# System Impact Study

**Long Term Point-To-Point OASIS Request**
**AREF: 94879734**
**On the GMS.MCA.REV to BC.US.BORDER Path**

**October 1, 2022 to October 1, 2027**

BC Hydro EGBC Permit to Practice No: 1002449

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**Report No: Transmission Planning 2022-15**
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BC Hydro
Power smart

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# ACKNOWLEDGEMENTS

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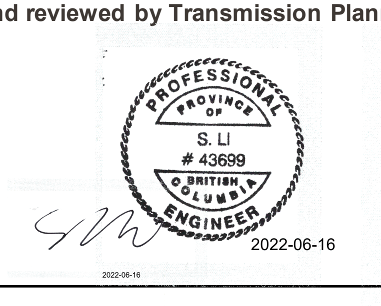


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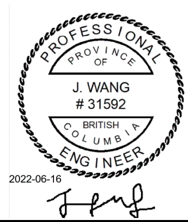


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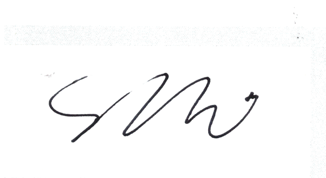


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# Revisions

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| 0 | 2022 May | Initial release |
| 1 | 2022 Jun | Clarifications added on Pages 2&4 |

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# Executive Summary

Pursuant to BC Hydro OATT Section 19, 700 MW of Long Term Firm Point-to-Point (LTFPTP) transmission service request (TSR) with OASIS AREF# 94879734 has been studied:

| | |
|---|---|
| **OASIS #** | 94879734 |
| **Point of Receipt** | GMS.MCA.REV |
| **Point of Delivery** | BC.US.BORDER |
| **Amount Requested** | 700 MW |
| **Start Time** | 2022-10-01 |
| **Stop Time** | 2027-10-01 |
| **Term** | 5 Years |
| **Submission Date** | 2021-09-01 |

The System Impact Study (SIS) identifies the system issues and potential upgrades necessary to facilitate this transmission service request (in full or in part) while maintaining or improving system reliability.

This SIS concludes the following with reference to the BC Hydro transmission system:

1. The 700 MW Service with OASIS AREF# 94879734 cannot be accommodated in whole as Long Term Firm transmission service without system upgrades.
2. 410 MW of Long-Term Firm Point-to-Point Partial Service from GMS.MCA.REV to BC.US.BORDER can be accommodated without the necessary system upgrades identified in this study. The amount of Partial Service to be granted was based upon a change to the Base Resource Plan (BRP) as detailed in Section 7.
3. To accommodate all 700 MW of Transmission Service, the series capacitors on 5L41, 5L42 and 5L82 need to be upgraded to a continuous rating of 3000 A. However, the possible earliest in-service date (ISD) of these system upgrades is winter 2026. Therefore, a full accommodation of the 700 MW LTFPTP service is not achievable for the entire service period requested.

BC Hydro (Transmission Provider) will tender a Service Agreement for Partial Service of 410 MW to the Transmission Customer on May 26, 2022. The Transmission Customer must respond to the Transmission Provider within 15 days, by June 9, 2022 with an executed Service Agreement for Partial Service, should the Transmission Customer elect to take partial service.

# ACRONYMS

The following are acronyms used in this report for BC Hydro's three letter codes and the planning regions.

| | |
|---|---|
| GMS | Gordon M. Shrum Generating Station |
| PCN | Peace Canyon Generating Station |
| STC | Site C Generating Station |
| WSN | Williston Substation |
| KLY | Kelly Lake Substation |
| MDN | Meridian Substation |
| CKY | Cheekye Substation |
| ING | Ingledow Substation |
| NIC | Nicola Substation |
| CUS | Custer Substation in US |
| REV | Revelstoke Generating Station |
| MCA | Mica Creek Generating Station |
| ACK | Ashton Creek Substation |
| SEL | Selkirk Substation |
| VAS | Vaseaux Lake Substation |
| CHP | Chapmans Series Capacitor Station |
| CRK | Creekside Series Capacitor Station |
| AMC | American Creak Series Capacitor Station |

| | |
|---|---|
| NI | North Interior |
| SI | South Interior |
| LM | Lower Mainland |
| LMVI | Lower Mainland and Vancouver Island |

| | |
|---|---|
| LTFPTP | Long Term Firm Point-to-Point Transmission Service |
| OATT | Open Access Transmission Tariff |

# 1. Introduction

Pursuant to BC Hydro Open Access Transmission Tariff (OATT) Sections 17.1, 17.2, and 17.3, the Transmission Service Request (TSR) with OASIS AREF# 94879734 was submitted by the Transmission Customer, BC Hydro Power Supply (BCPS), to the Transmission Provider, British Columbia Hydro and Power Authority (BC Hydro). The Application was accepted and deemed complete. An excerpt of the key information is as follows, with the full details shown in Appendix A.

**Table 1-1: OASIS AREF 94879734**

| | |
|---|---|
| **OASIS #** | 94879734 |
| **Point of Receipt (POR)** | GMS.MCA.REV |
| **Point of Delivery (POD)** | BC.US.BORDER |
| **Amount Requested** | 700 MW |
| **Start Time** | 2022-10-01 |
| **Stop Time** | 2027-10-01 |
| **Term** | 5 Years |
| **Submission Date** | 2021-09-01 |

In accordance with the BC Hydro OATT Sections 19.1 and 19.2, BC Hydro (Transmission Provider) determined that a System Impact Study (SIS) was needed to accommodate the requested service. BC Hydro informed BCPS (Transmission Customer) on September 2, 2021, and subsequently a System Impact Study Agreement was executed on September 13, 2021.

This SIS studies the incremental impact of the 700 MW export on the BC Hydro transmission grid. This 700 MW export is in addition to the current transmission commitments, which includes:

- The Network Integration Transmission Service (NITS) that serves the domestic loads.
- The pre-existing Long Term Firm Point-to-Point (LTFPTP) transmission service agreements.

The current transmission commitments above have been accommodated as specified in BC Hydro's Generation Dispatch in Transmission Planning (GDTP) Guideline, which was filed with BCUC in BC Hydro's 2021 Integrated Resource Plan Application Appendix H-3, section 2[1].

The outcomes indicate whether the 700 MW requested in the TSR can be granted without system reinforcements; and if system reinforcements are required, how much partial Long Term Firm Point-to-Point transmission service can be made available for the period requested in the TSR before system reinforcements are added.

# 2. Study Scope

The SIS only determines, under specified assumptions and limitations, whether 700 MW of transmission capacity is available, and if not, what network upgrades will be needed to provide that transfer capacity for the duration of the transmission service request. The SIS does

[1] The GDTP Guideline suggests that there is no immediate need to expand the transmission system to deliver the system surplus generation to serve the loads, which sets out the minimum transmission capability under a range of system conditions. In compliance with the GDTP requirements, generation re-dispatch after single system contingencies become necessary to adequate serve the current transmission commitments and the 700 MW LTFPTP service in this request. See pages 1282 to 1290 of PDF: https://docs.bcuc.com/Documents/Proceedings/2021/DOC_65194_B-1-BCH-IntegratedResourcePlan-Public.pdf

not determine nor guarantee the availability of generation resources should a transmission service agreement be executed. It is up to the Transmission Customer (BCPS) of the executed Service Agreement to provide the generation resources.

In accordance with the System Impact Study Agreement and BC Hydro OATT Section 19.3, this System Impact Study identifies the following to accommodate the Transmission Service Request:

- any transmission system constraints
- additional necessary Network Upgrades
- amount of partial service to be offered should the full amount of the request cannot be accommodated

Note that the study analyzed the BCH System only. A study of transfer limits in the neighboring systems is not within the scope of this study. **Customers requesting these services are responsible for obtaining transmission service from the neighboring Transmission Service Providers.**

# 3. Planning Criteria and Study Methodology

## 3.1. Planning Standards and Criteria

BC Hydro follows the general methodology outlined in BC Hydro's OATT Attachment D, *Methodology for Completing a System Impact Study*, as shown in Appendix B of this report.

BC Hydro performs this SIS to determine the impact of the requested transmission service on the BC Hydro transmission System in accordance with the following standards and criterion.

1. NERC Standard TPL-001-4 Standard
2. WECC Criterion TPL-001-WECC-CRT-3.2

To supplement the planning standard and criteria, BC Hydro's TPL-001-4 Study Methodology documents (Report No: T&S-Planning 2020-003 and T&S-Planning 2020-004) are also used in this SIS.

This SIS reviews the limiting factors including branch loading, voltage performance, voltage stability and transient stability limits under both normal and contingency conditions.

This SIS considers the following categories of contingencies:

- System normal or N-0 (Planning Event P0 in TPL-001-4)
- Single contingencies or N-1 (Planning Events P1 and P2 in TPL-001-4)
- Multiple contingencies (Planning Events P3 to P7 in TPL-001-4)

## 3.2. Generation Dispatch Methodology

In addition to the above NERC standard and the WECC criterion, the BC Hydro's Generation Dispatch in Transmission Planning (GDTP) Guideline is adopted for setting up the generation dispatch scenarios, which is used in this specific study for this Transmission Customer.

The GDTP Guideline specifies the generation dispatch scenarios that need to be implemented for three types of cut-planes, i.e., source, network and load cut-planes. The ones of interest for this SIS are the source and network cut-planes only, as follows:

Source cut-planes:

Cut-plane 1 - South of GMS/PCN

Cut-plane 2 – South of Williston

Network cut plane:

Cut plane 9 – Interior to Lower Mainland (ILM)

This SIS follows the GDTP principles listed below to set up generation dispatch scenarios for the ILM.

1. Under both N-0 and N-1 conditions, the ILM must be capable of serving the Lower Mainland and Vancouver Island (LMVI) peak load with the specified coastal generation scenario[2].

2. Under N-0 condition, the ILM must have the capability to transfer either the maximum North Interior generation or South Interior generation from the source side to the load side.

3. Under N-1 condition, the ILM must be capable of serving the LMVI peak loads with the following conditions:
   - for a single line outage on KLY-LM, 12% of the total generating capacity in the South Interior region is set to be out of service.
   - for a single line outage on NIC-LM, 12% of the total generating capacity in the North Interior region is set to be out of service.

Surplus generation as described in the GDTP is a key driver of the outcomes in this study. The GDTP states that when there is surplus generating capacity, there is no immediate need to expand the transmission system to deliver that surplus generation to serve the load. That is, when the transmission system performance becomes inadequate following a contingency, generation re-dispatch from one region to another (limited up to the surplus generation capacity) can be used to mitigate the inadequacy concern. For example, if there is a constraint identified after one of the Peace-to-Williston lines is in outage, generation re-dispatch from the North Interior to South Interior region may be used to alleviate the constraint. The maximum amount of generation re-dispatch allowed is limited to the surplus generation capacity available in the BC Hydro system. Refer to Section 5.1.1 for the detailed analysis.

Table 3-1 shows the surplus generation before and after addition of the requested 700 MW LTFPTP transmission service. The pre-LTFPTP surplus generation is duplicated from the NITS Base Resource Plan (BRP) r12 used in this SIS. The post-LTFPTP surplus generation is derived by subtracting 700 MW plus the associated loss from the pre-LTFPTP surplus generation column.

**Table 3-1: Surplus Generation Used in This SIS**

| Fiscal Year | Pre-LTFPTP Surplus Generation (MW) | Post-LTFPTP Surplus Generation (MW) |
|---|---|---|
| F2023 | 1014 | 258 |
| F2024 | 809 | 523 |
| F2025 | 674 | -82 |
| F2026 | 1336 | 580 |
| F2027 | 1423 | 667 |
| F2028 | 959 | 203 |

Note that the table above pertains to the winter peak load conditions only. However, the surplus generation in summer load conditions is not available for the study purpose. It can be expected that the system surplus generation in summer is significantly higher than those listed in Table 3-1 as the summer peak load in the BC Hydro system is much lower than its winter peak in a range of 2000 MW. As mentioned in Section 2, it is up to the Transmission Customer to provide adequate generation resources for this transmission service request, and the generation resources .

# 4. System Study Conditions

In this SIS, a range of system conditions and factors were considered when assessing the impact of the requested LTFPTP transmission service on BC Hydro's transmission system, which include, but are not limited to, relevant load forecasts, system interchanges, resource plans, generation dispatch scenarios, and in-plan transmission capital projects.

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[2] For the resource plan considered in this SIS, the largest load-side generator in the LMVI area (a 275 MW unit) is turned off to create the generation dispatch scenario required in the GDTP. With the turn-off, the Planning Event P3 as defined in NERC TPL-001-4 is inherently satisfied when assessing the first single contingency.

The study period mirrors the Start Time and Stop Time of TSR 94879734, from October 2022 to October 2027. Study cases for both winter and summer are included. The winter cases represent system conditions from November to April and the summer cases represent conditions from May to October.

## 4.1. Resource Plan

The study is performed based on the BC Hydro NITS Base Resource Plan (BRP) released on March 5, 2021 (referred to NITS BRP r12). The available resources in NITS BRP r12 inform the generation dispatch scenarios in this SIS.

Site C is the major capital project that will add a total of 1145 MW of generating capacity in the Peace region, and will enter service by the end of 2025.

Per the NITS BRP r12, one of MCA units is scheduled to be out of service from March 1 to December 1, 2027. During the MCA unit's down time, the total generation capacity in the South Interior will drop by approximately 431 MW.

## 4.2. Load Forecasts

The BC Hydro Dec 2020 System Reference Load Forecast and Aug 2021 Distribution Substation Load Forecast were used in this SIS. Note that the Aug 2021 Distribution Substation Load Forecast contains an improvement of power factors in comparison to previous years' load forecast.

## 4.3. System Interchanges

The pre-existing power interchanges (Committed Long Term Firm Point-to-Point transmission service) between the BC Hydro system and the neighboring utilities are modelled as follows:

1. BC Hydro to US (ING-CUS)[3]: 230 MW
2. Alberta to BC Hydro[4]: 0 MW
3. BC Hydro to Fortis BC: 280 MW

## 4.4. Transmission Capital Projects

The study cases used in this SIS include all the existing transmission facilities and the in-plan transmission capital projects. Three of the in-plan transmission capital projects that are most relevant are listed below.

[3] 50 MW is used as Transmission Reliability Margin (TRM) on the BC Hydro to US transfer path, i.e., WECC Path 3.

[4] The interchange on the BC Hydro to Alberta transfer path, i.e., WECC Path 1, is set at zero upon a coordinated arrangement by the Transmission Customer.

1. **Burrard Synchronous Condensers Ceasing Operation**
   Burrard synchronous condenser station (BSY) currently has three operable units. These units are near their end-of-life and are scheduled to cease operation by winter 2025.

2. **Lower Mainland Capacitive and Reactive Power Reinforcement (LMCRPR)**
   The LMCRPR project will provide reactive power supports to the Lower Mainland system after Burrard synchronous condensers cease operation. The leading alterative of adding several 230 kV shunt capacitors and reactors was used in the SIS. The scheduled in-service date (ISD) of the LMCRPR project is winter 2025, following the completion of the following activities:

   - Installation of 2 x 132 MVAr of mechanically switched shunt reactors at MDN 230 kV Bus.
   - Installation of 1 x 125 MVAr of mechanically switched shunt capacitor banks at CBN 230 kV Bus.
   - Installation of 2 x 125 MVAr of mechanically switched shunt capacitor banks at ING 230 kV Bus.
   - Installation of 1 x 125 MVAr of mechanically switched shunt capacitor banks at MLN 230 kV Bus.

3. **Kelly Lake Substation (KLY) New Reactor Addition**
   KLY Synchronous Condenser (SC2) is near the end-of-life and the recommended option to replace the KLY SC2 is to install a new 75 MVA, 12 kV switchable shunt reactor at the same station. The scheduled in-service date (ISD) for the KLY new reactor is before winter 2025.

# 5. Transfer Capability and Demand Analysis

Along the path from POR at GMS.MCA.REV to POD at BC.US.BORDER, there are seven cut-planes as shown in Figure 5-1 below. These are the crossings between the following system nodes or stations:

- Cut-plane 1: South of GM Shrum (GMS) and Peace Canyon (PCN)
- Cut-plane 2: South of Williston
- Cut-plane 6: West of Ashton Creek and Selkirk
- Cut-plane 7: Mica to Nicola
- Cut-plane 8: Revelstoke to Ashton Creek
- Cut-plane 9: Interior (NIC and KLY) to Lower Mainland
- Western intertie of WECC Path 3: BC Ingledow (ING) substation to the US border (Lower Mainland to US)

Adequate transfer capability on each of these cut-planes shall be maintained to accommodate a specific firm transmission service request in a safe and secure manner. If a transmission service request transverses multiple cut-planes, then adequate transfer capability must exist on each of the cut-planes for the path to be considered secured. For a firm transmission service request with the POR at GMS/MCA/REV and the POD at BC-US border at Custer, all of the above 7 cut-planes must have adequate transfer capability to accommodate the 700 MW Long-term Firm Point-to-Point service request before a full Transmission Service can be granted.

As described in Section 3 Planning Criteria and Study Methodology, the transfer capability is determined as per the NERC Transmission Planning Standard (TPL-001-4) and WECC performance criterion (TPL-001-WECC-CRT-3.2). Transmission constraints are identified based on branch ratings, voltage performance, voltage stability and transient stability. The system study conditions outlined in Section 4 are applied.

Among those cut-planes, the study focuses mainly on the three limiting cut-planes: Cut-plane 1 – South of GMS/PCN, Cut-plane 2 -South of Williston, and Cut-plane 9 - Interior to Lower Mainland. The analysis of the transfer capability and the committed use (or transfer demand) across each of these cut-planes are discussed in sections 5.1, 5.2, and 5.3. Other cut-planes are discussed in section 5.4.

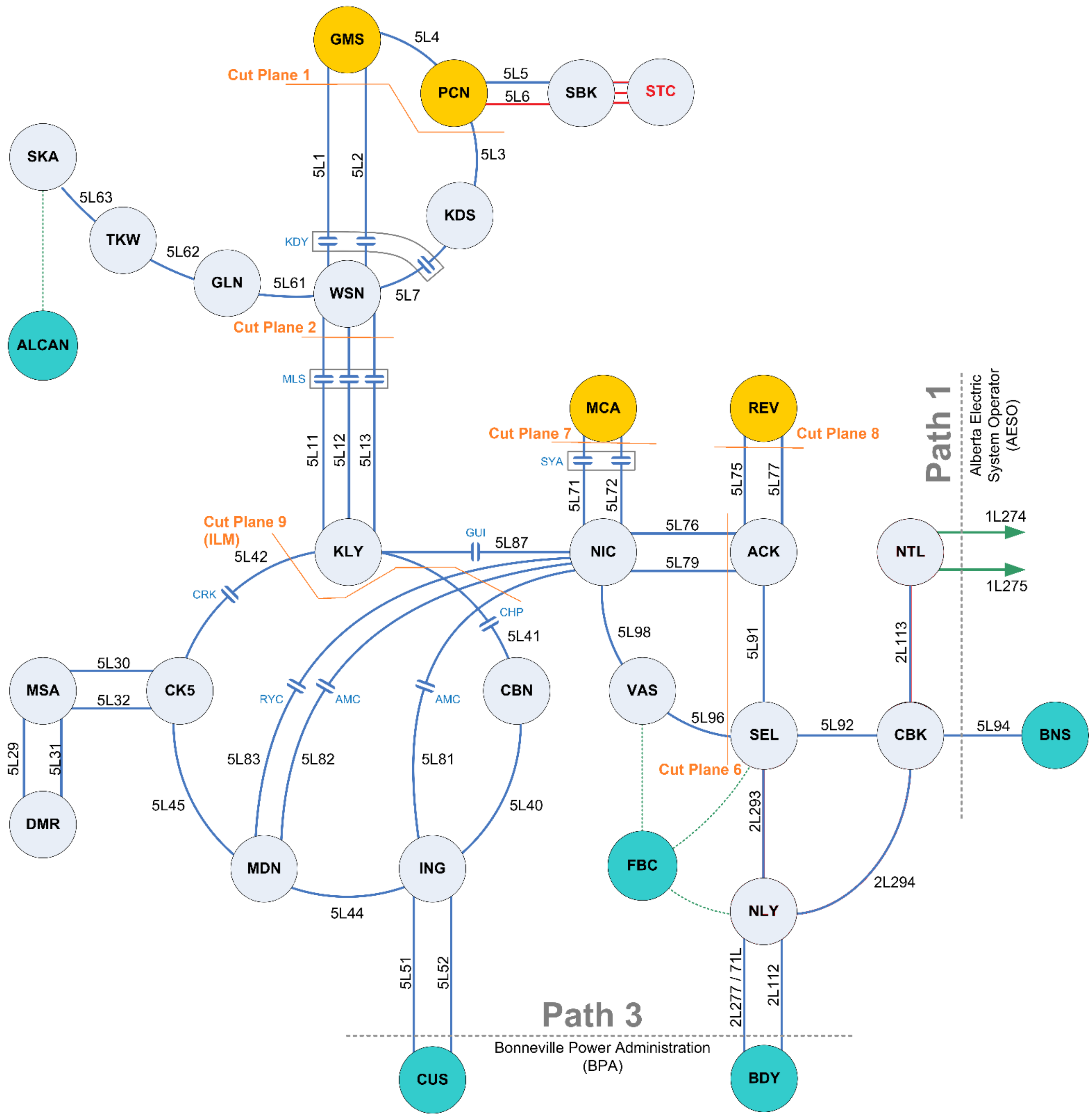


**Figure 5-1: BC Hydro Grid One Line Diagram**

# 5.1. Cut-plane 1 – South of GMS/PCN

This cut-plane crosses lines 5L1, 5L2 and 5L3. The power generated from GM Shrum (GMS), Peace Canyon (PCN) and future Site C (STC) in the Peace Region is transmitted through this cut-plane southward to Williston Substation (WSN).

The Peace Region is one of the largest power generation bases in British Columbia. The transfer demand through this cut-plane is driven by the surplus generation in this region. Higher generation and lower local load in the Peace Region yield higher transfer demand on this cut-plane, and vice versa.

In accordance with the GDTP Guideline as noted in Section 3.2, under system normal for this source cut-plane, the Peace generation needs to be dispatched to the maximum as specified in the GDTP. No system constraint was observed to serve the winter peak load in the system normal condition. Figure 5-2 shows the transfer capability and the committed use on this cut-plane under system normal.

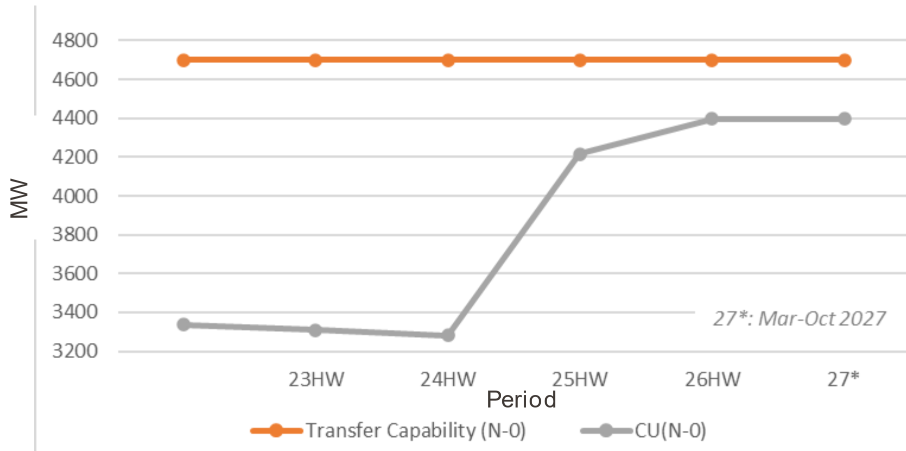


**Figure 5-2: Transfer Capability and Committed Use Plot for South of GMS/PCN Cut-plane, N-0**

When a single contingency occurs on one of the 500 kV lines crossing the cut-plane with the Peace generation outputs at the maximum in pre-contingency, overloading on the series capacitors of the remaining circuits (5L1, 5L2 or 5L3) were observed starting in winter 2025. As per the GDTP, there is no immediate need to expand the transmission system to address such a constraint, and instead a part of Peace generation equivalent to the system surplus generation capacity can be shed to eliminate overloading on the series capacitors. The shedding amount can be made up via generation re-dispatch and delivered from South Interior after a momentary change to the system interchanges.

Figure 5-3 shows the N-1 transfer capability and the committed use on this cut-plane under a single contingency. It can be observed with Peace generation shedding or re-dispatch up to the system surplus generation capacity, the South of GMS/PCN cut-plane has adequate transfer capability to fully accommodate the 700 MW Long-Term Firm Point-to-Point transmission service in winter peak. As noted in Section 3.2, the system surplus generation capacity here refers to the post-LTFPTP values.

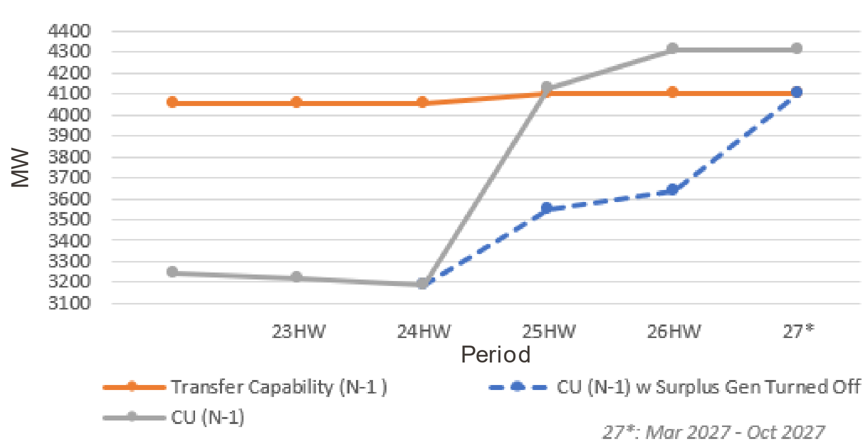


**Figure 5-3: Transfer Capability and Committed Use Plot for South of GMS/PCH Cut-plane, N-1**

The heavy summer load condition is the heavily stressed scenario for the South of GMS/PCN cut-plane because the summer ratings of circuits 5L1 and 5L2 are slightly lower than their winter ratings and the local load is lower in the summer, which yields higher transfer demand on the cut-plane. It is found that overloading occurs on 5L1 or 5L2 under single contingencies of the parallel lines during the 2026 heavy summer load period if the Peace generation operates at the maximum in pre-contingency (or the system scenario before the considered contingency is applied).

To alleviate overloading on 5L1 and 5L2, it is required to shed a total of 750 MW generation in the heavy summer load of 2026 and 2027 in the Peace region after a single contingency on 5L1 or 5L2 and then re-dispatch this amount to the South Interior generation. Although the required shedding amount is higher than the system surplus generation listed in Table 3-1 for the post-LTFPTP (i.e., 83 MW higher in 2026 heavy summer and 547 MW higher in 2027 heavy summer), it can be expected that the system surplus generation in the summer is significantly higher as noted in Section 3.2. With the assumption that 750 MW surplus generation capacity in the summer period is available, the South of GMS/PCN cut-plane has adequate transfer capability to fully accommodate the 700 MW Long-Term Firm Point-to-Point transmission service.

Summer light load conditions could be more stressed for this source cut-plane after a single contingency if the Peace generation operates at the maximum in the pre-contingency. However, compared to the heavy summer cases discussed above, additional system surplus generation under light load conditions would be available to shed and re-dispatch after a contingency. Therefore, overloading in post-contingency can be mitigated adequately in the summer light load conditions.

Table 5-1 shows the South of GMS/PCN transfer capability and the expected committed use with full LTFPTP service in winter peak load scenario.

**Table 5-1: South of GMS/PCN Capacity with Full LTFPTP Service in Heavy Winters**

| | 2022 Heavy Winter | 2023 Heavy Winter | 2024 Heavy Winter | 2025 Heavy Winter | 2026 Heavy Winter | 2027 |
|---|---|---|---|---|---|---|
| System Normal Capacity (N-0) | 4700 | 4700 | 4700 | 4700 | 4700 | 4700 |
| N-1 Transfer Capability (MW) | 4050 [a] | 4050 [a] | 4050 [a] | 4100 [b] | 4100 [b] | 4100 [b] |
| CU before re-dispatch (MW) | 3247 | 3219 | 3190 | 4125 | 4306 | 4305 |
| CU after re-dispatch (MW) | (No re-dispatch needed) | (No re-dispatch needed) | (No re-dispatch needed) | 3545 | 3640 | 4102 |
| Full LTFPTP service can be accommodated? | Yes | Yes | Yes | Yes | Yes | Yes |

Note: (a) N-1 transfer capability before Site-C generation in service.
(b) N-1 transfer capability after Site-C generation in service.

## 5.2. Cut-plane 2 – South of Williston

South of Williston cut-plane crosses lines 5L11, 5L12, 5L13 and 2L96. Electricity from WSN flows south through this cut-plane towards Kelly Lake substation (KLY). The resultant flow from WSN to KLY via this cut-plane depends on the generation at Peace and North Coast, and the Rio-Tinto Alcan import as well as the local load in the region.

In accordance with the GDTP Guideline, under system normal for this source cut-plane, the upstream generation needs to be dispatched to the maximum as specified in the GDTP. No system constraint was observed to serve the winter peak load in the system normal condition. Figure 5-4 shows the transfer capability and the committed use on this cut-plane under system normal.

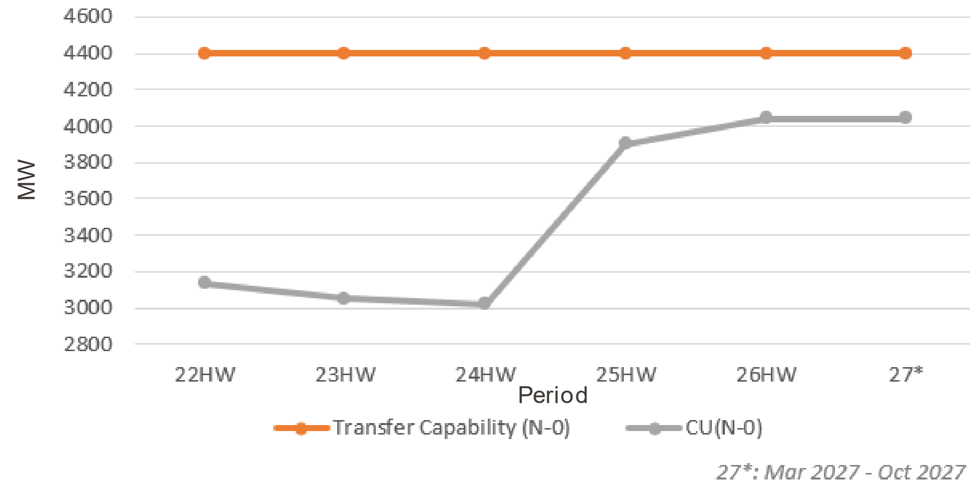


**Figure 5-4: Transfer Capability and Committed Use Plot for South of Williston Cut-plane, N-0**

When a single contingency occurs on one of the 500 kV lines (5L11, 5L12 and 5L13) crossing the cut-plane with the upstream generation outputs at the maximum in pre-contingency, overloading on the series capacitors of the remaining circuits (5L11, 5L12 or 5L13) were observed starting in winter 2025. A part of the upstream generation equivalent to the system surplus generation capacity is shed to eliminate overloading on the series capacitors. The shedding amount is made up via generation re-dispatch and delivered from South Interior after a momentary change to the system interchanges.

Figure 5-5 shows the N-1 transfer capability and the committed use on this cut-plane under a single contingency. After the N-1 contingency, the upstream generation including the generation in the Peace and North Coast regions can be shed or re-dispatched up to the system surplus generation for the post-LTFPTP. With the generation shedding and redispatch, the South of Williston cut-plane has adequate transfer capability to fully accommodate the 700 MW Long-Term Firm Point-to-Point transmission service in winter peak.

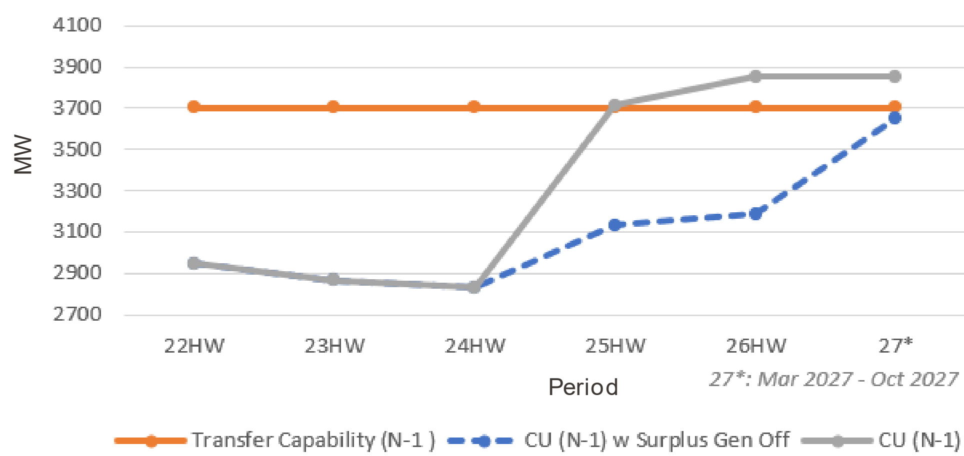


**Figure 5-5: Transfer Capability and Committed Use Plot for South of Williston Cut-plane, N-1**

Similar to the South of GMS/PCN cut-plane, the transfer demand on the South of Williston cut-plane is higher under heavy summer load conditions due to the lower local load in the summer. To mitigate overloading on series capacitors of 5L11, 5L12 and 5L13, a total of 500 MW surplus generation shedding in 2027 heavy summer is required in the Peace region after a single contingency and to re-dispatch this amount to the South Interior generation. Although the required shedding amount is 297 MW higher than the system surplus generation listed in Table 3-1 for the post-LTFPTP, it can be expected that the system surplus generation in summer is significantly higher as noted in Section 3.2. With the assumption that 500 MW surplus generation capacity in the summer period is available, the South of Williston cut-plane has adequate transfer capability to fully accommodate the 700 MW Long-Term Firm Point-to-Point transmission service.

Summer light load conditions could be more stressed for this source cut-plane after a single contingency if the upstream generation operates at the maximum in pre-contingency. However, compared to the heavy summer cases discussed above, additional system surplus generation under light load conditions would be available to shed and re-dispatch. Therefore, the overloading in post-contingency can be mitigated adequately in the summer light load conditions.

Table 5-2 shows the South of Williston transfer capability and the expected transfer with full LTFPTP transmission service in winter peak load scenario.

**Table 5-2: South of Williston Capacity with Full LTFPTP service in Heavy Winters**

<table>
<tr><th></th><th>2022<br>Heavy Winter</th><th>2023<br>Heavy Winter</th><th>2024<br>Heavy Winter</th><th>2025<br>Heavy Winter</th><th>2026<br>Heavy Winter</th><th>2027</th></tr>
<tr><td>System Normal Capacity (N-0)</td><td>4400</td><td>4400</td><td>4400</td><td>4400</td><td>4400</td><td>4400</td></tr>
<tr><td>N-1 Transfer Capability (MW)</td><td>3700</td><td>3700</td><td>3700</td><td>3700</td><td>3700</td><td>3700</td></tr>
<tr><td>CU before re-dispatch (MW)</td><td rowspan="2">2945<br><br>(No re-dispatch needed)</td><td rowspan="2">2863<br><br>(No re-dispatch needed)</td><td rowspan="2">2832<br><br>(No re-dispatch needed)</td><td>3714</td><td>3853</td><td>3853</td></tr>
<tr><td>CU after re-dispatch (MW)</td><td>3134</td><td>3186</td><td>3650</td></tr>
<tr><td>Full LTFPTP service can be accommodated?</td><td>Yes</td><td>Yes</td><td>Yes</td><td>Yes</td><td>Yes</td><td>Yes</td></tr>
</table>

## 5.3. Cut-plane 9 - Interior to Lower Mainland (ILM)

This cut-plane is generally referred to as the ILM cut-plane, which crosses lines 5L41, 5L42, 5L81, 5L82, 5L83 and 2L90. Through this cut-plane, electricity is transmitted from the generation in both Northern Interior and South Interior to the BC provincial load centers in the Lower Mainland and Vancouver Island (LMVI), which is approximately 70% of provincial demand.

The flow through the ILM cut-plane is driven by the net load in the LMVI region including the export to the US border near Custer. Decreasing the load or increasing the Coastal Generation will reduce the committed use on the ILM cut-plane.

The ILM system is fed by two sources at NIC and KLY respectively from the generation in the Northern Interior and the generation in South Interior. The ILM system connected to these two resources is asymmetrical: there are three lines (5L81, 5L82 and 5L83) connecting NIC to Lower Mainland while two lines (5L41 and 5L42) connect KLY to Lower Mainland. With this configuration, the connection from Kelly Lake to Lower Mainland is prone to be congested under a contingency and the ILM system generally has higher transfer capability when transmitting more generation from South Interior.

In accordance with the GDTP Guideline, under system normal for the network cut-plane, the Lower Mainland and Vancouver Island loads plus the export to US may be served by either maximum Peace generation or maximum Columbia generation with specified coastal generation outputs. No system constraint was observed to serve the system winter peak in the normal operating condition. Figure 5-6 shows the transfer capability and the committed use on this cut-plane under system normal.

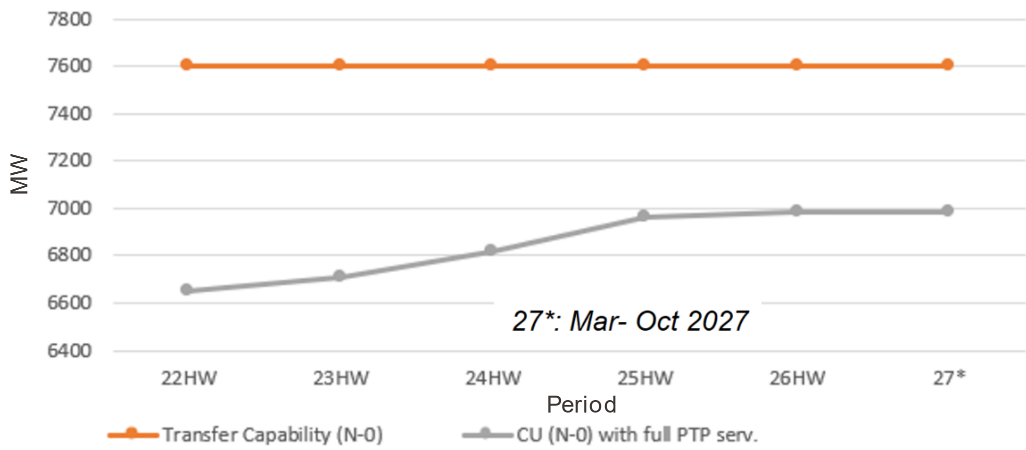


**Figure 5-6: Transfer Capability and Committed Use (CU) Plot for ILM Cut-plane, N-0**

When the Peace generation operates at the maximum in the heavy winter load condition, if a single contingency occurs on one o f the 500 kV lines between KLY and Lower Mainland (5L41 and 5L42), overloading on the series capacitor of the remaining circuit (5L41 or 5L42) was observed. As per the GDTP, generation re-dispatch from the Peace region to the Columbia region is used to alleviate the overloading as long as adequate reserve can be maintained in the Columbia generation.

When the Columbia generation operates at the maximum in the heavy winter load condition, if a single contingency occurs on the 500 kV line between NIC and lower Mainland (5L83), overloading on the series capacitor of the circuit (5L81 and 5L82) were observed before generation re-dispatching. Generation re-dispatch from the Columbia region to the Peace region is used to alleviate the overloading as long as adequate generation reserve can be maintained in the Peace generation per the GDTP.

The SIS identified the thermal constraints on the ILM cut-plane with full LTFPTP transmission service starting from 2023 heavy winter. This thermal constraint is limited by the continuous ratings of the series capacitors in 5L41, 5L42 and 5L82 when an outage o ccurs on one of ILM 500 kV lines followed by required generation re-dispatch. To accommodate the 700MW export in full, the 5L41, 5L42 and 5L82 Series Capacitors will need to be uprated to have a continuous rating of 3000 A.

Without the rating upgrade, only partial LTFPTP transmission service can be accommodated from 2023 winter onwards.

Given the summer rating and winter rating of series capacitors are the same, the most stressed system condition for the ILM cut-plane is the winter peak load cases. The summer load in LMVI is much lower than winter peak load , which results in lower transfer and more capacity for LTFPTP transmission service on the ILM cut-plane. Thus, only winter peak load cases are discussed in the repo rt.

The cut-plane capability under a single contingency and the expected CU with full and partial LTFPTP service are shown in Figure 5-7, Table 5-3 and Table 5-4.

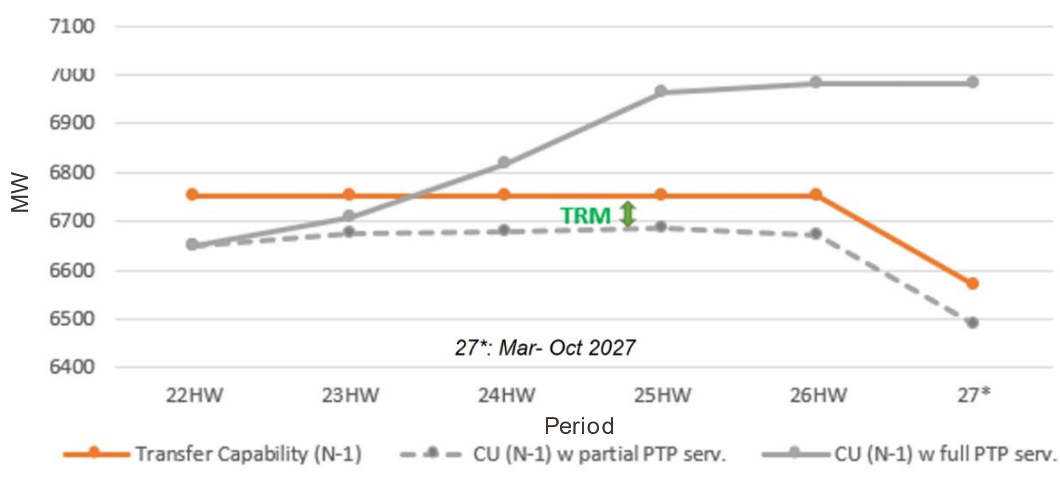


**Figure 5-7: Transfer Capability and Committed Use Plot for ILM Cut-plane, N-1**

**Table 5-3: ILM Cut-plane Capacity with Full LTFPTP Service**

| | 2022 Heavy Winter | 2023 Heavy Winter | 2024 Heavy Winter | 2025 Heavy Winter | 2026 Heavy Winter | 2027 [(a)] |
|---|---|---|---|---|---|---|
| N-1 Transfer Capability (MW) | 6750 [(b)] | 6750 [(b)] | 6750 [(b)] | 6750 [(b)] | 6750 [(b)] | 6570 [(b)] |
| CU with full LTFPTP service (MW) | 6648 | 6707 | 6817 | 6963 | 6983 | 6982 |
| Transmission Reliability Margin (TRM) (MW) | 50 | 50 | 50 | 50 | 50 | 50 |
| Full LTFPTP service can be accommodated? | Yes | **No** | **No** | **No** | **No** | **No** |

Note: (a) This is the period starting from Mar. 2027 to Oct 2027. The available capacity in South Interior for re-dispatch decreases as one of MCA units is out of service, which results in less transfer capability on ILM cut-plane.

(b) Generation re-dispatch is applied for transmission capability determination.

**Table 5-4: ILM Cut-plane Capacity with Partial LTFPTP Service**

| | 2022 Heavy Winter | 2023 Heavy Winter | 2024 Heavy Winter | 2025 Heavy Winter | 2026 Heavy Winter | 2027 [(a)] |
|---|---|---|---|---|---|---|
| N-1 Transfer Capability (MW) | 6750 [(b)] | 6750 [(b)] | 6750 [(b)] | 6750 [(b)] | 6750 [(b)] | 6570 [(b)] |
| CU with Partial LTFPTP service (MW) | 6648 | 6675 | 6678 | 6685 | 6672 | 6489 |
| Transmission Reliability Margin (TRM) (MW) | 50 | 50 | 50 | 50 | 50 | 50 |
| **Partial LTFPTP transmission service accommodated (MW)** | **700** | **670** | **570** | **440** | **410** | **240** |

Note: (a) This is the period starting from Mar. 2027 to Oct 2027. The available capacity in South Interior for re-dispatch decreases as one of MCA units is out of service, which results in less transfer capability on ILM cut-plane.

(b) Generation re-dispatch is applied for transmission capability determination.

## 5.4. Other Cut-planes

The transfer capability of other cut-planes is also investigated in the study. Those cut-planes have adequate transfer capability to accommodate the 700 MW LTFPTP transmission service in full for the entire requested period therefore no details are discussed in the report.

Those cut-planes include:

- West of Ashton Creek and Selkirk (Cut-plane 6)

  This cut-plane crosses lines 5L96, 5L76 and 5L79. Power from Ashton Creek Substation and Selkirk Substation flows through this cut-plane westward to NIC Substation.

- Mica to Nicola (Cut-plane 7)

  Mica to Nicola cut-plane crosses lines 5L71 and 5L72. Power from Mica generating station (MCA) flows through this cut-plane to NIC Substation.

- Revelstoke to Ashton Creek (Cut-plane 8)

  Revelstoke to Ashton Creek cut-plane crosses lines 5L75 and 5L77. Power from Revelstoke generating station (REV) flows through this cut-plane to Ashton Creek Substation (ACK).

- BC ING to US border (Lower Mainland to US), which is the western tie of WECC Path 3

# 5.5. Transfer Analysis Results

The transfer capabilities established in sections 5.1 to 5.4 are associated with transmission constraints identified under either system normal or single contingency conditions. To supplement these results, this SIS includes a high-level assessment of multiple contingencies and extreme events under selected scenarios. The assessment indicates that BC Hydro's transmission system performance under those contingencies meets the requirements under the NERC Planning Standard[5]. As such, the transfer capabilities established in sections 5.1 to 5.4 remain valid under all contingencies and scenarios studied.

Table 5-5 below shows whether the requested LTFPTP service can be fully accommodated through each of the 7 cut-planes from the GMS.MCA.REV to BC.US.BORDER.

**Table 5-5: LTFPTP Service Accommodated Across Cut-planes**

| | 2022 Oct - 2023 Oct | 2023 Nov. – 2024 Oct. | 2024 Nov. – 2025 Oct. | 2025 Nov. – 2026 Oct. | 2026 Nov. – 2027 Feb. | 2027 Mar. – 2027 Oct. |
|---|---|---|---|---|---|---|
| South of GMS/PCN (Cut-plane 1) | Full | Full | Full | Full | Full | Full |
| South of Williston (Cut-plane 2) | Full | Full | Full | Full | Full | Full |
| West of Ashton Creek and Selkirk (Cut-plane 6) | Full | Full | Full | Full | Full | Full |
| Mica to Nicola (Cut-plane 7) | Full | Full | Full | Full | Full | Full |
| Revelstoke to Ashton Creek (Cut-plane 8) | Full | Full | Full | Full | Full | Full |
| Interior to Lower Mainland (Cut-plane 9) | Full | Partial (670 MW) | Partial (570 MW) | Partial (440 MW) | Partial (410 MW) | Partial (240 MW) |
| BC to US border (Lower Mainland to US) | Full | Full | Full | Full | Full | Full |

[5] In accordance with NERC TPL-001-4 Table 1, non-consequential load loss and interruption of firm transmission services are allowed to meet the system performance requirement for certain categories of planning events.

The key results are summarized below.

- The ILM cut-plane is the bottleneck for a full accommodation of the 700 MW LTFPTP transmission service.
- Without the rating upgrades of the series capacitors, only partial LTFPTP transmission service can be accommodated starting 2023 winter onwards. That is, a maximum of 240 MW can be accommodated for the 5-year period between October 2022 and October 2027, per the Start Time and Stop Time of TSR 94879734.
- With the continuous rating upgrades to 3000 A of the series capacitors on 5L41, 5L42 and 5L82, the requested 700 MW export can be fully accommodated. Refer to Section 6 for the detail.

In addition, this study finds that there is insufficient capacity to accommodate roll-over of TSR 94879734. The future load growth in LMVI and the expected reduction of the system surplus generation will have additional negative impact on the partial service after October 2027.

# 6. Network Upgrades

Table 6-1 below shows the network upgrades needed to accommodate TSR 94879734 in full.

**Table 6-1: Network Upgrades Identified in this SIS**

| Upgrades Required | Details |
|---|---|
| To uprate the 5L41, 5L42 and 5L82 series capacitor (SC):<br>• 5L41 SC (CHP) upgrade to a continuous rating of 3000 A.<br>• 5L42 SC (CRK) upgrade to a continuous rating of 3000 A.<br>• 5L82 SC (AMC) upgrade to a continuous rating of 3000 A. | The earliest in-service date (ISD) is estimated to be no sooner than winter 2026, which can be confirmed in the Facilities Study stage, if requested. A full accommodation of the requested 700 MW export can be achieved upon completion of series capacitors rating upgrades. |

# 7. Deferral of MCA Outage

The study results discussed in Section 5 are derived upon the Base Resource Plan used for the SIS, in which a major generating unit is out of service, i.e., the MCA unit outage from March 1st, 2027 to December 1st, 2027.

The SIS indicates that the MCA outage has a negative impact on the amount of Partial Service that can be granted. If the scheduled MCA outage can be deferred to October 2027 or later, up to 410 MW of Partial Service from GMS.MCA.REV to BC.US.BORDER can be accommodated as Long-Term Firm transmission service without necessary system upgrades. Table 7-1 shows the LTFPTP transmission service that may be accommodated with the deferral of the MCA outage.

During the report finalizing stage, a BC Hydro internal discussion confirmed that the MCA outage had been deferred to 2028 or later. Therefore, with the change to the BRP, a maximum of 410 MW can be accommodated for the 5-year period between October 2022 and October 2027, per the Start Time and Stop Time of TSR 94879734.

**Table 7-1: LTFPTP Service Accommodated across Cut-Planes if the MCA outage is Deferred**

| | 2022 Oct - 2023 Oct | 2023 Nov. – 2024 Oct. | 2024 Nov. – 2025 Oct. | 2025 Nov. – 2026 Oct. | 2026 Nov. – 2027 Feb. | 2027 Mar. – 2027 Oct. |
|---|---|---|---|---|---|---|
| South of GMS/PCN (Cut-plane 1) | Full | Full | Full | Full | Full | Full |
| South of Williston (Cut-plane 2) | Full | Full | Full | Full | Full | Full |
| West of Ashton Creek and Selkirk (Cut-plane 6) | Full | Full | Full | Full | Full | Full |
| Mica to Nicola (Cut-plane 7) | Full | Full | Full | Full | Full | Full |
| Revelstoke to Ashton Creek (Cut-plane 8) | Full | Full | Full | Full | Full | Full |
| Interior to Lower Mainland (Cut-plane 9) | Full | Partial (670 MW) | Partial (570 MW) | Partial (440 MW) | Partial (410 MW) | Partial (410 MW) |
| BC to US border (Lower Mainland to US) | Full | Full | Full | Full | Full | Full |

# 8. Conclusions

This SIS concludes the following with reference to the BCH transmission system:

- The 700 MW TSR with OASIS AREF# 94879734 cannot be accommodated in whole as Long-Term Firm transmission service without system upgrades.
- 410 MW of Long-Term Firm Point-to-Point Partial Service from GMS.MCA.REV to BC.US.BORDER can be accommodated without the necessary system upgrades identified in this study. The amount of Partial Service to be granted was based upon a change to the Base Resource Plan (BRP) as detailed in Section 7.
- To accommodate all 700 MW of Transmission Service, this study has determined that the series capacitors on 5L41, 5L42 and 5L82 need be upgraded to a continuous rating of 3000 A. However, the earliest possible in-service date (ISD) of these system upgrades is winter 2026 upon a high-level assessment. Therefore, a full accommodation of the 700 MW LTFPTP transmission service cannot be granted for the entire service period requested.

BC Hydro (Transmission Provider) will tender a Service Agreement for Partial Service of 410 MW to the Transmission Customer on May 26, 2022. The Transmission Customer must respond to the Transmission Provider within 15 days, by June 9, 2022 with an executed Service Agreement for Partial Service, should the Transmission Customer elect to take partial service.

# Appendix A: TSR 94879734

TSR 94879734 - Internet Explorer provided by BC Hydro Technology

https://www.oasis.oati.com/webSmartOASIS/TransmissionReservationDetail?TSRID=27531274&AREF=94879734&TP=BCHA&FromHistory=0&overrideTimeZone=PD

**Transmission Reservation Detail [ AREF : 94879734 ] - [STUDY] [ORIGINAL]   (All times are in PD)**

PD

Status Flow & Actions

**TSR Information**

| TP | Seller | Customer | POR | POD | Path | Start Time | Stop Time | MW Req | MW Grant |
|---|---|---|---|---|---|---|---|---|---|
| | | | Source: | | Request Type: ORIGINAL | | | | |
| BCHA | BCHA | BCPS | GMS.MCA.REV | BC.US.BORDER | W/BCHA/BCHA-BPAT/GMS.MCA.REV-BC.US.BORDER/ | 2022-10-01 00:00 PD | 2027-10-01 00:00 PD | 700 | |
| | | | Sink: | | Service Code: YRLY_FIRM_PTP_EXTENDED | | | | |

**Reservation Profile**

| Start Time | Stop Time | MW Req | MW Grant | MWH | Bid Price | Offer Price |
|---|---|---|---|---|---|---|
| 2022-10-01 00:00 PD | 2027-10-01 00:00 PD | 700 | | 30676800.00 | $78262.0000 | |
| | | | Profile Total: | 30676800.00 | | |

**Service Details**

| Preconfirmed | Increment | Class | Type | Period | Window | Subclass | Nerc Priority | Ceiling Price | Price Unit |
|---|---|---|---|---|---|---|---|---|---|
| NO | YEARLY | FIRM | POINT_TO_POINT | FULL_PERIOD | EXTENDED | | 7 | $78262.0000 | $CDN/MW-Y |

**Comments**

| Status | Seller | Provider | Customer |
|---|---|---|---|
| | Not enough ATC. ATC pending on higher queued. | System Impact Study Agreement Executed on September 13, 2021 | |

**Additional Information**

| | | | | | |
|---|---|---|---|---|---|
| Competing Request Flag: | | Related: | | Provider Approval: | |
| Negotiated: | | Reassigned: | | Provisions: | |
| Affiliate: | YES | Sale: | | Rollover Waived: | |
| Impacted: | 0 | Request: | | CG Status: | |
| Effective Queued Time: | | Seller: | | CG Deadline: | |
| Queued: | 2021-09-01 10:20:32 PD | Deal: | | Concomitant Eval Flag: | |
| Updated: | 2021-09-27 10:09:26 PD | Posting: | | Status Notification: | |
| Response: | | SIS: | NO | | |

**Customer/Seller Information**

| Type | Entity | Name | Phone | Email | Fax |
|---|---|---|---|---|---|
| Customer | BCPS | Brian_Samson | (604) 895-7047 | joseph.mikawoz@powerex.com | (604) 891-5056 |
| Seller | BCHA | PaulusMau | | Paulus.Mau@bchydro.com | |

**Audit Statuses**

| Time Of Last Update | Modifying Company Code | Modifying Name | Status |
|---|---|---|---|
| 2021-09-01 10:20 PD | BCPS | Brian_Samson | QUEUED |
| 2021-09-01 10:21 PD | BCHA | BCHA_WEBTRANS | RECEIVED |
| 2021-09-27 10:09 PD | BCHA | PaulusMau | STUDY |

# Appendix B: BC Hydro OATT Attachment D



**ATTACHMENT D**

**Methodology for Completing a System Impact Study**

BC Hydro will perform system planning studies and apply its published planning criteria, standards and procedures to determine the impacts of the requested Transmission Service. The transfer capability of the system will be assessed for the period of the requested service to determine if the requested service can be accommodated. Thermal loading, transient stability, and voltage stability limits will be investigated for normal and outage conditions. If this analysis indicates that the requested Transmission Service cannot be accommodated, then alternative reinforcements will be investigated. A least cost transmission expansion plan will be developed for consideration by BC Hydro and the Transmission Customer and will include but not be limited to the following considerations: technical, economic, reliability, losses, environmental and social. The Transmission Customer can decide whether to proceed, modify, or cancel its request. More details can be found in the BC Hydro System Planning document entitled "Planning Process".

ACCEPTED: JAN 17 2011

ORDER NO. G 1 92 10

COMMISSION SECRETARY