System Impact Study for

Long Term Point-To-Point Oasis Requests

75223431	**75223432**	**75223433**	**75223434**
75223435	**75223436**	**75223437**	**75223438**
75223441	**75223442**	**75223443**	**75223444**

On the AESO – BCH – BPAT Path

1 January 2013 – 1 January 2020

Report No: ASP-Transmission 2011-051
November 2011

British Columbia Hydro and Power Authority

ACKNOWLEDGEMENTS

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Executive Summary

The following applications for Long Term Firm Transmission Services for wheeling power from Alberta to BC and from Alberta to US on the AESO x BPAT Path and AESO x BCHA Path were submitted by Transmission Customer, Powerex, to Transmission Provider, British Columbia Hydro and Power Authority (BCH), in accordance with the BCH Open Access Transmission Tariff (OATT):

OASIS #	Point of Receipt	Point of Delivery	Amount	Term
75223432	AB-BC Border	Selkirk, BC	200 MW	5 year (1 Jan 2013 – 1 Jan 2018)
75223431	AB-BC Border	BC-US Border	200 MW	5 year (1 Jan 2013 – 1 Jan 2018)
75223434	AB-BC Border	Selkirk, BC	200 MW	5 year (1 Jan 2013 – 1 Jan 2018)
75223433	AB-BC Border	BC-US Border	200 MW	5 year (1 Jan 2013 – 1 Jan 2018)
75223435	AB-BC Border	BC-US Border	200 MW	5 year (1 Jan 2013 – 1 Jan 2018)
75223436	AB-BC Border	BC-LM*	200 MW	5 year (1 Jan 2013 – 1 Jan 2018)
75223437	AB-BC Border	BC-US Border	200 MW	5 year (1 Jan 2013 – 1 Jan 2018)
75223438	AB-BC Border	BC-LM	200 MW	5 year (1 Jan 2013 – 1 Jan 2018)
75223441	AB-BC Border	BC-US Border	200 MW	5 year (1 Jan 2015 – 1 Jan 2020)
75223442	AB-BC Border	BC-LM	200 MW	5 year (1 Jan 2015 – 1 Jan 2020)
75223443	AB-BC Border	BC-US Border	200 MW	5 year (1 Jan 2015 – 1 Jan 2020)
75223444	AB-BC Border	BC-LM	200 MW	5 year (1 Jan 2015 – 1 Jan 2020)

*BC-LM means Meridian and Ingledow substations in the Lower Mainland

The Point of Receipt (POR) for these transmission requests are at the Alberta-BC border. The Point of Delivery (POD) is at various locations: Selkirk substation (SEL) in the BC South Interior, Meridian (MDN) and Ingledow (ING) substations in BC Lower Mainland, and US-BC border. Depending on the Point of Delivery, each of these Service Requests must pass through a number of "cut-planes" in the BCH transmission system. Each of these "cut-plane" represents a

transmission bottle neck between two adjacent regions. There must exist Available Transfer Capability (ATC) before a new request for transmission service can be accommodated.

This System Impact Study (SIS) analyzed the BCH System only and did not evaluate the transfer capability of the neighbouring systems. The Customers requesting these services are responsible for obtaining transmission services from the respective Transmission Service Providers.

The ATC through each of the cut-plane in BCH system is reviewed upon the most current information available. No additional feasible system reinforcement is identified, beyond those already identified in previous studies, that can be implemented within the time frame of these Requests.

With reference to the BCH transmission system only, this SIS concludes the following:

- Only one 200 MW Service Requests from AB-BC border to Selkirk substation can be accommodated in full for the whole duration of the requested period .
- Without necessary system upgrades, none of the Service Requests with POD in the Lower Mainland or BC-US border can be accommodated in full for the duration of the service period requested due to lack of Firm ATC at various cut-planes.
- With the new 500 kV circuit 5L83 (Nicola - Meridian) in service, one of the Service Requests with POD in Lower Mainland or at the BC-US border may be accommodated as long term firm service only for one year in 2017 if the in-service date of the Series Compensation of 5L91/5L98, known as SISC project, is advanced to the end of 2016.

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1. Introduction

The following applications for Long Term Firm Transmission Services for wheeling power from Alberta to BC and from Alberta to US on the AESO x BCHA Path and AESO x BPAT Path were submitted by Transmission Customer, Powerex, to Transmission Provider, British Columbia Hydro and Power Authority (BCH), in accordance with the BCH Open Access Transmission Tariff (OATT).

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75223444	AB-BC Border	BC-LM	200 MW	5 year (1 Jan 2015 – 1 Jan 2020)

*BC-LM means Meridian (MDN) and Ingledow (ING) substations in the Lower Mainland.

Depending on the Point of Delivery, each of these Requests must cross a number of cut-planes, and each will have its share of impact on the South Interior path (between BC-AB border and Nicola (NIC) substation), the Interior to Lower Mainland (ILM) transmission path (between NIC/KLY (Kelly Lake substation) and MDN/ING), and the transmission path between Lower Mainland and the US border. A cut plane is a fictitious surface crossing a transmission circuit or

a group of transmission circuits on a system segment/path and is used in this report to converse the information of transfer capability on the segment/path.

2. Terms of Reference

A review of the submitted requests and System Impact Study were conducted as follow:

(a) BCH used its current planning and operating criteria, standards and procedures, which conform to NERC/WECC Standards, to determine necessary transmission system reinforcements and re-dispatch requirements.

(b) Specifically, the following analyses were performed, and information drawn from prior completed technical studies.
- Identifying system transmission constraints and any Network Upgrades;
- Analyzing the amount of firm available transfer capability (FATC) through each of the cut-planes that each of these Transmission Requests must cross;
- Reviewing load shedding, generator shedding and re-dispatch options referred to in the prior completed study reports, tie-line transfer limits and network curtailment remedial action schemes required for the reliable operation of the inter-connected system.

(c) The studies analyzed the BCH System only. Study of transfer limits in the neighbouring systems is not within the scope of this study. **Customers requesting these services are responsible for obtaining transmission service from the neighbouring Transmission Service Providers.**

(d) The FATC analysis was based on the information contained in the latest BCH transmission system study reports. These studies were based on the 2011 resource allocations and load forecasts, and high stress system conditions including but not restricted to winter peak load, summer heavy and summer light load cases.

3. Point-of-Receipt and Point-of-Delivery

The Point-of-Receipt (POR) for these 12 Requests is at AB.BC border on WECC Path 1.

Point-of-Delivery (POD) for Request #75223432 and #75223434 is Selkirk (SEL) substation in the South Interior.

The POD for #75223436, #75223438, #75223442 and #75223444 is Meridian (MDN) and Ingledow (ING) substations in BC Lower Mainland.

The POD for #75223431, #75223433, #75223435, #75223437, #75223441 and #75223443 is at US-BC border on WECC Path 3.

4. System Study Conditions

Review of these OASIS requests was based on the following network conditions and assumptions:

- Total Transfer Capability (TTC) and Committed Use (CU) across the various cut-planes in BCH System
- System Operating Orders 7T-17 and 7T-18.
- Existing firm reservations or CU on the BCHA x BPAT Path;
- Existing firm reservations or CU on the AESO x BCHA Path;
- Transmission Reliability Margin (TRM) on the AESO x BCHA Path: 65 MW; and
- Transmission Reliability Margin (TRM) on the BCHA x BPAT Path: 50 MW.

5. Analysis

There are 4 major cut-planes along the AESO-BCHA-BPAT path. These are crossings between system segments:

1. Alberta-BC Tie
2. West of Selkirk
3. Interior to Lower Mainland
4. Lower Mainland to US

There must be adequate Available Transfer Capability (ATC) on each of these cut-planes to accommodate a specific firm transmission request in a safe and secure manner. If a Request for transmission service transverse 3 cut-planes, then adequate ATC must exist on all 3 cut-planes for the path to be considered secured. Therefore, for a Request for firm transmission service with POR in AB-BC border and POD at US-BC border, then all of the above 4 cut-planes must have Firm ATC no less than the firm amount requested before full service can be granted.

5A Capability of the transmission system to support transmission services from Alberta to Lower Mainland and to US

When power is transferred from Alberta to the Lower Mainland and US, the power will flow in an east to west direction, competing for transmission capacity with the generation in the South Interior. Significant network upgrades are required to improve the transfer capability across the West of Selkirk cut-plane just to meet the NITS requirements.

Transfer Capability of the ILM path depends on the load and coastal generation in the Lower Mainland. With load growth in the Lower Mainland and pending retirement of Burrard Generating station, the ILM path is congested before the new 500 kV circuit 5L83 between NIC and MDN is put into service.

The following is an analysis of Firm Available Transfer Capability (FATC) across each of these cut-planes.

5B-1) **Alberta-BC Cut-plane**:

This path is also known as WECC Path 1. The WECC Path 1 Rating is 1000MW East to West. This is the transfer limit under favourable system conditions without any transmission element outage.

However, due to the competing effect between power import from Alberta and power injection at SEL500 from the local generation on this path, BCH System Operating Order 7T-17 indicates that maximum import from Alberta to BC is 600 MW when the injected power into SEL500 through the SEL 500 kV transformers is at 2000 MW.

There are existing long term firm reservations totaling 249 MW on the AESO x BCHA Path. The following table shows the available firm ATC on this path to accommodate any additional firm transfer.

Table 1: Alberta - BC Cut-plane Capacity

	2013	2014	2015	2016	2017	2018	2019
Firm TTC	600	600	600	600	600	600	600
TRM	65	65	65	65	65	65	65
CU	249	249	249	249	249	249	249
FATC	286	286	286	286	286	286	286

Additional 286 MW of firm transfers capacity is available on the Alberta to BC Cut-plane.

5B-2) **West of Selkirk Cut-plane**:

South Interior is a generation rich area and the use of the transfer capability across this cut-plane is dominated by the generations in the area. The results from recent studies of the transfer capability in this region were used as the basis for this analysis.

This analysis concluded the following FTTC and Committed Use (CU) across this cut-plane in Table 2a, which is based upon the NITS Base Resource Plan (BRP):

Table 2a: West of Selkirk Cut-plane Capacity

	2013 Summer	2013 Winter	2014 Summer	2014 Winter	2015 Summer	2015 Winter	2016 Summer
Firm TTC	2000	1910	2000	1910	2000	1910	2000
CU	2041	1842	2041	1842	2041	1842	2041
FATC	-41	68	-41	68	-41	68	-41

	2016 Winter	2017 Summer	2017 Winter	2018 Summer	2018 Winter	2019 Summer	2019 Winter
Firm TTC	1910	2000	1910	2000	1910	2000	1910
CU	1842	2041	1842	2041	1842	2041	1842
FATC	68	-41	68	-41	68	-41	68

The recent studies identify that in order to accommodate additional generating units beyond those in BRP, system upgrades are required to improve the transfer capability of this cut-plane. Series Compensation of 5L91/98, known as SISC project, is identified as a feasible upgrade. SISC will add ~257 MW of TTC to this cut-plane with a good faith cost estimate of $62M.

The studies also conclude that SISC will need to be advanced to October 1 2018 to accommodate Revelstoke Unit 6 and other new generations in the area indicated in one NITS Contingency Resource Plan (CRP). It is estimated that this project will take approximately 5 years to complete. Thus, the in-service date of SISC can therefore be advanced to the end of 2016 to accommodate some of the new requests. The following table shows the FATC with SISC advanced to the end of 2016.

Table 2b: West of Selkirk Cut-plane Capacity
With SISC advanced to 2017

	2013 Summer	2013 Winter	2014 Summer	2014 Winter	2015 Summer	2015 Winter	2016 Summer
Firm TTC	2000	1910	2000	1910	2000	1910	2000
CU	2041	1842	2041	1842	2041	1842	2041
FATC	-41	68	-41	68	-41	68	-41

	2016 Winter	2017 Summer	2017 Winter	2018 Summer	2018 Winter	2019 Summer	2019 Winter
Firm TTC	1910	2257	2167	2257	2167	2257	2167
CU	1842	2041	1842	2041	>1842	>2041	>1842
FATC	68	216	325	216	0	0	0

The Transmission Service customers can choose to bring the SISC project forward to serve their needs, with the understanding that

- It is estimated in good faith that the project will take 5 years to implement.
- They will be responsible for the incremental cost of advancing the project to an earlier in-service date.
- The additional capacity created by SISC project has been committed to prior request with services starting 1 October 2018.

5B-3) Interior to Lower Mainland (ILM) Cut-Plane

This cut-plane is generally referred to as the ILM path. It comprises of 5L41, 5L42, 5L81, 5L82 and a few other circuits, and transmits electricity from the Peace River generation (in the Northern Region) and the Columbia River generation (in the South Interior) to the major provincial load centers in the Lower Mainland and Vancouver Island (LM&VI), which together comprise approximately 70% of the provincial demand.

The previous study reports identify that without 5L83, the N-1 limit of the ILM path is 5000 MW with specified generation patterns. The flow on this path is dependent on two factors: the load

and the Coastal Generations in LM&VI. Increasing the Coastal Generation will lessen the flow on the ILM path and increase the FATC. The ILM path is fed by two sources: generation in the Northern (Peace) Region and South Interior. In addition to LM&VI load and Coastal Generation, the transfer capability of the ILM path can be influenced by power contributions from the two sources feeding into the ILM path. During congested periods, generation re-dispatch may be used to optimize the ILM transfer capability.

Table 3a shows the path capability and the expected firm transfer with Burrard generating at 0 MW and without 5L83.

Table 3a: ILM Path Capacity without 5L83

	2013	2014	2015	2016	2017	2018	2019
Firm TTC	5000	5000	5000	5000	5000	5000	5000
ILM transfer without BGS	4734	4602	5157	5738	5588	5552	5565
FATC	266	398	0	0	0	0	0

When the circuit 5L83 (NIC-MDN) with the ILM Transmission Reinforcement project is put into service in Oct 2014, it will enhance the ILM firm transfer capability by about 1550 MW. Table 3b shows the path capability and the expected firm transfer with Burrard generating at 0 MW and with 5L83.

Table 3b: ILM Path Capacity with 5L83

	2013	2014	2015	2016	2017	2018	2019
Firm TTC	5000	5000/6550	6550	6550	6550	6550	6550
ILM Transfer without BGS	4734	4602	5157	5738	5588	5552	5565
FATC	266	398/1948	1393	812	962	998	985

Tables 3a and 3b assume that there is no change in the Coastal Generation dispatch pattern used in the analysis. Should any existing Coastal generator not be available to meet the RMR requirement, additional power will need to be brought down to the Lower Mainland on the ILM path. This will increase path utilization and decrease the path FACT.

It can be observed in Table 3b that up to 4 Requests can be accommodated in full on this path after 5L83 is in service.

5B-4 **BC-US Cut-plane (Path 3)**

This path is also known as WECC Path 3. The WECC Path 3 Rating is 3150 MW North to South. This is the transfer limit under favorable system conditions without any transmission element outage.

Considering other system limitations in a single contingency situation, BCH Business Practice sets the Firm Total Transfer Capability (FTTC) from the British Columbia to Washington at 2400 MW. The TRM for this path is 50 MW.

There are existing long term firm reservations totaling 600 MW on the BCHA x BPAT Path. The following table shows the available firm ATC on this path to accommodate any additional firm transfer.

Table 4: BC x BPAT Path Capacity

	2013	2014	2015	2016	2017	2018	2019
Firm TTC	2400	2400	2400	2400	2400	2400	2400
TRM	50	50	50	50	50	50	50
CU	600	600	600	600	600	600	600
FATC	1750	1750	1750	1750	1750	1750	1750

Additional 1750 MW of transfer capacity is available for firm North to South transfer on this path.

6. Study Conclusions

Tables 1 to 4 show the available firm transfer capability through each of the 4 cut-planes between BC-AB border and BC-US border. The cut-planes between the POR and POD must have enough FATC to accommodate a specific transmission service request. In this study, all 12 Requests have the same size of 200 MW each.

The POR for all these 12 Requests is the BC-AB border, the following table shows the FATC for various cut-planes along the path.

Table 5: FATC across cut-planes

	2013	2014	2015	2016	2017	2018	2019
AB-BC	286	286	286	286	286	286	286
West of Selkirk (without SISC)	0	0	0	0	0	0	0
West of Selkirk (with advanced SISC)	0	0	0	0	216	216/0[1]	0[1]
ILM (without 5L83)	266	398	0	0	0	0	0
ILM (with 5L83)	266	398/1948	1393	812	962	998	985
BC-US border	1750	1750	1750	1750	1750	1750	1750

[1]FATC has been committed to prior requests starting October 1 2018

The FATC for new Transmission Services between POR and POD will be determined by the minimum of the FATC for the cut-planes between the POR and POD.

Referring to Table 5, it can be observed that

- Only one Service Request with POD at Selkirk can be fully accommodated as Long Term Firm Service.
- Without necessary system upgrades, none of the Service Requests with POD in Lower Mainland or in the BC-US Border can be fully accommodated for the full duration of the time frame requested due to limitation on the West of Selkirk cut-plane.
- With the advancement of the SISC project to the end of 2016, only one of the Service Requests with POD in Lower Mainland or at the BC-US border can be fully accommodated as Long Term Firm Service for partial duration of the time frame requested due to limitation on the West of Selkirk cut-plane.

This study has not identified any additional feasible system reinforcements beyond those already identified in the previous studies that can be implanted prior to the End Date of these 12 Requests.

References

The following references are used in this study:

- System Operating Order 7T-17 BC-Alberta Interconnection
  March 9 2011

- System Operation Order 1T-18 Custer-Ingledow 500 kV Interconnection
  April 18 2011

- South Interior Cut-Plane Reinforcement Justification Report
  October 2006, SPA-2006-117