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

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T&D Engineering
& Grid Operations

T&D ENGINEERING

Executive Summary

On 1 March 2000 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.

The 31 January 2001 "Facilities Study for Power Supply 1000 MW Export on the BCHA × BPAT Path" identified the required modifications to T&D's Transmission System that were able to provide 500 MW of the requested transmission service.

In response to transmission customer requests, the 28 February 2002 "System Impact Study for Increased Interior to Lower Mainland Transfer (without new transmission line)" identified extraordinary Network Upgrades that provided approximately 1090 MW of additional ATC.

This Further Facilities 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 the remaining 500 MW of Power Supply's transmission service request.

The required incremental Network Upgrades, and scheduled completion dates for the remaining 500 MW of Power Supply's transmission service request are as follows:

- *Series capacitor banks on 5L81 and 5L82 upgraded for 3.3 kA operation*
- *Series capacitor bank on 5L87 upgraded for 3.0 kA operation*
- *Series capacitor banks on 5L41 and 5L42 upgraded for 3.0 kA operation*
- *Summer ratings of 5L81 and 5L82 restored to 3.37 kA*
- *Summer ratings of 5L40, 5L41, 5L42 and 5L44 upgraded to 3.0 kA*
- *Summer ratings of 2L1, 2L2, 2L90 and 2L91 upgraded up to 2 kA*
- *Addition of –200 to +300 MVAr SVC at Ingledow 500 kV Station*
- *Addition of 3 × 250 MVAr and 3 × 250 MVAr mechanically switched shunt capacitors at Ingledow 500 kV Station and Meridian 500 kV Station*
- *Addition of 1 × 250 MVAr mechanically switched shunt capacitors at Nicola 500 kV Station*
- *Replace 5L81 and 5L82 3.0 kA circuit breakers (5CB12, 5CB18, 5CB22 & 5CB28 at Nicola Station; 5CB9 & 5CB10 at Ingledow Station; and 5CB7 & 5CB8 at Meridian Station) with 4.0 kA circuit breakers*

- *Replace 5L40 and 5L44 2.0 kA circuit breakers (5CB7, 5CB8 & 5CB11 at Ingledow Station) with 3.0 kA circuit breakers salvaged from the item above*
- *Upgrade/Modify Remedial Action Schemes for Undervoltage-Load-Shedding, Direct Load Shedding, and Transfer Trip.*

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

The remaining 500 MW of Power Supply's transmission service request will be available in July 2006. The earliest possible in-service date of Network Upgrades is considered to be 31 December 2004.

Appendix A contains the Network Upgrade facilities costs and schedules for providing the remaining 500 MW of transmission service.

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1. Introduction

On 1 March 2000, 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.

The 28 February 2002 "System Impact Study for Increased Interior to Lower Mainland Transfer (without new transmission line)" identified extraordinary Network Upgrades that provided approximately 1090 MW of additional ATC.

This Further Facilities 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 complete Power Supply's transmission service request.

2. Terms of Reference

This Facilities Study is to determine the cost and schedule of the required Network Upgrades to complete Power Supply's transmission service request.

3. System Study Results

The expected sequence of Network Upgrades and ATC of the BCHA × BPAT path for the Power Supply 1000 MW transmission service request are:

- 1 January 2002: No Network Upgrades in-service – ATC is 0 MW
- 1 July 2003: McLeese I & II series capacitor banks in-service – ATC is 500 MW for the Summer and Fall
- 1 November 2003: Guichon series capacitor bank in-service – ATC is maintained at 500 MW for the Winter and beyond
- 1 July 2006: Remainder of Network Upgrades in-service – ATC is increased to 1000 MW for the Winter and beyond.

The earliest possible in-service date for the Network Upgrades is considered to be 31 December 2004.

4. Network Upgrade and Direct Assignment Facilities

The required Network Upgrades facilities costs and schedules for providing the remaining 500 MW of transmission service are shown in Appendix A.

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

5. Project and Transmission Service Risks

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

6. Conclusions

The required incremental Network Upgrades, and scheduled completion dates for the remaining 500 MW of Power Supply's transmission service request are as follows:

- Series capacitor banks on 5L81 and 5L82 upgraded for 3.3 kA operation
- Series capacitor bank on 5L87 upgraded for 3.0 kA operation
- Series capacitor banks on 5L41 and 5L42 upgraded for 3.0 kA operation
- Summer ratings of 5L81 and 5L82 restored to 3.37 kA
- Summer ratings of 5L40, 5L41, 5L42 and 5L44 upgraded to 3.0 kA
- Summer ratings of 2L1, 2L2, 2L90 and 2L91 upgraded up to 2 kA
- Addition of –200 to +300 MVAr SVC at Ingledow 500 kV Station
- Addition of 3 × 250 MVAr and 3 × 250 MVAr mechanically switched shunt capacitors at Ingledow 500 kV Station and Meridian 500 kV Station
- Addition of 1 × 250 MVAr mechanically switched shunt capacitors at Nicola 500 kV Station
- Replace 5L81 and 5L82 3.0 kA circuit breakers (5CB12, 5CB18, 5CB22 & 5CB28 at Nicola Station; 5CB9 & 5CB10 at Ingledow Station; and 5CB7 & 5CB8 at Meridian Station) with 4.0 kA circuit breakers
- Replace 5L40 and 5L44 2.0 kA circuit breakers (5CB7, 5CB8 & 5CB11 at Ingledow Station) with 3.0 kA circuit breakers salvaged from the item above
- Upgrade/Modify Remedial Action Schemes for Undervoltage-Load-Shedding, Direct Load Shedding, and Transfer Trip.

The available transmission capability for this long-term firm transmission service request is 500 MW from 1 July 2003 to 30 June 2006 and 1000 MW from 1 July 2006 until 31 December 2020.

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

Appendix A contains the Network Upgrade facilities costs and schedules.

Appendix A.

Network Upgrade Facilities

A.1 Guichon Series Capacitor Station

A.1.1 American Creek I & II Series Capacitor Stations on 5L81 & 5L82

Upgrade American Creek I & II Series Capacitor Stations by installing a second set of platforms and distributing the capacitors equally between them. The characteristics of each segment are:

Compensation	47/49%
Series reactance	40 ohms
Nameplate current rating	3000 A
Continuous overload rating	3300 A (8 hrs in 12 hrs)
Reactive Rating	654 MVAR
Bank Configuration	MOV gapless (approx 100 MJ per platform)
Nom. operating voltage	500 kV
Max. continuos voltage	550 kV

Provide new protection and control for equipment on new platforms, and replace existing protection and control on the existing platforms. Provide transfer trip facilities for the new bypass breakers associated with the second platform, and breaker failure signals to Ingledow and Nicola Stations for AMC I and to Meridian and Nicola Stations for AMC II. Reconfigure transfer trip facilities related to generation shedding associated with the new bypass CBs equivalent to what exists today.

Add local and remote Control and Indication for the new bypass CBs, and revise SCADA.

A.1.2 Guichon Series Capacitor Station on 5L87

This reinforcement was identified in the initial Facilities Study with a Nameplate current rating of 2727 A. In optimizing the costs and performance of the reinforcement, the scope of the project was reduced to an optimal 2400 A Nameplate current rating. However, with an incremental 500 MW of transfer, the Nameplate current rating will have to revert back to 2727 A.

Project has already started as it had been identified in the initial Facilities Study.

A.1.3 Chapmans Series Capacitor Stations on 5L41

Upgrade Chapmans Series Capacitor Stations by reconnecting existing capacitors on one set of platforms and provide additional capacitors on separate platforms to

increase the rating with no change to compensation level. The station characteristics are:

Compensation	57%
Series reactance	51.4 ohms
Nameplate current rating	2730 A
Continuous overload rating	3000 A (8 hrs in 12 hrs)
Reactive Rating	1147 MVAR (550 & 600 MVAR per segment)
Bank Configuration	MOV gapless (approx 100 MJ per platform)
Nom. operating voltage	500 kV
Max. continuos voltage	550 kV

Provide new protection and control for equipment on new platforms, and using existing protection and control on the existing platforms. Provide transfer trip facilities for the new bypass breakers associated with the second platform, and breaker failure signals to Clayburn and Kelly Lake Stations. Reconfigure transfer trip facilities related to generation shedding associated with the new bypass CBs equivalent to what exists today.

A.1.4 Creekside Series Capacitor Stations on 5L42

Upgrade Creekside Series Capacitor Stations by reconnecting existing capacitors on one set of platforms and provide additional capacitors on separate platforms to increase the rating with no change to compensation level. The station characteristics are:

Compensation	55%
Series reactance	36.8 ohms
Nameplate current rating	2730 A
Continuous overload rating	3000 A (8 hrs in 12 hrs)
Reactive Rating	803 MVAR (~520 & 280 MVAR per segment)
Bank Configuration	MOV gapless (~100 MJ per platform)
Nom. operating voltage	500 kV
Max. continuos voltage	550 kV

Provide new protection and control for equipment on new platforms, and using existing protection and control on the existing platforms. Provide transfer trip facilities for the new bypass breakers associated with the second platform, and breaker failure signals to Cheekye and Kelly Lake Stations. Reconfigure transfer trip facilities related to generation shedding associated with the new bypass CBs equivalent to what exists today.

Add local and remote Control and Indication for the new bypass CBs, and revise SCADA.

Add local and remote Control and Indication for the new bypass CBs, and revise SCADA.

A.2 Transmission Line Upgrades

A.2.1 Upgrade 5L81 and 5L82

Upgrade the contingency summer rating of 5L81 and 5L82 to 3.37 kA. The lines can be upgraded by raising existing towers, adding new towers and where practical recountouring the right-of-way.

- 5L81: 12 months project duration & 2 weeks outage duration.
- 5L82: 3 months project duration & no outage duration.

A.2.2 Upgrade 5L40, 5L41, 5L42 and 5L44

Upgrade the contingency summer rating of 5L40, 5L41, 5L42 and 5L44 to 3.0 kA. The four lines can be upgraded by raising existing towers, adding new towers and where practical recountouring the right-of-way.

- 5L40: 8 months project duration & 3 weeks outage duration.
- 5L41: 12 months project duration & 1 week outage duration.
- 5L42: 8 months project duration & 1 week outage duration.
- 5L44: 10 months project duration & 1.5 weeks outage duration.

A.2.3 Upgrade 2L1, 2L2, 2L90 and 2L91

Upgrade the summer rating of 2L1 to 0.98 kA, 2L2 to 1.98 kA, and 2L90 and 2L91 to 0.7 kA.

- 2L1: upgrade the clearances at 12 locations (assumes mobilization is in place).
- 2L2: reconductor a 1 km section and upgrade the clearance at 2 locations (assumes mobilization is in place).
- 2L90 and 2L91: initial assessments required although no major work is anticipated.

A.3 SVC and CX Additions

A.3.1 Ingledow SVC

Add SVC rated -200 to +300 MVARS connected to the Ingledow Station 500 kV bus.

Protection of the SVC and associated transformer will be provided as part of the SVC itself. Provide local and remote control additions, from both SCC and relevant ACC, for new MODS and CBs for the SVC 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, TSA and RAS setup scheme. Revise RAS systems at the stations to add more initiating signals. At Mica and Revelstoke Generating Stations, provide redundant Generation Shedding Setup Panels.

A.3.2 Ingledow, Meridian, and Nicola 500 kV Shunt Capacitor Banks

These reinforcements replace the Ingledow and Ashton Creek shunt capacitors identified in the initial study. Add 500 kV, 250 MVAR switchable shunt capacitor banks at Ingledow (3), Meridian (3), and Nicola (1) Stations.

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. One capacitor bank at Ingledow Station will be reserved for switching by the new SVC. One capacitor bank at Meridian Station will be reserved for switching by the Burrard Station SCs.

At SCC revise SCADA/EMS power system models to include the new equipment. Also revise network application functions including DTS, VSA, TSA and RAS setup scheme. Revise RAS systems at the stations to add more initiating signals.

A.4 CB Replacements

Upgrade 5L81 and 5L82 line positions at ING, MDN and NIC to 4000 A continuous.

- Upgrade MDN 5CB7 and 8 and associated equipment (between 5MB1 and 2) to 4 kA continuous.
- Upgrade ING 5CB9 and 10 and associated equipment (between 5MB1 and 2) to 4 kA continuous.
- Upgrade NIC 5CB12 and 22 and associated equipment (between 5MB1 and 3) to 4 kA continuous.
- Upgrade NIC 5CB18 and 28 and associated equipment (between 5MB2 and 4) to 4 kA continuous.
- Replace ING 5CB7, 8 and 11 with 3 kA CBs released from ING 5CB9 and 10 and MDN 5CB7 or 8.

Revise 5L81 and 5L82 protection to suit. Replace 5L44 protection with new protection capable of single pole trip and reclose.

At ING and MDN add a control & indication point for Single Pole Reclose ON/OFF. Add alarm(s) as required. At ING, MDN and NIC add alarms if new type of CBs require additional alarms.

A.5 Remedial Action Scheme Upgrades

Upgrade/modify Remedial Action Schemes for Undervoltage-Load-Shedding, Direct Load Shedding for N-2 events, and Transfer Trip of 2L27 to protect 2L22 and 2L27 from thermal overload.

A.6 Costs and Schedules

The $k costs below are Capital Direct with T&D External Loadings and have an accuracy of –15% & +30%.

Description	Total	02/03	03/04	04/05	05/06	06/07
AMC (5L81) upgraded to 3.0 kA nominal	11216	664	1995	8558		
AMC (5L82) upgraded to 3.0 kA nominal	10617	550	1657	8411		
GUI (5L87) upgraded to 2.73 kA nominal	1837	735	1102			
CHP (5L41) upgraded to 2.73 kA nominal	8061		374	1264	6424	
CRK (5L42) upgraded to 2.73 kA nominal	6405		415	1236	4754	
5L81 restored to 3.37 kA Summer	2963	849	2114			
5L82 restored to 3.37 kA Summer	293	293				
5L40 upgraded to 3.0 kA Summer	1085	386	698			
5L41 upgraded to 3.0 kA Summer	3106	1115	1991			
5L42 upgraded to 3.0 kA Summer	1002	359	642			
5L44 upgraded to 3.0 kA Summer	1973	703	1269			
2L1 upgraded to 0.98 kA Summer	293	293				
2L2 upgraded to 1.98 kA Summer	195	195				
2L90 upgraded to 0.63 kA Summer	246		121	126		
2L91 upgraded to 0.63 kA Summer	197		97	100		
ING -200/+300 MVAR 500 kV SVC	29619	1051	3412	25155		
ING 3 x 250 MVAR 500 kV CX	9174			753	2089	6332
MDN 3 x 250 MVAR 500 kV CX	8540		1185	3847	3508	
NIC 1 x 250 MVAR 500 kV CX	3083			208	692	2184
ING 2 x 4 kA CB	4406	481	1401	2524		
MDN 2 x 4 kA CB	3401			449	1474	1478
NIC 4 x 4 kA CB	8266			366	1238	6662
ING 3 x 3 kA CB	3678		409	1186	2083	
Upgrade/Modify RAS	1500			600	900	
Totals	**121155**	**7674**	**18882**	**54782**	**23162**	**16656**