

**Facilities Study for
Power Supply 1000 MW Export on the
BCHA × BPAT Path**

**Report No: NPP2000-20
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**T&D Engineering
& Grid Operations**



Executive Summary

On 1 March 2000, Powerex, on behalf of Power Supply, submitted an OASIS request (No. 254221) to the BC Hydro Transmission & Distribution Engineering Business Unit (T&D) for Long Term Firm Point-to-Point transmission service under the Wholesale Transmission Service (WTS) tariff to export 1000 MW on the BCHA × BPAT Path.

This Facilities Study identifies the required modifications to T&D's Transmission System, including the cost and scheduled completion date for such modifications, that will be required to provide the requested transmission service. A good faith estimate of the cost of any required Network Upgrades is also provided.

The required Network Upgrades and scheduled completion dates are as follows:

I) Interior to Lower Mainland Bulk Transmission

- new 50% compensated 3000 A Guichon Series Capacitor Station on 5L87 (between Nicola and Kelly Lake Substations) on 1 October 2006 (earliest in-service).*
- Two 230 kV 190 MVAR mechanically switched shunt capacitors at Ingledow Substation on 1 October 2006.*

These Network Upgrades will allow more generation in the South Interior to be transferred to the Lower Mainland. A Certificate of Public Convenience and Necessity (CPCN) from the British Columbia Utilities Commission (BCUC) is required for Guichon Series Capacitor Station.

II) South Interior West Bulk Transmission

- Add a 500 kV 150 MVAR shunt capacitor at Ashton Creek Substation on 1 October 2006 (to coincide with Guichon's in-service).*
- Reconfigure the Nicola 500 kV Station on 1 October 2006.*

These Network Upgrades will allow the new generation resources specified in the request for Transmission Service to be transferred across the South Interior West bulk transmission system for delivery to the Nicola Substation.

III) Central Interior North Bulk Transmission

- Refurbish the McLeese 1 and 2 Series Capacitor Stations to 25% series compensation on the 500 kV Williston-Kelly Lake 5L11 & 5L12 lines on 1 October 2006 (to coincide with Guichon's in-service). This Network Upgrade will allow maximum Peace generation during Summer Light loads.*

As there were no generation Interconnection Studies performed, the Direct Assignment Facilities associated with this request for Transmission Service have not been identified.

Only 500 MW can be provided because re-dispatch to a higher level of Coastal region generation was found not to be technically feasible. No service can be provided from 1 January 2002 until 1 October 2006. When the above reinforcements are built at their earliest in-service date, they will provide 500 MW of available transmission capability from 1 October 2006 until 31 December 2020.

Appendix B contains the Network Upgrade facilities costs and schedules.

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1. Introduction

On 1 March 2000, BC Power Exchange Corporation (Powerex), on behalf of Power Supply, submitted an OASIS request (No. 254221) for 1000 MW of Long-Term Firm Point-To-Point Transmission Service on the BCHA × BPAT Path for the period 1 January 2002 to 31 December 2020.

Pursuant to the WTSA, BC Hydro T&D (T&D) determined that a System Impact Study was required for the Application. The System Impact Study was completed on 27 October 2000. A Facilities Study Agreement was signed between Power Supply and T&D on 23 November 2000.

2. Terms of Reference

The Terms of Reference as given to NPP are:

Provide cost estimates of the facilities identified in the System Impact Study or alternatives to the original facility additions with the exception of the Nicola-Meridian 500 kV transmission line (5L83) and interconnection studies for new generation resources.

3. System Study Results

The available transfer capability of the BCHA x BPAT path is 0 MW from 1 January 2002 until the in-service date of the Interior-Lower Mainland reinforcements on 1 October 2006. Redispatch was found to be not feasible. Beginning 1 October 2006, the available transfer capability of the Interior-Lower Mainland grid is increased by 500 MW with the addition of the Guichon Series capacitor in the Kelly Lake-Nicola line and mechanically switched capacitor banks at the Ingledow Substation in the fall of 2006. The study results are shown in Appendix A.

Studies have found that there is no requirement to install the Kelly Lake reactor in 2002 assuming that sufficient Burrard units are available as synchronous condenser operation during light load periods. Three equivalent Burrard synchronous condensers are required from 2006 to 2009 inclusive and two equivalent Burrard synchronous condensers are required thereafter as ancillary service (equivalent to Reactive Supply and Voltage Control, Schedule 3004) to provide this transmission service.

4. Network Upgrade and Direct Assignment Facilities

The required Network Upgrades along with the schedules and costs that include overheads, interest during construction, loading, and inflation are shown in Appendix B.

As there were no generation Interconnection Studies performed, the Direct Assignment Facilities associated with this request for Transmission Service have not been identified.

5. Project and Transmission Service Risks

This Facilities Study contains some uncertainty in the plan, reinforcement, and costs.

6. Conclusions

The required Network Upgrades and scheduled completion dates are as follows:

1. Interior to Lower Mainland Bulk Transmission
A new 50% compensated 3000 A Guichon Series Capacitor Station in 5L87 (between Nicola and Kelly Lake Substations) on 1 October 2006 (earliest in-service), and two 230 kV 190 MVAR mechanically switched shunt capacitors at Ingledow Substation on 1 October 2006.
2. South Interior West Bulk Transmission
Add a 500 kV 150 MVAR shunt capacitor at Ashton Creek Substation and reconfigure the Nicola 500 kV Station on 1 October 2006.
3. Central Interior North Bulk Transmission
Refurbish the McLeese I and II Series Capacitor Stations to 25% series compensation on the 500 kV Williston-Kelly Lake 5L11 & 5L12 lines on 1 October 2006 (to coincide with Guichon's in-service).

The available transmission capability for this long-term firm transmission service request is 500 MW from 1 October 2006 until 31 December 2020.

As there were no generation Interconnection Studies performed, the Direct Assignment Facilities associated with this request for Transmission Service have not been identified.

Appendix B contains the Network Upgrade facilities costs and schedules.

Appendix A.
System Studies

A.1 Interior to Lower Mainland

Thermal and load flow studies have shown that Guichon series capacitor bank and the mechanically switched capacitors at Ingledow will increase the transfer capability of the Interior to Lower mainland grid at the Nicola Substation by 550 MW in 2006/07. This transfer capability is shown in Figures 1 without Guichon and Figure 2 with Guichon.

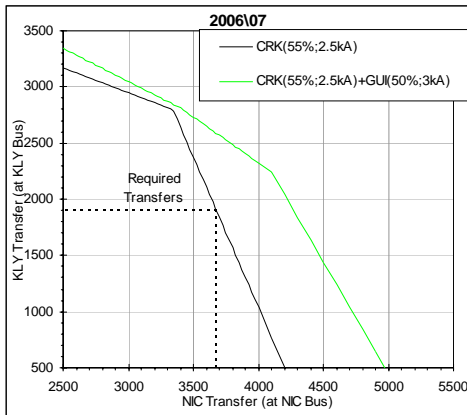


Figure 1: Transfer Capability without Guichon

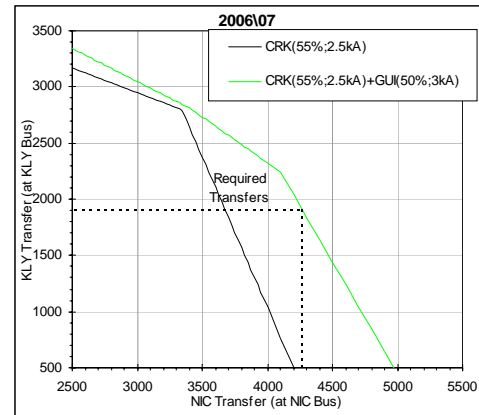


Figure 2: Transfer Capability with Guichon

However, losses in the Interior to Lower Mainland system during a line outage will result in an export capability at Ingledow Substation of 500 MW.

The size of the mechanically switched capacitors was determined by comparing the incremental var requirement during a line outage with and without the additional transfer in 2006. The incremental var requirement was 380 Mvars that can be supplied by two MSCs at Ingledow.

Transient stability studies were done for simultaneous outages of 5L81 and 5L82 in the year 2009. The total flow on 5L81/82/87 was 4330 MW and the flow on 5L81/82 was 3394 MW. The system was stable when 2390 MW of South Interior generation was dropped.

Upgrading American Creek I & II Series Capacitor Stations to 3000 A to further increase the transfer capability after Guichon is built was also considered. However, this upgrade does not add significant transfer capability benefits for new generation in the South Interior.

A.2 Central Interior North

The McLeese Series Capacitors #1 & 2 are nearing end of life and their PCB capacitor must be retired by 2003. Studies have shown that the transmission system between Nicola and Kelly Lake substations cannot meet BC Hydro's planning criteria during light and medium loads and full Peace generation. An outage of 5L13 without McLeese Series Capacitor banks # 1 and 2 is transiently unstable. A double line outage of 5L13 and 5L11

without the series capacitors was stable if 7 units or 1950 MW of GMS generation was dropped. To meet BC Hydro's planning criteria performance of no loss of load or generation during stressed conditions and a single contingency, McLeese Series Capacitor Banks #1 and 2 will have to be replaced to provide this export service.

A.3 South Interior West

Previous studies have demonstrated that with the Ashton Creek shunt capacitor addition, the South Interior West system will be able to accommodate the identified resource additions for this request for Transmission Service.

Nicola is a 500 kV switching station in the South Interior connecting 500 kV lines from Mica, Revelstoke generating stations, and the Lower Columbia regions to lines leading to the Lower Mainland. Nicola has been developed as a 1-1/3 circuit breaker station configuration. Studies have shown that there are disturbances that may pose a significant risk to system security especially during higher transfer levels.

There are potentially six extreme disturbance events (WSCC category D) that can occur during certain station network topologies (station elements out of service) and subsequent line or station element outages. Category "D" WSCC performance events are the most severe type of performance event of the WSCC four categories of performance levels.

For this transmission request, new generation as specified in the request for Transmission Service increases the consequences of these disturbances by utilizing more of the line capability. As well, other generation in the Lower Columbia region and imports at Nelway and Cranbrook substations will exacerbate this situation. Thus, the Nicola station needs to be reconfigured to reduce the probability of the high consequence disturbances and/or to reduce the consequences.

A detailed study of the Nicola station is required to determine the optimum re-configuration to undertake. In the absence of a detailed study, it is assumed that two bus sectionalizing circuit breakers will be adequate to mitigate the severity of the anticipated performance events.

A.4 Kelly Lake Reactor Requirements

The SIS studies identified the need for the Kelly Lake reactor to control overvoltages during a loss of the Intertie. This study found that this reactor is not required because only 500 MW of the original 1000 MW request can be provided.

Appendix B.

Network Upgrade Facilities

B.1 Guichon Series Capacitor Station

B.1.1 Project Description

Guichon is a proposed 500 kV Series Capacitor Station to be located at approximately the mid-point of 5L87 between Nicola and Kelly Lake Substations to increase the power transfer capability of the Interior to Lower Mainland transmission grid by about 550 MW. The station characteristics are:

Compensation	50%
Series reactance	23.82 ohms
Nameplate current rating	2727 A
Continuous overload rating	3000 A (8 hrs in 12 hrs)
Reactive Rating	531.4 MVAR (177 MVAR per phase)
Bank Configuration	MOV plus trigger gap
Nom. operating voltage	500 kV
Max. continuous voltage	550 kV

B.1.2 Schedule

Start date is 1 April 2001; completion by 1 October 2006.

B.1.3 Project Risks

Regulatory approvals and public consultation to be undertaken are extensive and could impact directly on the project schedule.

B.2 Mechanically Switched Shunt Capacitor at Ingledow

B.2.1 Project Description

Install two 230 kV, 190 MVAR shunt capacitor banks, separately switchable, supplied from the Ingledow 230 kV main bus through two 230 kV circuit breakers with associated protection, control and communications.

B.2.2 Schedule

Both capacitor banks in service coinciding with Guichon series capacitor station. Project should start two years in advance of in-service date.

B.2.3 Project Risks

There are no significant risks associated with the shunt capacitor projects.

B.3 Refurbish McLeese I & II Series Capacitor Stations

B.3.1 Project Description

Technical data of the capacitor banks at McLeese station		
Bank	5CX1- 25% compensation	5CX2- 25% compensation
Rated Output	308 Mvar	308 Mvar
Rated Current	1950 A	1950 A
Reactance at 20 deg C	27.0 ohms	27.0 ohms

B.3.2 Schedule

The start date is 1 April 2003; completion by 2006

B.4 Shunt Capacitor at Ashton Creek

B.4.1 Project Description

500 kV 150 MVAR shunt capacitor at Ashton Creek substation.

B.4.2 Schedule

The initiation of the project is April 2004 with completion scheduled for October 2006.

B.4.3 Project Risks

There are no significant risks associated with shunt capacity project.

B.5 Nicola Station Configuration

B.5.1 Project Description

The Nicola station needs to be reconfigured to reduce the probability of the high consequence disturbances and/or to reduce the consequences. In the absence of a detailed study, it is assumed that two bus sectionalizing circuit breakers will be adequate to mitigate the severity of the anticipated performance events.

B.5.2 Schedule

The in-service date for the re-configuration is summer 2006. The recommended start for detailed station configuration/reliability studies is 2002, with one year for studies,

one year for developing detailed cost estimates and two years for equipment ordering and construction.

B.5.3 Project Risks

Most of the project risks have been accounted for by allowing more time for studies and for developing detailed cost estimates. However, there remains some likelihood that a proper station reconfiguration will not be found.

B.6 Costs

Project	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	Total
Guichon Series Capacitor Station	278	1224	711	2203	559	16693	21,668
Ingledow Shunt Capacitor #1 & 2				556	1080	7692	9,328
McLeese 1 & 2 Series Capacitor Station			2021	2822	16161	10403	31,407
Ashton Creek Shunt Capacitor		0		435	607	4977	6,019
Nicola Station Reconfiguration		286	633	557	488	7367	9,331
Total (\$k)	278	1,510	3,365	6,573	18,895	47,132	77,753