Point to Point US to BC, BC to Alberta

and wheel through US to Alberta

System Impact Study

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Transmission System Planning
British Columbia Transmission Corporation

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Executive Summary

This report provides a preliminary review of requirements in responding to an aggregated firm import request for 1350 MW of power from the US Northwest (NW) into British Columbia, Canada. This report also provides a preliminary review of the requirements for delivering up to 1200MW from BCTC system to BC-Alberta border. This System Impact Study did not analyze firm transfer capability levels that require building a new tie-line. The study assumes all transmission elements are in service and uses first contingency criteria to identify the constraints in the BCTC transmission system to permit such transfers.

Cost estimates for some required reinforcements are provided. These are preliminary estimates, and some are based on previous studies. As such, they need to be updated once all the required reinforcement details from a Facility Study have been identified.

This study examines the BCTC transmission system only and assumes that the US NW is capable of sending the power into BC and that Alberta system is able to take the wheeled power without restrictions. As such, no contingency in US NW or Alberta system is studied.

BCTC has recently analyzed and confirmed the existing firm total transfer capability (FTTC) of the BPAT-BCTC Path. The analysis confirmed that the FTTC for Path 3 is 1930 MW in both directions.

Also, BCTC has recently completed a study, the System Impact Studies for Increasing Firm ATC from BC to Alberta and from BC Interior to the US*. This study indicated that the transmission facilities of BCTC-AESO Path are capable of 850 MW FTTC.*

This System Impact Study (SIS) shows that to increase the Firm TTC (FTTC) of the BPAT-BCTC Path above 1930 MW, Network Upgrades are required. The cost estimates of some of the upgrade options are shown in Section 4 of this report. When power is imported into BC from the US, it will be counter flow on the ILM path. Most of the imported power will be consumed in the Lower Mainland, and power originally designated to flow on the ILM to supply Lower Mainland load will be diverted eastward towards Alberta. Other than upgrading the BPAT-BCTC Path firm transfer capability, no major problems are anticipated in importing power from the US.

This SIS also showed that to increase FTTC of the BCTC-AESO Path from 850 MW to 1200 MW, reactive reinforcement in the Cranbrook/Selkirk area or series compensation in 5L92 and 5L94 is required

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1.0 Introduction

As of October 2007 there are 42 LTPTP transmission requests on the West to East direction of flow for paths on BPAT-BCTC, BCTC-AESO and BPAT-AESO. A total of 23 requests underwent the System Impact Study process. Out of the 23 studies, 11 participated in the Open Season hosted by BCTC from July 1 to July 31 of 2007. To efficiently meet customers' requests, BCTC combined all requests and conducted two studies to identify any system reinforcements.

BCTC has determined, in a separate study, that a firm transfer capacity of 1930MW is available without any Network Upgrades. The SIS on the BPAT-BCTC Path was conducted in steps to determine incremental firm transfer capacity by increasing thermal ratings of 5L52 to 2520 Amp, and 5L51 and 5L52 to 3000 Amp, 3400 Amp and 4000 Amp. This SIS indicated higher firm transfer capacity for this path is available by modifying:

1) thermal rating of circuit 5L52 to 2520A to provide firm transfer capacity of 2380MW;
2) thermal ratings of both 5L51 and 5L52 to 3000A to obtain 2800MW;
3) thermal ratings of 5L51 and 5L52 to 3400A to obtain 3143MW
4) thermal ratings of 5L51 and 5L52 to 4000A to provide 3663MW

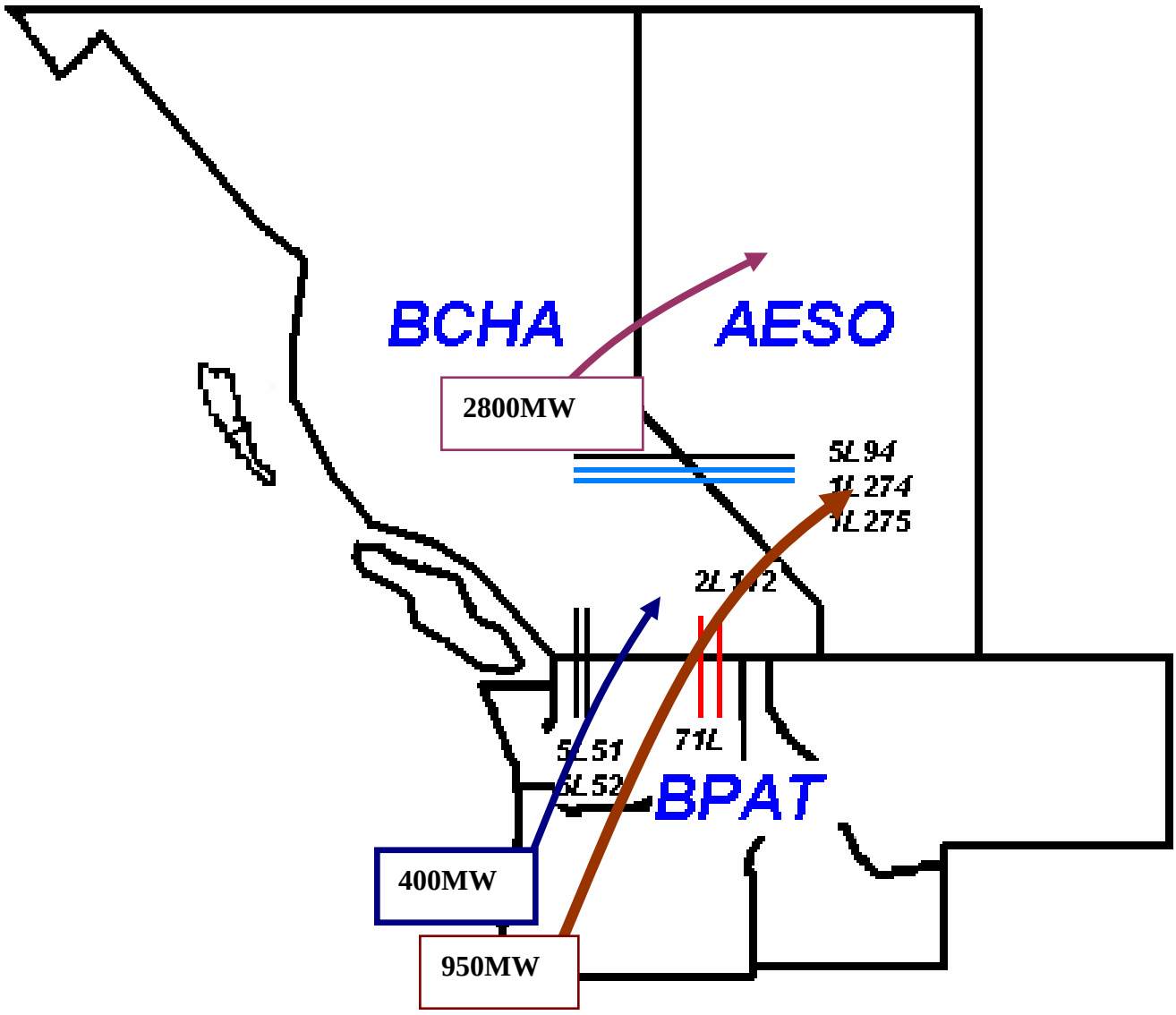
For the BCTC-AESO path, the System Impact Studies for Increasing Firm ATC from BC to Alberta and from BC Interior to the US, based on N-1 criteria shows a firm transfer capacity of 850 MW is possible without any upgrades. Increasing firm transfer capacity to 1200MW will require Network Upgrades.

The scope of this SIS is based on the pending capacity in addition to existing BCTC Long Term PTP Firm commitments. The following table shows the existing contracts and new capacity requested from year 2008 to 2011.

Existing Contracted Commitments & New Requests (MW) by path

		2008	**2009**	**2010**	**2011**	
A.	BPAT>BCTC					
	Contracted	1742	1844	1844	1844	
	TRM	50	50	50	50	
	New Requests	150	750	850	1350	
B.	BCTC>AESO					
	Contracted	480	100	100	100	
	TRM	65	65	65	65	
	New Requests	550	2150	2250	3750	
	BPAT>AESO					
	New Requests	150	550	650	950	(Subsets of A & B)

The following map illustrates the new capacity requested on the inter-tie.



2.0 Study Performed

This SIS is carried out to examine the capability of the BCTC transmission system in terms of importing power from US NW and wheeling part of it to Alberta. The criteria for the study are to ensure that the system can maintain proper voltages and remain stable under N-1 conditions. Transfers would have to be curtailed under multiple contingencies. It does not study contingencies in the US or Alberta systems but assumes that these two systems are capable of exporting and importing the transferred amount respectively without causing any problem within its own system.

Study Assumptions:

For the purpose of this SIS, two heavy winter load flow base cases for 2008 are used. These base cases have the BCH December 2006 load forecast, and up-to-date load, and resource and IPP data, and represent a stressed system. The following assumptions are used in the base cases:

- Because BCTC-AESO Path has a maximum rating of 1200MW, one base case has BC importing 1200MW from US and wheeling this 1200MW to Alberta.
- The second base case differs from the first base case in that it imports a total of 1350MW from US and wheels only 900MW to Alberta.
- Alberta is capable of importing 1200MW from BC.
- BPA is capable of exporting 3663MW to BC.
- Transmission Reliability Margin (TRM) for BCTC-BPAT Path is 50MW.
- TRM for BCTC-AESO Path is 65MW.
- Firm transfer capability including TRM for from US to BC is 1930 MW.
- Firm transfer capability including TRM from BC to AB is 850 MW.

3.0 Study Results

Load flow and transient stability simulations were carried out for the above base cases to investigate the performance and behavior of the transmission system. Station voltage profiles, equipment loading and system stability under N-1 conditions are monitored.

The study indicates two major reinforcements are required to support the transmission service requests. These two reinforcements are:

1. Upgrade BPAT-BCTC Path parallel 500 kV circuits (5L51 and 5L52) between Ingledow and Custer to a higher rating for a higher firm transfer capability.
2. Provide reactive reinforcement in Cranbrook area to support system voltages at system normal and maintain system stability during an N-1 contingency.

The study for the wheel through scenario can be viewed as a combination of two sub-studies. The first part consists of examining the portion from US into BC for the import, and the second part consists of the portion from BC to Alberta for the export.

US to BC

As discussed above, the existing firm transfer limit for BPAT-BCTC Path has been determined to be 1930MW. Of this 1930 MW, 1792 MW and 1894, including TRM, have been reserved by prior requests starting 2008 and 2009 respectively. To accommodate additional firm requests, BPAT-BCTC Path firm transfer capability must be upgraded. This can be achieved by upgrading the thermal ratings of circuits 5L51 and 5L52 to a higher load carrying capability. A change to the WECC path rating will be required.

BC to Alberta

Further to the System Impact Studies for Increasing Firm ATC from BC to Alberta and from BC Interior to the US, BC is connected to Alberta by a single 500kV transmission line between Cranbrook and Langdon, and two 138 kV lines between Natal–Coleman, and Fording Coal-Pocaterra. For interchanges between BC and Alberta, power flows proportionally on these three circuits. The higher the interchange, the more flow will be on the 138 kV circuits.

The following table shows the over loading condition (bold) of the Natal transformers that supply the 138kV lines as a function of the size of the BC-AB interchange:

BC to AB Transfer	Loading on Natal T1 (50MVA)	Loading on Natal T2 (50 MVA)	Loading on Green hills Tap -Fording Coal (63.3 MVA)
1200 MW	**88.7**	**87.2**	**81.5**
850 MW	**66.7**	**65.7**	**63.4**
800 MW	**64.0**	**62.9**	61.1
750 MW	**59.8**	**58.7**	57.7
650 MW	**53.8**	**52.9**	52.6
550 MW	47.9	47.1	47.5
450 MW	42.1	41.3	42.7

In order to avoid overloads on the Natal transformers, the two 138 kV ties lines to Alberta can be operated in an open-loop configuration during periods of high transfers. Therefore, all the power flows on the radial Cranbrook-Langdon 500 kV tie line.

Because of this single 500kV radial connection, it should be noted that the term ‘firm transfer’ means Firm Point-to-Point transmission service as defined in BCTC’s Open Access Transmission Tariff.

When power is transferred from point A to point B, reactive power is required to support such transfers. For wheeling 1200MW into Alberta, a major concern for the South Interior East region is voltage support. Preliminary studies show that starting at around 850 MW of transfer from BC to AB, additional reactive support at Cranbrook is required. The other alternative is to series compensate 5L94 (Cranbrook-Langdon) and 5L92 (Cranbrook-Selkirk).

Assuming a reactive device such as a SVC is installed at Cranbrook, the following tables show at 1200MW transfer, the voltages at key stations, flows on the paths of interest, and the loading on Natal transformers:

Voltage at Key Stations @1200MW Transfer Level

	138 kV ties closed	138 kV ties open
	Voltage (pu)	Voltage (pu)
Nicola	1.054	1.054
Vaseux	1.054	1.054
Ashton Creek	1.058	1.058
Selkirk	1.044	1.045
Cranbrook	1.030	1.030
Langdon	1.029	1.013

Flows on Major Lines at 1200MW Transfer Level

	138 kV ties closed	138 kV ties open
	Flows (MW)	Flows (MW)
Selkirk-Cranbrook	1186	1180
Cranbrook-Langdon	1077	1200
Fording Coal-Pocaterra	61.9 MW	0
Natal-Coleman	63.2 MW	0

Loading on Natal Transformers @ 1200MW Transfer Level

	138 kV ties closed	138 kV ties open
Natal T1 (50 MVA)	88.7 MVA	23.2 MVA
Natal T2 (50 MVA	87.2 MVA	22.8 MVA

With an SVC modeled at Cranbrook, transient stability study shows that a contingency on 5L91 or 5L96 does not create any voltage abnormality or equipment overload and the system remains stable after this contingency.

4.0 Reinforcement Options and Cost Estimates

- Assuming that the 138 kV BC-Alberta ties are operated in an open-loop configuration during high transfer periods, the following reinforcement options are required in order to enable the 1200MW firm transfer from BC to Alberta

- Reactive support in the form of a SVC at Cranbrook is required to support the transfer. The size of the SVC should not be less than 350 MVar.

  or

  Series compensation of 5L94 (Cranbrook-Langdon) and 5L92 (Cranbrook-Selkirk)

For additional US to BC firm transfer capability at various levels from US to BC, an upgrade of the thermal rating of 5L51 and 5L52 to allow a higher firm transfer capability between Custer and Ingledow is required.

The following table shows good faith estimates of the costs of implementing the various options:

	Reinforcement	Cost Estimate	Benefit
1	Upgrade 5L52 capacity to match that of 5L51	$2.0 M 1-1.5 years to implement	Increase BPAT-BCTC Path firm transfer capability by 450 MW to 2380 MW.
2	Upgrade both 5L51 and 5L52 to a thermal rating of 3000 Amp.	$2.5M 1-2 years to implement	Increase BPAT-BCTC Path firm transfer capability by 870 MW to 2800 MW.
3	Upgrade both 5L51 and 5L52 to a thermal rating of 3400 Amp, Upgrade station equipment at Ingledow substation	(to be determined)	Increase BPAT-BCTC Path firm transfer capability by 1213 MW to 3143 MW
4	Upgrade both 5L51 and 5L52 to a thermal rating of 4000 Amp, Upgrade other network and station equipments	(to be determined)	Increase BPAT-BCTC Path firm transfer capability by 1733 MW to 3663 MW. Detailed Facilities Study needs to be performed.
5	Reactive reinforcement (i.e. SVC) at Cranbrook or Series Compensation of 5L92 and 5L94	(to be determined) or (to be determined)	Allow the transfer to go above 850 MW and up to the full path rating of 1200 MW. or Allow the transfer to go above 850 MW and up to the full path rating of 1200 MW

5.0 Conclusion:

Under single contingency criteria, the existing BCTC system can transfer up to 850MW to BC Alberta border without system upgrade. For transfers higher than 850MW, reactive reinforcement at Cranbrook area or series compensation in 5L92 and 5L94 is required.

For BC to Alberta transfers above 550MW, Natal transformers will be overloaded. Thermal upgrades in the Natal area can be avoided by operating the 138 kV ties to Alberta in an open-loop configuration to force the transfers to take place on the 500 kV circuit (5L94) between Cranbrook (BC) and Langdon (Alberta). However, it should be noted in such open-loop situation, Elk Valley Coal, Elkford, Cranbrook Regional Hospital and Fording Coal are supplied radially from Natal and their reliability will be less than when they are supplied in a looped configuration.

To meet the increased demand for firm transmission service on the BPAT-BCTC path, upgrading of the thermal ratings of 5L51 and 5L52 between Custer and Ingledow substations is required. Upgrading 5L52 to match 5L51 at 2520A will increase the firm TTC to 2380MW, resulting in an incremental increase of 450MW. Upgrading both 5L51 and 5L52 to 3000A will increase the firm TTC to 2800MW, resulting in an incremental increase of 870MW.

The present WECC Path Rating limits the total transfer on Path 3 to 2000 MW from US into BC (BPAT-BCTC Path), and 3150MW from BC to the US (BCTC-BPAT Path). A WECC path uprating process will be required to allow for the new transfers.