2	230_Cable_230@Pt_Mack	Pt.Mack-Teeland_230@Pt_Mack	Pt.Mack-Teeland_230@Teeland	Kenai_Tie_115@University	Kenai_Tie_115@Daves_Ck	Kenai_Tie_230@University	Kenai_Tie_230@Daves_Ck	South_Tie_138@ITSS	South_Tie_138@Bernice	South_Tie_230@ITSS	South_Tie_230@Bernice	Bradley-Quartz_115@Brad_Lk	Bradley-Quartz_115@Quartz	'DC_tie_100@Bernice'	'DC_tie_100@Beluga'	ITSS_Unit_Trip	Bradley_Unit_Trip	Watana_Unit_Trip
			a1	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	b1	b2	b3	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	c12	g1	g2	g3
C1	1	124	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C1	2	124	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C1	3	124	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C1	4	124	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C1	5	124	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	
C1	6	124	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	
C1	7	124	x	x	x [yellow]	x [yellow]	x [yellow]	x [yellow]	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	
C1	8	124	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
C1	9	124	x [green]	x [green]	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x [olive]							x	x	
C1	10	124	x [green]	x [green]	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C1	11	124	x [green]	x [green]	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C1	12	124	x [green]	x [green]	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C1	13	124	x [green]	x [green]	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
C1	14	124	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C1	15	124	x [green]	x [green]	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C1	16	124	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C1	17	124	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	
C1	18	124	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	
C1	19	124	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	
C2	1	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C2	2	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C2	3	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C2	4	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C2	5	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	
C2	6	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	
C2	7	99	x	x	x [yellow]	x [yellow]	x [yellow]	x [yellow]	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	
C2	8	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
C2	9	99	x [green]	x [green]	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C2	10	99	x [green]	x [green]	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C2	11	99	x [green]	x [green]	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C2	12	99	x [green]	x [green]	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C2	13	99	x [green]	x [green]	x [yellow]	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
C2	14	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C2	15	99	x [green]	x [green]	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C2	16	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C2	17	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	
C2	18	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	
C2	19	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	
			[green]	out of step on Soldotna - Diamond local line																														
			[yellow]	out of step on Quartz - Bradley Lake line																														
			[olive]	out of step on Dave's Creek - Hope																														

Table F.3 Stability Results – Summer Peak – Cases D and E

Gen Case	Trans Config	Kenai Export (MW)	Bradley-Soldotna_115@Soldotna	Bradley-Soldotna_115@Brad_Lk	Soldotna-Sterling_115@Soldotna	Soldotna-Sterling_115@Sterling	Sterling-Quartz_115@Sterling	Sterling-Quartz_115@Quartz	Quartz-Daves_115@Quartz	Quartz-Daves_115@Daves_Ck	University-Plant_2_230@University	University-Plant_2_230@Plant_2	Soldotna_SVC_115@Soldotna	Daves_SVC_115@Quartz	230_Cable_230@Plant_2	Pt.Mack-Douglas_230@Pt_Mack	Pt.Mack-Douglas_230@Douglas	Pt.Mack-Lorraine_230@Pt_Mack	Pt.Mack-Lorraine_230@Lorraine	Watana-Gold Creek_115@Watana	Watana-Gold Creek_115@Gold_Ck	Kenai_Tie_115@University	Kenai_Tie_115@Daves_Ck	Kenai_Tie_230@University	Kenai_Tie_230@Daves_Ck	South_Tie_138@ITSS	South_Tie_138@Bernice	South_Tie_230@ITSS	South_Tie_230@Bernice	Bradley-Quartz_115@Brad_Lk	Bradley-Quartz_115@Quartz	'DC_tie_100@Bernice'	'DC_tie_100@Beluga'	ITSS_Unit_Trip	Bradley_Unit_Trip	Watana_Unit_Trip
			a1	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	w1	w2	w3	w4	w5	w6	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	c12	g1	g2	g3
D	1	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
D	2	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
D	3	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
D	4	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
D	5	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	x
D	6	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	x
D	7	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	x
D	8	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
D	9	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
D	10	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
D	11	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
D	12	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
D	13	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
D	14	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
D	15	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
D	16	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
D	17	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	x
D	18	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	x
D	19	61	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	x
E	1	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
E	2	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
E	3	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
E	4	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
E	5	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	x
E	6	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	x
E	7	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	x
E	8	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
E	9	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
E	10	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
E	11	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
E	12	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
E	13	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
E	14	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
E	15	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
E	16	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
E	17	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	x
E	18	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	x
E	19	67	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	x

(green) out of step on Soldotna - Diamond local line

(purple) Tesoro out of step, Tesoro - Soldotna line

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Table F.4 Stability Results – Summer Peak – Cases F, G, and H

Gen Case	Trans Config	Kenai Export (MW)	Bradley-Soldotna_115@Soldotna a1	Bradley-Soldotna_115@Brad_Lk a2	Soldotna-Sterling_115@Soldotna a3	Soldotna-Sterling_115@Sterling a4	Sterling-Quartz_115@Sterling a5	Sterling-Quartz_115@Quartz a6	Quartz-Daves_115@Quartz a7	Quartz-Daves_115@Daves_Ck a8	University-Plant_2_230@University a9	University-Plant_2_230@Plant_2 a10	Soldotna_SVC_115@Soldotna a11	Daves_SVC_115@Quartz a12	230_Cable_230@Plant_2 a13	Pt.Mack-Douglas_230@Pt_Mack w1	Pt.Mack-Douglas_230@Douglas w2	Pt.Mack-Lorraine_230@Pt_Mack w3	Pt.Mack-Lorraine_230@Lorraine w4	Watana-Gold Creek_115@Watana w5	Watana-Gold Creek_115@Gold_Ck w6	Kenai_Tie_115@University c1	Kenai_Tie_115@Daves_Ck c2	Kenai_Tie_230@University c3	Kenai_Tie_230@Daves_Ck c4	South_Tie_138@ITSS c5	South_Tie_138@Bernice c6	South_Tie_230@ITSS c7	South_Tie_230@Bernice c8	Bradley-Quartz_115@Brad_Lk c9	Bradley-Quartz_115@Quartz c10	'DC_tie_100@Bernice' c11	'DC_tie_100@Beluga' c12	ITSS_Unit_Trip g1	Bradley_Unit_Trip g2	Watana_Unit_Trip g3
F	1	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
F	2	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
F	3	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
F	4	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
F	5	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	x
F	6	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	x
F	7	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	x
F	8	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
F	9	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
F	10	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
F	11	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
F	12	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
F	13	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
F	14	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
F	15	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
F	16	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
F	17	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	x
F	18	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	x
F	19	89	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	x
G	1	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
G	2	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
G	3	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
G	4	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
G	5	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	x
G	6	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	x
G	7	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	x
G	8	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
G	9	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
G	10	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
G	11	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
G	12	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
G	13	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
G	14	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
G	15	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
G	16	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
G	17	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	x
G	18	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	x
G	19	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	x
H	1	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
H	2	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
H	3	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
H	4	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
H	5	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	x
H	6	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	x
H	7	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	x
H	8	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
H	9	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
H	10	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
H	11	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
H	12	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
H	13	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
H	14	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
H	15	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
H	16	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
H	17	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	x
H	18	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	x
H	19	11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	x

out of step on Soldotna - Diamond local line

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Appendix G – Transient Analysis – Summer Valley

Table G.1 Stability Results – Summer Valley – Cases A, B, and C

Gen Case	Trans Config	Kenai Export (MW)	Bradley-Soldotna_115@Soldotna	Bradley-Soldotna_115@Brad_Lk	Soldotna-Sterling_115@Soldotna	Soldotna-Sterling_115@Sterling	Sterling-Quartz_115@Sterling	Sterling-Quartz_115@Quartz	Quartz-Daves_115@Quartz	Quartz-Daves_115@Daves_Ck	University-Plant_2_230@University	University-Plant_2_230@Plant_2	Soldotna_SVC_115@Soldotna	Daves_SVC_115@Quartz	230_Cable_230@Plant_2	230_Cable_230@Pt_Mack	Pt.Mack-Teeland_230@Pt_Mack	Pt.Mack-Teeland_230@Teeland	Kenai_Tie_115@University	Kenai_Tie_115@Daves_Ck	Kenai_Tie_230@University	Kenai_Tie_230@Daves_Ck	South_Tie_138@ITSS	South_Tie_138@Bernice	South_Tie_230@ITSS	South_Tie_230@Bernice	Bradley-Quartz_115@Brad_Lk	Bradley-Quartz_115@Quartz	'DC_tie_100@Bernice'	'DC_tie_100@Beluga'	ITSS_Unit_Trip	Bradley_Unit_Trip	Watana_Unit_Trip
			a1	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	b1	b2	b3	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	c12	g1	g2	g3
A	base	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x											x	x	
B	1	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
B	2	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
B	3	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
B	4	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
B	5	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	
B	6	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	
B	7	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	
B	8	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
B	9	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
B	10	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
B	11	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
B	12	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
B	13	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
B	14	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
B	15	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
B	16	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
B	17	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	
B	18	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	
B	19	111	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	
Ca	1	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
Ca	2	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
Ca	3	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
Ca	4	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
Ca	5	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	
Ca	6	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	
Ca	7	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	
Ca	8	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
Ca	9	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
Ca	10	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
Ca	11	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
Ca	12	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
Ca	13	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
Ca	14	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
Ca	15	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
Ca	16	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
Ca	17	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	
Ca	18	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	
Ca	19	126	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	

out of step on Soldotna - Diamond local line

out of step on Quartz - Bradley Lake line

out of step on Dave's Creek - Hope

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Table G.2 Stability Results – Summer Valley – Cases C1, C2

Gen Case	Trans Config	Kenai Export (MW)	Bradley-Soldotna_115@Soldotna	Bradley-Soldotna_115@Brad_Lk	Soldotna-Sterling_115@Soldotna	Soldotna-Sterling_115@Sterling	Sterling-Quartz_115@Sterling	Sterling-Quartz_115@Quartz	Quartz-Daves_115@Quartz	Quartz-Daves_115@Daves_Ck	University-Plant_2_230@University	University-Plant_2_230@Plant_2	Soldotna_SVC_115@Soldotna	Daves_SVC_115@Quartz	230_Cable_230@Plant_2	230_Cable_230@Pt_Mack	Pt.Mack-Teeland_230@Pt_Mack	Pt.Mack-Teeland_230@Teeland	Kenai_Tie_115@University	Kenai_Tie_115@Daves_Ck	Kenai_Tie_230@University	Kenai_Tie_230@Daves_Ck	South_Tie_138@ITSS	South_Tie_138@Bernice	South_Tie_230@ITSS	South_Tie_230@Bernice	Bradley-Quartz_115@Brad_Lk	Bradley-Quartz_115@Quartz	'DC_tie_100@Bernice'	'DC_tie_100@Beluga'	ITSS_Unit_Trip	Bradley_Unit_Trip	Watana_Unit_Trip
			a1	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	b1	b2	b3	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	c12	g1	g2	g3
C1a	1	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C1a	2	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C1a	3	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C1a	4	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C1a	5	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	
C1a	6	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	
C1a	7	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	
C1a	8	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
C1a	9	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C1a	10	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C1a	11	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C1a	12	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C1a	13	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x									x	x	
C1a	14	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C1a	15	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C1a	16	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C1a	17	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	
C1a	18	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	
C1a	19	127	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	
C2a	1	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C2a	2	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C2a	3	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C2a	4	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C2a	5	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	
C2a	6	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	
C2a	7	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	
C2a	8	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
C2a	9	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C2a	10	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	
C2a	11	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C2a	12	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	
C2a	13	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	
C2a	14	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C2a	15	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C2a	16	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	
C2a	17	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	
C2a	18	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	
C2a	19	118	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	

Legend:
- (green) out of step on Soldotna - Diamond local line
- (orange) out of step on Quartz - Bradley Lake line
- (olive) out of step on Dave's Creek - Hope
- (pink) out of step on Soldotna - Quartz Creek

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Table G.3 Stability Results – Summer Valley – Cases D and E

Gen Case	Trans Config	Kenai Export (MW)	Bradley-Soldotna_115@Soldotna a1	Bradley-Soldotna_115@Brad_Lk a2	Soldotna-Sterling_115@Soldotna a3	Soldotna-Sterling_115@Sterling a4	Sterling-Quartz_115@Sterling a5	Sterling-Quartz_115@Quartz a6	Quartz-Daves_115@Quartz a7	Quartz-Daves_115@Daves_Ck a8	University-Plant_2_230@University a9	University-Plant_2_230@Plant_2 a10	Soldotna_SVC_115@Soldotna a11	Daves_SVC_115@Quartz a12	230_Cable_230@Plant_2 a13	Pt.Mack-Douglas_230@Pt_Mack w1	Pt.Mack-Douglas_230@Douglas w2	Pt.Mack-Lorraine_230@Pt_Mack w3	Pt.Mack-Lorraine_230@Lorraine w4	Watana-Gold Creek_115@Watana w5	Watana-Gold Creek_115@Gold_Ck w6	Kenai_Tie_115@University c1	Kenai_Tie_115@Daves_Ck c2	Kenai_Tie_230@University c3	Kenai_Tie_230@Daves_Ck c4	South_Tie_138@ITSS c5	South_Tie_138@Bernice c6	South_Tie_230@ITSS c7	South_Tie_230@Bernice c8	Bradley-Quartz_115@Brad_Lk c9	Bradley-Quartz_115@Quartz c10	'DC_tie_100@Bernice' c11	'DC_tie_100@Beluga' c12	ITSS_Unit_Trip g1	Bradley_Unit_Trip g2	Watana_Unit_Trip g3
D	1	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
D	2	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
D	3	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
D	4	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
D	5	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	x
D	6	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	x
D	7	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	x
D	8	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
D	9	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
D	10	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
D	11	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
D	12	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
D	13	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
D	14	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
D	15	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
D	16	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
D	17	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	x
D	18	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	x
D	19	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	x
E	1	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
E	2	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
E	3	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
E	4	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
E	5	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	x
E	6	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	x
E	7	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	x
E	8	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
E	9	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
E	10	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
E	11	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
E	12	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
E	13	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
E	14	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
E	15	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
E	16	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
E	17	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	x
E	18	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	x
E	19	81	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	x

out of step on Soldotna - Diamond local line

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Table G.4 Stability Results – Summer Valley – Cases F, G, and H

Gen Case	Trans Config	Kenai Export (MW)	Bradley-Soldotna_115@Soldotna	Bradley-Soldotna_115@Brad_Lk	Soldotna-Sterling_115@Soldotna	Soldotna-Sterling_115@Sterling	Sterling-Quartz_115@Sterling	Sterling-Quartz_115@Quartz	Quartz-Daves_115@Quartz	Quartz-Daves_115@Daves_Ck	University-Plant_2_230@University	University-Plant_2_230@Plant_2	Soldotna_SVC_115@Soldotna	Daves_SVC_115@Quartz	230_Cable_230@Plant_2	Pt.Mack-Douglas_230@Pt_Mack	Pt.Mack-Douglas_230@Douglas	Pt.Mack-Lorraine_230@Pt_Mack	Pt.Mack-Lorraine_230@Lorraine	Watana-Gold Creek_115@Watana	Watana-Gold Creek_115@Gold_Ck	Kenai_Tie_115@University	Kenai_Tie_115@Daves_Ck	Kenai_Tie_230@University	Kenai_Tie_230@Daves_Ck	South_Tie_138@ITSS	South_Tie_138@Bernice	South_Tie_230@ITSS	South_Tie_230@Bernice	Bradley-Quartz_115@Brad_Lk	Bradley-Quartz_115@Quartz	'DC_tie_100@Bernice'	'DC_tie_100@Beluga'	ITSS_Unit_Trip	Bradley_Unit_Trip	Watana_Unit_Trip
			a1	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	w1	w2	w3	w4	w5	w6	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	c12	g1	g2	g3
F	1	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
F	2	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
F	3	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
F	4	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
F	5	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	x
F	6	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	x
F	7	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	x
F	8	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
F	9	99	**x**	**x**	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
F	10	99	**x**	**x**	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
F	11	99	**x**	**x**	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
F	12	99	**x**	**x**	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
F	13	99	**x**	**x**	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
F	14	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
F	15	99	**x**	**x**	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
F	16	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
F	17	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	x
F	18	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	x
F	19	99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	x
G	1	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
G	2	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
G	3	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
G	4	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
G	5	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	x
G	6	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	x
G	7	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	x
G	8	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
G	9	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
G	10	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
G	11	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
G	12	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
G	13	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
G	14	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
G	15	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
G	16	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
G	17	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	x
G	18	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	x
G	19	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	x
H	1	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
H	2	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
H	3	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
H	4	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
H	5	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x			x	x			x	x	x
H	6	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x	x	x			x	x	x
H	7	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x					x	x			x	x	x
H	8	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
H	9	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
H	10	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x
H	11	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
H	12	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x					x	x	x
H	13	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x									x	x	x
H	14	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
H	15	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
H	16	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x									x	x	x	x	x
H	17	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x							x	x	x	x	x
H	18	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x							x	x	x
H	19	26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x					x	x	x

x (green) out of step on Soldotna - Diamond local line

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Appendix H – DC Size Analysis Detailed Results

Table H.1 – Kenai Trip Analysis – Summer Valley

Season	Trans Config	Gen Case	Spin (MW)	Line Flow Kenai Export	Line Flow Daves - Quartz	DC Flow (MW) Initia	DC Flow (MW) Post	UFLS Action MW	UFLS Action %
Summer Valley	16	CA	73	127	60.4	75	75	39	9%
							80	39	9%
							90	29	6%
							100	0	0%
		C1A	74	123	56.5	75	75	39	9%
							80	29	6%
							90	0	0%
							100	0	0%
	21	CA	73	127	59.8	75	75	39	9%
							80	39	9%
							90	39	9%
							100	0	0%
		C1A	74	123	56	75	75	39	9%
							80	39	9%
							90	0	0%
							100	0	0%

(highlighted) load shedding in Anchorage and GVEA

Table H.2 – Kenai Trip Analysis – Summer Peak

Season	Trans Config	Gen Case	Spin (MW)	Line Flow Kenai Export	Line Flow Daves - Quartz	DC Flow (MW) Initial	DC Flow (MW) Post	UFLS Action MW	UFLS Action %
Summer Peak	16	CA	82	125	61.1	75	75	44	6%
							80	44	6%
							90	44	6%
							100	0	0%
		C1A	72	125	61.1	75	75	44	6%
							80	44	6%
							90	0	0%
							100	0	0%
	16	CA	82	125	60.5	75	75	68	9%
							80	44	6%
							90	44	6%
							100	0	0%
		C1A	72	125	60.4	75	75	44	6%
							80	44	6%
							90	0	0%
							100	0	0%

(highlighted) load shedding in Anchorage and GVEA

Table H.2 – Kenai Trip Analysis – Winter Peak

Season	Trans Config	Gen Case	Spin (MW)	Line Flow		DC Flow (MW)		UFLS Action	
				Kenai Export	Daves - Quartz	Initial	Post	MW	%
Winter Peak	16	CA	73	123	61.5	75	75	62	6%
							80	62	6%
							90	62	6%
							100	0	0%
		C1A	66	125	63.4	75	75	62	6%
							80	29	3%
							90	0	0%
							100	0	0%
	21	CA	73	123	60.8	75	75	62	6%
							80	62	6%
							90	62	6%
							100	0	0%
		C1A	66	125	62.7	75	75	62	6%
							80	62	6%
							90	0	0%
							100	0	0%

(shaded) load shedding in Anchorage and GVEA

Appendix I – DC / Southern Intertie Trip Detailed Results

Table I.1 – DC / Southern Intertie Trip Results

Season		Summer Valley							Summer Peak							Winter Peak						
Gen Case	Trans Config	Kenai Export (MW)	South_Tie_138@ITSS c5	South_Tie_138@Bernice c6	South_Tie_230@ITSS c7	South_Tie_230@Bernice c8	'DC_tie_100@Bernice' c11	'DC_tie_100@Beluga' c12	Kenai Export (MW)	South_Tie_138@ITSS c5	South_Tie_138@Bernice c6	South_Tie_230@ITSS c7	South_Tie_230@Bernice c8	'DC_tie_100@Bernice' c11	'DC_tie_100@Beluga' c12	Kenai Export (MW)	South_Tie_138@ITSS c5	South_Tie_138@Bernice c6	South_Tie_230@ITSS c7	South_Tie_230@Bernice c8	'DC_tie_100@Bernice' c11	'DC_tie_100@Beluga' c12
C	1	126	x	x					125	x	x					122	x	x				
C	2	126	x	x					125	x	x					122	x	x				
C	3	126			x	x			125			x	x			122			x	x		
C	4	126			x	x			125			x	x			122			x	x		
C	14	126					x	x	125					x	x	122					x	x
C	16	126					x	x	125					x	x	122					x	x
C	20	126	x	x					125	x	x					122	x	x				
C	21	126					x	x	125					x	x	122					x	x
C1	1	127	x	x					124	x	x					123	x	x				
C1	2	127	x	x					124	x	x					123	x	x				
C1	3	127			x	x			124			x	x			123			x	x		
C1	4	127			x	x			124			x	x			123			x	x		
C1	14	127					x	x	124					x	x	123					x	x
C1	16	127					x	x	124					x	x	123					x	x
C1	20	127	x	x					124	x	x					123	x	x				
C1	21	127					x	x	124					x	x	123					x	x
C2	1	118	x	x					99	x	x					77	x	x				
C2	2	118	x	x					99	x	x					77	x	x				
C2	3	118			x	x			99			x	x			77			x	x		
C2	4	118			x	x			99			x	x			77			x	x		
C2	14	118					x	x	99					x	x	77					x	x
C2	16	118					x	x	99					x	x	77					x	x
C2	20	118	x	x					99	x	x					77	x	x				
C2	21	118					x	x	99					x	x	77					x	x

Appendix J – Costs of Individual Line Improvements

Cost estimates for each of the proposed transmission upgrades are presented below:

J.1 Upgrade Existing Kenai Tie to 230 kV

The project includes the rebuild of 76.8 miles of 115 kV transmission line to 230 kV. The project includes removal of the existing 115 kV intertie and reconstruction of the intertie to 230 kV. The detailed line sections and their estimates are outlined in Table J.1 below.

Table J.1 Conductor Costs – Upgrade Kenai Tie to 230 kV

Line Section	Existing Structure Type*	Existing Framing	Existing Line Miles	Proposed Structure Type*	Proposed Framing	Proposed Location	Construction Estimate
Daves Creek - Hope	STH-1A	115kV	18.9	230-H	230kV	Existing Alignment	$14,000,000
Hope - Portage	STH-1A	115kV	19.7	230-H	230kV	Existing Alignment	$15,000,000
Portage - Girdwood	STH-1A	138kV	11.0	230-H	230kV	Existing Alignment	$8,000,000
Girdwood - Indian	STH-1A	115kV	10.7	230-H	230kV	Existing Alignment	$7,500,000
Indian - University	STH-1A	115kV	16.5	230-H	230kV	Existing Alignment	$13,000,000
Total			76.8				$57,500,000

The project includes the installation of 30 MVAr of reactive compensation at Dave's Creek for voltage control. The project will require the construction of a new 230 kV bay at Dave's Creek Station and the addition of a 230 kV termination at University station. Existing 115 kV stations at Summit Lake, Hope, Portage, Girdwood and Indian stations would require conversion to 230 kV. The detailed substations and their estimates are outlined in Table J.2 below.

Table J.2 Substation Costs – Upgrade Kenai Tie to 230 kV

Station	Description	Costs
Daves Creek	230 kV Transformer,breaker	$5,383,168
Daves Creek	30 MVAr Reactor/SVC integration	$1,450,000
Summit	230 kV Circuit Switcher/transformer	$1,803,319
Hope	230 kV Circuit Switcher/transformer	$180,332
Portage	230 kV Circuit Switcher/transformer	$3,791,449
Girdwood	230 kV GIS, two 230 kV transformers	$12,028,689
Indian	230 kV Circuit Switcher/transformer	$3,026,814
University	230 kV relaying/controls	$361,475
Total		$28,025,245

The total costs for upgrading the existing Kenai Tie to 230 kV are shown in Table J.3.

Table J.3 Total Costs – Upgrade Kenai Tie to 230 kV

Item	Costs
Total Conductor Upgrade Costs	$57,500,000
Total Substation Upgrade Costs	$28,025,245
Total Costs	$85,525,245

J.2 Modified 115 kV Kenai Transmission Substations

This cost estimate provides the costs for the modifications to each of the substations required between Bradley Lake and Dave's Creek stations. The station costs can be used in combination with the appropriate line costs to arrive at the total project costs.

Table J.4 Cost Analysis – Kenai Transmission Substations

Station	Description	Costs
Bradley Lake	Add new Bay/115 kV cable to Bradley GIS	$2,865,141
Soldotna	115 kV station - Ring Bus	$4,800,000
Quartz Creek	Add 115 kV station	$2,580,000
Daves Creek	Add 115 kV Bay	$1,480,000
Total		$11,725,141

J.3 New 115 kV Line – Bradley Lake to Soldotna

This project includes the construction of a new transmission line along the existing Bradley – Bradley Junction – Soldotna transmission line. The line would utilize 556 MCM Dove conductor and wooden H-structures for the line construction.

Table J.5 Cost Analysis – New 115 kV line, Bradley Lake - Soldotna

Line Section	Existing Structure Type*	Existing Framing	Existing Line Miles	Proposed Structure Type*	Proposed Framing	Proposed Location	Construction Estimate
Bradley - Bradley Jct	X-Twr	115kV	19.2	X-Twr	115kV	Parallel to Existing	$18,000,000
Bradley Jct - Soldotna	STH-1A	115kV	48.6	STH-1A	115kV	Parallel to Existing	$37,000,000
Total							$55,000,000

J.4 New 115 kV Line – Soldotna to Quartz Creek

This project includes the construction of a new 115 kV transmission line adjacent to the existing 115 kV Quartz Creek – Soldotna 115 kV Transmission line. Station costs would be the same as previously listed.

Table J.6 Cost Analysis – New 115 kV line, Soldotna – Quartz Creek

	Existing Structure Type*	Existing Framing	Existing Line Miles	Proposed Structure Type*	Proposed Framing	Proposed Location	Construction Estimate
Soldotna - Quartz Ck	STH-1A	115kV	54.8	STH-1A	115kV	Parallel to Existing	$44,000,000

J.5 New 115 kV Line – Bradley Lake to Quartz Creek

This project includes the construction of a new 115 kV line from Bradley Lake to Quartz Creek station. The line would by-pass Bradley Junction and Soldotna stations, but would be routed adjacent to these facilities. The substation facilities are the same as previously listed.

Table J.7 Cost Analysis – New 115 kV line, Bradley – Quartz Creek

	Existing Structure Type*	Existing Framing	Existing Line Miles	Proposed Structure Type*	Proposed Framing	Proposed Location	Construction Estimate
Bradley - Bradley Jct	X-Twr	115kV	19.2	X-Twr	115kV	Parallel to Existing	$18,000,000
Bradley Jct - Soldotna	STH-1A	115kV	48.6	STH-1A	115kV	Parallel to Existing	$37,000,000
Soldotna - Quartz Ck	STH-1A	115kV	54.8	STH-1A	115kV	Parallel to Existing	$44,000,000
Total							$99,000,000

J.6 New 115 kV Line – Quartz Creek to Dave's Creek

This project includes the construction of a new 115 kV line from Quartz Creek to Dave's Creek. The structures would be a single pole, double circuit configuration with the exception of the Kenai Lake Crossing.

Table J.8 Cost Analysis – New 115 kV line, Quartz Creek – Dave's Creek

	Existing Structure Type*	Existing Framing	Existing Line Miles	Proposed Structure Type*	Proposed Framing	Proposed Location	Construction Estimate
Quartz Ck - Daves Ck	STH-1A	115kV	14.5	STH-1D	115kV DBL	Existing Alignment	$12,180,000

The substation improvements for this project include a new 115 kV breaker bay at Quartz Creek and a new 115 kV breaker position at Dave's Creek.

J.7 Reconductor Existing 115 kV Diamond Ridge – Soldotna Line

This project includes the reconstruction of the existing 4/0 sections of the Diamond Ridge – Soldotna transmission line to 556 MCM "Dove" conductor. The reconductor is required due to heavy losses and severe thermal limits on the 4/0 conductor.

Table J.9 Cost Analysis – Reconductor 115 kV line, Diamond Ridge - Soldotna

	Existing Structure Type*	Existing Framing	Existing Line Miles	Proposed Structure Type*	Proposed Framing	Proposed Location	Construction Estimate
Diamond Ridge - Soldotna	HPT-1	115kV	75	HPT-1	115kV		$75,500,000

J.8 New Kenai Intertie – 230 kV AC

This project includes the reconstruction of the new Kenai intertie from Pt. Woronzof to Bernice Lake Substation. The line consists 18.2 miles of submarine cable, 4.9 miles of land cable and 38.0 miles of overhead.

Table J.10 Conductor Costs – New 230 kV AC Kenai Intertie

Line Section	Line Miles	Construction Estimate Range	
Sub Cable - Worz. to Pt. Possession	18.6	$143,000,000	$205,000,000
Pt. Possession - Captain Cook Park	26.2	$19,000,000	$19,000,000
Land Cable - Captain Cook Park	4.0	$33,000,000	$43,000,000
Captain Cook to Bernice	11.8	$11,000,000	$11,000,000
	60.6	$206,000,000	$278,000,000

Table J.11 Compensation Costs – New 230 kV AC Kenai Intertie

Compensation - 230 kV Cable option	MVAr	Installed Costs - Range	
Fixed Compensation	135	$ 6,350,000	$ 8,255,000
SVC compensation	135	$ 48,750,000	$ 63,375,000
Total	270	$ 55,100,000	$ 71,630,000

Table J.12 Total Costs – New 230 kV AC Kenai Intertie

Item	Costs Range	
Total Conductor Upgrade Costs	$206,000,000	$278,000,000
Total Compensation Costs	$55,100,000	$71,630,000
Total Costs	$261,100,000	$349,630,000

The total installed costs for this option is the combined costs of the transmission lines plus the required compensation. The specialized switching for this project may require an energization resistor in the cable circuit such that the cable could only be energized from one end. Although we have no doubt the project could be technically completed, the project has risk in the switching and performance studies that will be required to define the energization and de-energization sequence. There is a risk that due to the heavy compensation required and the direct connection to hydro, steam and Frame type combustion turbines that sub-synchronous resonance will require mitigating measures.

J.9 New Kenai Intertie – 138 kV AC

This project is essentially identical to the 230 kV option above, but assumes the line is constructed and operated at 138 kV.

Table J.13 Conductor Costs – New 138 kV AC Kenai Intertie

Line Section	Line Miles	Construction Estimate Range	
Sub Cable - Worz. to Pt. Possesion	18.6	$107,250,000	$153,700,000
Pt. Possession - Captain Cook Park	26.2	$14,250,000	$14,250,000
Land Cable - Captain Cook Park	4.0	$24,750,000	$32,250,000
Captain Cook to Bernice	11.8	$8,250,000	$8,250,000
	60.6	$154,500,000	$208,450,000

Table J.14 Compensation Costs – New 138 kV AC Kenai Intertie

Compensation - 230 kV Cable option	MVAr	Installed Costs - Range	
Fixed Compensation	30	$ 5,300,000	$ 6,890,000
SVC compensation	90	$ 37,500,000	$ 48,750,000
Total	120	$ 42,800,000	$ 55,640,000

Table J.15 Total Costs – New 138 kV AC Kenai Intertie

Item	Costs Range	
Total Conductor Upgrade Costs	$154,500,000	$208,450,000
Total Compensation Costs	$42,800,000	$55,640,000
Total Costs	$197,300,000	$264,090,000

The total installed costs for this option is the combined costs of the transmission lines plus the required compensation. Similar to the 230 kV option, specialized switching for this project may require an energization resistor in the cable circuit such that the cable could only be energized from one end. Although we have no doubt the project could be technically completed and the project has less risk than the 230 kV project, the project has risk in the switching and performance studies that will be required to define the energization and de-energization sequence. There is a risk that due to the heavy compensation required and the direct connection to hydro, steam and Frame type combustion turbines that subsynchronous resonance will require mitigating measures. The implementation will not be straight-forward and could result in unforeseen operating issues.

J.10 New Kenai Intertie – 100 kV HVDC Bernice - Beluga

This project has not been evaluated in terms of detailed routing and environmental studies as has the other two options, however the HVDC interconnection will be much more straightforward and present less risk than either of the two AC options. The project appears more economically and technically feasible than the 138 kV or 230 kV alternatives. The project also allows a more diverse interconnected system to future generation resources in the Beluga area. The cost estimate below is for an 80 MW, mono-pole system with redundant submarine cables. If redundant cables are not required, the cost of the cables could be reduced by 35-40%.

Table J.16 Cost Analysis – New 100 kV HVDC Kenai Intertie

+/- 100 kV HVDC Beluga - Bernice	Qty	Installed Costs - Range	
Submarine Cable (33 mi)	33	$ 74,050,000	$ 113,256,000
SVC compensation (100 MW)	2	$ 60,500,000	$ 82,500,000
Total	35	$ 134,550,000	$ 195,756,000

J Regulation Resource Study