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Study for
Selkirk Station to Nicola Station
Available Transfer Capability

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T&D Engineering
& Grid Operations

T&D ENGINEERING

Executive Summary

There is in excess of 1000 MW of Long-Term-Firm Point-to-Point Transmission Service requests on the EAL × BCHA and EAL × BPAT Paths. BC Hydro has performed sufficient studies to determine the reinforcements required on the Southern Interior transmission network to accommodate the high level of requested EAL to BCHA/BPAT transmission service.

Further to the Long-Term Transmission Service Update Bulletin, "BC Hydro Southern Interior Transmission Network", dated 28 February 2002 (http://gridops.bchydro.bc.ca/bulletins/archives.shtml), BC Hydro conducted this Study to identify Network Upgrades that would provide Available Transfer Capability (ATC) from the Selkirk 500 kV Station to the Nicola 500 kV Station. The results of this Study will be incorporated into the Facilities Study to be conducted for transmission service requests on the EAL × BCHA and EAL × BPAT Paths.

This Study does not propose, implied or otherwise, that all of the requested EAL to BCHA/BPAT transmission service will use the transfer capability from the Selkirk Station to the Nicola Station, but will identify the ATC with the required Network Upgrades.

The Study concluded that up to 1685 MW of ATC is available from the Selkirk Station to the Nicola Station without the addition of a new transmission line in 2007/08.

The following are Network Upgrades required to provide incremental ATC above existing commitments:

- *50% Series Compensation on 5L91 (3000 A or 3500 A)*
- *50% Series Compensation on 5L98 (3000 A or 3500 A)*
- *50% Series Compensation on 5L76 & 5L79 (3500 A)*
- *Up to 15 Circuit Breakers at Selkirk, Nicola and Ashton Creek Stations*
- *Selkirk 250 MVAR 500 kV Shunt Capacitor*

Alternatively, without the benefit of the Network Upgrades identified above, the ATC will be in excess of 1685 MW with a new 500 kV transmission line, 5L99 from Selkirk Station to Nicola Station, and a 250 MVAR Shunt Capacitor at Selkirk Station.

As there are no interconnection requirements identified, there are no Direct Assignment Facilities included in this Study.

The earliest possible in-service date of the no new transmission line Network Upgrades is considered to be January 2006. The earliest possible in-service date of 5L99 is considered to be October 2009.

Appendix A contains the Network Upgrade facilities costs and schedules for providing the transmission service.

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1. Introduction

On 28 February 2002, a Long-Term Transmission Service Update Bulletin was posted on BC Hydro Southern Interior Transmission Network stating that reinforcements may be required on the BC Hydro Southern Interior transmission network to accommodate the high level of requested EAL to BCHA/BPAT transmission service.

This Study identifies the required modifications to T&D's Transmission System, including a good faith estimate of the cost and scheduled completion date for such modifications to provide ATC from the Selkirk 500 kV Station to the Nicola 500 kV Station.

2. Terms of Reference

The base conditions for the study are the BC Hydro native load requirements in 2007/08 and current firm export and transfer commitments. The Point-of-Receipt (POR) for the transmission service is assumed to be the Selkirk 500 kV Station, and the Point-of-Delivery (POD) is along the way to and includes the Nicola 500 kV Station.

This Study is limited to the route between the Selkirk 500 kV Station and the Nicola 500 kV Station and does not address constraints outside of this system. However, reinforcements outside of this system are assumed to be available to support the transmission service at the POR and POD.

This Study does not propose, implied or otherwise, that all of the requested EAL to BCHA/BPAT transmission service will use the transfer capability from the Selkirk Station to the Nicola Station, but will identify the ATC with the required Network Upgrades.

3. System Study Results

Studies were performed as per T&D's Transmission System Planning Criteria and Study Methodology. These studies were conducted to:

- Determine the ATC of the Selkirk 500 kV to Nicola 500 kV transmission network.
- Assess the elements constraining the ATC.
- Determine Network Upgrades that would relieve the constraints.

3.1. N-1 Capability

The Selkirk 500 kV to Nicola 500 kV transmission network is voltage stability limited by the first contingency single outage of 5L98 or 5L91. The system is then limited thermally after adding series compensation to 5L91, 5L98, 5L76 and 5L79. After thermal upgrades to 5L91 and 5L98 the system is voltage stability limited by the first contingency single outage of 5L98.

3.2. N-1 during Maintenance Capability

With 5L91 or 5L98 out-of-service for maintenance, the remaining Selkirk to Nicola transmission system is radial. Maintenance opportunity for 5L91 or 5L98 can be provided during summer weekends by curtailing the firm transfers.

3.3. Available Transfer Capability

The following reinforcement sequence will provide 1685 MW of ATC without the addition of a transmission line:

1. 50% Series Compensation on 5L91 (3 kA)
2. 50% Series Compensation on 5L98 (3 kA)
3. Upgrade 5L76 & 5L79 to 3.5 kA
   - 50% Series Compensation on 5L76 & 5L79 (3.5 kA)
   - NIC 5 × 4 kA CBs; ACK 4 × 4 kA CBs
4. Selkirk 250 MVAR 500 kV Shunt Capacitor
5. Upgrade 5L98 to 3.5 kA
   - 50% Series Compensation on 5L98 (3.5 kA)
   - SEL 2 × 4 kA CBs
6. Upgrade 5L91 to 3.5 kA
   - 50% Series Compensation on 5L91 (3.5 kA)
   - SEL 2 × 4 kA CBs; ACK 2 × 2 kA CBs

An alternative reinforcement is to build a new 500 kV transmission line, 5L99 from Selkirk Station to Nicola Station, and to add a 250 MVAR shunt capacitor at Selkirk Station. With this alternative reinforcement the ATC will be in excess of 1685 MW.

At this level of ATC, the Selkirk to Nicola 500 kV transmission system with the new transmission line will have approximately 50 MW less losses than the system with no new transmission line.

4. Network Upgrade and Direct Assignment Facilities

The required Network Upgrade Facilities costs and schedules for providing transmission service are shown in Appendix A.

As there are no interconnection requirements identified, there are no Direct Assignment Facilities included in this Study.

5. Project and Transmission Service Risks

This Study contains some uncertainty in the plan, reinforcement, costs and in-service dates.

6. Conclusions

The Study concluded that up to 1685 MW of ATC is available from the Selkirk Station to the Nicola Station without the addition of a new transmission line in 2007/08.

The following are Network Upgrades required to provide incremental ATC above existing commitments:

- 50% Series Compensation on 5L91 (3000 A or 3500 A)
- 50% Series Compensation on 5L98 (3000 A or 3500 A)
- 50% Series Compensation on 5L76 & 5L79 (3500 A)
- Up to 15 Circuit Breakers at Selkirk, Nicola and Ashton Creek Stations
- Selkirk 250 MVAR 500 kV Shunt Capacitor

Alternatively, without the benefit of the Network Upgrades identified above, the ATC will be in excess of 1685 MW with a new 500 kV transmission line, 5L99 from Selkirk Station to Nicola Station, and a 250 MVAR Shunt Capacitor at Selkirk Station.

The earliest possible in-service date of the non-transmission line Network Upgrades is considered to be January 2006. The earliest possible in-service date of 5L99 is considered to be October 2009.

Appendix A contains the Network Upgrade facilities costs and schedules for providing the transmission service.

Appendix A.

Network Upgrade Facilities

A.1 Series Capacitor Stations

A.1.1 New Series Capacitor Stations on 5L91 (Selkirk – Ashton Creek)

Install a Series Capacitor Station midway on 5L91. The characteristics of the station are:

Compensation	50%
Series reactance	36.7 ohms
Nameplate current rating	2727 A or 3182 A
Continuous overload rating	3000 A or 3500 A (8 hrs in 12 hrs)
Reactive Rating	820 MVAR or 1114 MVAR
Bank Configuration	MOV gapless (approx 100 MJ per platform)
Nom. operating voltage	500 kV
Max. continuos voltage	550 kV

Add/replace SAs at line-ends. New line-end CBs are not required for the first current rating.

Provide new protection and control for equipment. Provide transfer trip facilities for the bypass CBs, and breaker failure signals to Selkirk and Ashton Creek Stations. Add transfer trip facilities related to generation shedding associated with the bypass CBs.

Add local and remote Control and Indication for the bypass CBs, and revise SCADA. Provide microwave telecommunications channels for voice, data and protection.

A.1.2 New Series Capacitor Stations on 5L98 (Selkirk – Nicola)

Install two Series Capacitor Stations at the 1/3 and 2/3 sections of 5L98. The characteristics of each station are:

Compensation	25%
Series reactance	25 ohms
Nameplate current rating	2727 A or 3182 A
Continuous overload rating	3000 A or 3500 A (8 hrs in 12 hrs)
Reactive Rating	558 MVAR or 758 MVAR
Bank Configuration	MOV gapless (approx 100 MJ per platform)
Nom. operating voltage	500 kV
Max. continuos voltage	550 kV

Add/replace SAs at line-ends. New line-end CBs are not required for the first current rating.

Provide new protection and control for equipment. Provide transfer trip facilities for the two bypass CBs, and breaker failure signals to Selkirk and Nicola Stations. Add transfer trip facilities related to generation shedding associated with the bypass CBs.

Add local and remote Control and Indication for the bypass CBs, and revise SCADA. Provide microwave telecommunications channels for voice, data and protection.

A.1.3 New Series Capacitor Stations on 5L76 & 5L79 (Ashton Creek – Nicola)

Install two Series Capacitor Stations, one each midway on 5L76 and 5L79. The characteristics of each station are:

Compensation	50%
Series reactance	19.3 ohms
Nameplate current rating	3182 A
Continuous overload rating	3500 A (8 hrs in 12 hrs)
Reactive Rating	586 MVAR
Bank Configuration	MOV gapless (approx 100 MJ per platform)
Nom. operating voltage	500 kV
Max. continuos voltage	550 kV

Add/replace SAs at line-ends. Replace line-end CBs.

Provide new protection and control for equipment. Provide transfer trip facilities for the bypass CBs, and breaker failure signals to Selkirk and Nicola Stations. Add transfer trip facilities related to generation shedding associated with the bypass CBs.

Add local and remote Control and Indication for the bypass CBs, and revise SCADA. Provide microwave telecommunications channels for voice, data and protection.

A.2 Transmission Circuit Upgrades and Additions

A.2.1 Upgrade 5L76 and 5L79 to 3500 A

Upgrade the summer rating of 5L76 and 5L79 to 3.5 kA:

- Reconductor at least one span of 5L76.
- Upgrade Ashton Creek Station 5CB1, 2, 5 and 6 and associated equipment to 4 kA continuous.
- Upgrade Nicola Station 5CB5, 6, 15, 16 and 25 and associated equipment to 4 kA continuous.

Revise 5L96 and 5L79 protection to suit.

A.2.2 Upgrade 5L91 to 3500 A

Upgrade the summer rating of 5L91 to 3.5 kA:

- No line work required.
- Upgrade Selkirk Station 5CB9 and 11 and associated equipment to 4 kA continuous.
- Upgrade Ashton Creek Station 5CB3 and 4 and associated equipment to 4 kA continuous.

Revise 5L91 protection to suit.

A.2.3 Upgrade 5L98 to 3500 A

Upgrade the summer rating of 5L98 to 3.5 kA:

- No line work required.
- Upgrade Selkirk Station 5CB5 and 8 and associated equipment to 4 kA continuous.

Revise 5L98 protection to suit.

A.2.4 New 5L99 from Selkirk to Nicola

Undertake environmental and engineering studies, conduct public consultation, obtain regulatory approvals and acquire new right-of-way. Design and construct a new 500 kV transmission line similar to 5L98:

- 302 km along/near 5L98 routing; widening of the existing 5L98 right-of-way by approximately 54 m
- Mica ACSR, 4 bundle conductor and existing family of 500 kV towers
- Current rating of 3500 A summer
- line-end reactors
- no series compensation
- two CBs at Selkirk and two CBs at Nicola
- Single-pole reclose protection

A.3 Shunt Capacitor Additions

A.3.1 Selkirk 500 kV Shunt Capacitor Bank

Add a 500 kV, 250 MVAR switchable shunt capacitor bank at Selkirk Station.

Make 500 kV bus reconnections and add 500 kV main bus CVTs. Provide associated protection (including unbalance and breaker failure protection), control and telecom facilities. Provide local and remote control additions, from both SCC and relevant

ACC, for new MODS and CBs for the shunt capacitor banks including control, indication, and alarms.

At SCC revise SCADA/EMS power system models to include the new equipment. Also revise network application functions including DTS, VSA, and TSA.

A.4 Costs and Schedules

The $k costs below are Capital Direct with T&D External Loadings and have an accuracy of -15% & +40%. The Totals do not include IDC.

Network Upgrades – No new transmission line

Description	Total	Year 1	Year 2	Year 3	Year 4	Year 5
50% Series Compensation on 5L91 (3.0 kA)*	16353	360	1553	5427	6877	2136
50% Series Compensation on 5L98 (3.0 kA)*	32147	360	2429	13403	12005	3949
50% Series Compensation on 5L91 (3.5 kA)	19756	435	1876	6556	8308	2580
50% Series Compensation on 5L98 (3.5 kA)	35128	394	2654	14646	13119	4315
50% Series Compensation on 5L76 & 5L79 (3.5 kA)	22281	402	2028	7379	9418	3053
Upgrade 5L76 & 5L79 to 3.5 kA (line & ACK 4 × 4 kA CBs & NIC 5 × 4 kA CBs)	17728	949	4401	12378		
Upgrade 5L91 to 3.5 kA (SEL 2 × 4 kA CBs & ACK 2 × 4 kA CBs)	7587	820	2718	4049		
Upgrade 5L98 to 3.5 kA (SEL 2 × 4 kA CBs)	4057	355	1173	2529		
Selkirk 250 MVAR 500 kV CX	3083	208	692	2184		

* The costs provided are not for capacitor stations upgradeable to 3500 A as it is assumed that the required level of ATC is known before proceeding with the reinforcements.

Network Upgrades – New transmission line

Description	Total	Year 1	Year 2	Year 3	Year 4	Year 5
Selkirk 250 MVAR 500 kV CX	3083	208	692	2184		
New 5L99 from Selkirk to Nicola	128394	1030	2195	4304	11518	11422
	-	**Year 6**	**Year 7**	**Year 8**		
New 5L99 from Selkirk to Nicola (continued)	-	23155	36874	37896		