Transmission Impact Study

for

Mica Unit 5 and Unit 6 Advancement

Report No: SPPA2010-009

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System Planning & Performance Assessment

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1 Introduction

To support Mica Unit 5 and Unit 6 CPCN filing, BC Hydro requested BCTC to perform a transmission system assessment to identify the transmission requirements for five Mica peaking generation development scenarios:

Scenario 1: Mica Unit 5 in F2027[1] and Mica Unit 6 never built as in the Base Resource Plan (BRP) 2010-March-8

Scenario 2: Mica Unit 5 in F2027 and Mica Unit 6 in F2028[2]

Scenario 3: Mica Unit 5 in F2015[3] and Mica Unit 6 never built

Scenario 4: Mica Unit 5 in F2015 and Mica Unit 6 never built, but with provision made to accommodate the integration of Mica Unit 6

Scenario 5: Mica Unit 5 in F2015 and Mica Unit 6 in F2016[4]

Major study assumptions have been provided by BC Hydro in this transmission requirement study as follows:

- BC Hydro's BRP (2010-March-8) including new BC Hydro resources and new purchases (IPP's) is used as the basic generation plan.
- Generation dispatching pattern assumptions are specified in Appendix C of F2010 BCTC Transmission System Capital Plan.
- The proposed Interior to Lower Mainland (ILM) transmission system reinforcement project (5L83) will enter service by October 2014.
- The direct project costs are provided in 2008$ based on the cost estimates prepared in 2008 with +100%/-50% accuracy except for the load-shedding RAS implementation costs that have an accuracy of +200%/-50%.

[1] As indicated by BCH Energy Planning, the ISD of F2027 should be interpreted as Sept 30, 2026
[2] ISD is September 30, 2027
[3] ISD is September 30, 2014
[4] ISD is September 30, 2015

2 Background

In 2007, per BC Hydro's request, BCTC performed a system impact study (SIS) for NITS Update 2007 based on its 2007-Dec-18 Contingency Resource Plan 2 (CRP2). That SIS focused on the transmission system requirement in South Interior to accommodate the integration of Mica Unit 5 in 2013 and Unit 6 in 2014; study report was finalised and posted in 2008 on BCTC website[5].

The NITS Update 2007 SIS identified the following transmission system upgrades that are required to accommodate Mica Unit 5 and Unit 6 integration:

a. 50% series compensation on 5L71 and 5L72 with 2960 Amps of nominal rating that would allow either line to carry the full 2876 MW maximum output of the 6-unit Mica plant continuously at any time of the year.

b. One 500 kV, 250 Mvar Mechanically Switched Capacitor (MSC) bank at Nicola substation. (The size of the MSC bank will be optimized in project definition phase.)

c. Load-shedding Remedial Action Scheme (RAS) may be required to secure the interconnected system from a double system contingency of simultaneously losing 5L71 and 5L72.

3 Transmission Requirement Identification

Mica generation station interconnects to the 500 kV transmission system at Nicola substation through two 500 kV transmission lines 5L71 and 5L72.

Interior to Lower Mainland (ILM) system and Mica to Nicola (MCA-NIC) are the major transmission paths to deliver power generated at Mica generating station to load centers in Lower Mainland and Vancouver Island.

Presently, to meet voltage stability criteria, a generation shedding scheme has been implemented to shed up to 475 MW (one fully-loaded Mica unit) for multi-phase and unsuccessfully cleared single-line-to-ground faults on either 5L71 or 5L72. When the Mica plant was originally integrated into the BC Hydro system, single-pole tripping and reclosing was employed to avoid the need for generation

[5] http://www.bctc.com/NR/rdonlyres/03BBFB16-6499-4013-892C-017E2E7A2A89/0/SystemImpactStudyforPeakingUnitsatMicaandRevelstoke_final.pdf)

shedding for the much more common single-line-to-ground (SLG) faults such as those caused by lightning strikes. However, any increase in the Mica plant's generating capacity (i.e. the addition of more generators like G5 and G6) would clearly require transmission reinforcement(s) of the MCA-NIC system. When the new 500 kV transmission line, circuit 5L83 (NIC-MDN#2) enters service, the ILM system will provide adequate transfer capability to accommodate the integration of Mica Unit 5 and Unit 6.

Mica Unit 5 and Unit 6 are two new 500 MW peaking units. This additional peaking capacity will be used to serve the system peak demand, but the Mica plant may be dispatched at its maximum output level (2876 MW at the 6-unit stage) at any time of the year and under any system loading condition, even during very light summer load levels.

Based on previous transmission system studies[6] by BCTC System Planning and Performance Assessment (SPPA), the transmission requirements for the five scenarios are summarized as follows with planning level (+100%/-50%) un-inflated direct project cost estimates.

Scenario 1

In this scenario, Mica Unit 5 is scheduled to enter service by September 30, 2026 and Mica Unit 6 is not built. The 2010-March-8 BRP, shows no significant increase in generation resources in the South Interior compared to the resource plan upon which the previous studies were based[6], so the ILM loading is similar to that of the previous studies. Therefore, transmission upgrade required to integrate only Mica Unit 5 is:

1 a. A series capacitor station at Seymour Arm (approximately mid-point of 5L71/72) with 40% series compensation to 5L71 and 5L72 with a nominal rating of 2350 Amps would be needed by September 30, 2026.

1 b. The total un-inflated direct project cost[7] is $35M in 2008$ with +100%/-50% accuracy. The estimated cash flow is provided in Appendix 1.

Scenario 2

[6] MCA/REV Preliminary Study Report and MCA/REV Integration SIS Report (SPA 2008-55)
[7] Inflation, IDC and OH are not included. The same thereafter

In this scenario, Mica Unit 5 and Unit 6 are scheduled to enter service by September 30, 2026 and September 30, 2027 respectively. The transmission upgrades required to accommodate both Mica Unit 5 and Unit 6 integration are:

2 a. A series capacitor station at Seymour Arm (approximately mid- point of 5L71/72) with 50% series compensation to 5L71 and 5L72 with a nominal rating of 2960 Amps would be needed by September 30, 2026.

2 b. A 500 kV mechanically switched shunt capacitor bank (about 250 Mvar) would be needed at Nicola substation by September 30, 2027.

2 c. A load-shedding RAS to address the rare but severe simultaneous double-contingency loss of 5L71 and 5L72 would be needed by September 30, 2027.

2 d. The total un-inflated direct cost of these three projects is $50M in 2008$ with +100%/-50% accuracy[8]. The estimated cash flow is provided in Appendix 1.

Scenario 3

Similar to Scenario 1, but Mica Unit 5 is advanced to September 30, 2014 and Mica Unit 6 is not built. Therefore, the transmission upgrade required to accommodate only Mica Unit 5 is same as that of Scenario 1 but with a different in-service date:

3 a. A series capacitor station at Seymour Arm with 40% series compensation to 5L71 and 5L72 and 2350 Amps of nominal rating is needed by September 30, 2014.

3 b. The total un-inflated direct project cost is $35M in 2008$ with +100%/-50% accuracy. The estimated cash flow is provided in Appendix 1.

Scenario 4

In this scenario, Mica Unit 5 and Unit 6 have the same schedule as Scenario 3 (i.e. Mica Unit 6 is never built) but special provisions are made in designing and constructing the 40%/2350A series capacitor banks to accommodate upgrading them to 50%/2960A should Mica Unit 6 be added in the future. The transmission upgrade needed for Mica Unit 5 would be the same 40%/2350A series

[8] The cost estimate accuracy for Load-shedding RAS is +200%/-50%

capacitor banks indicated for Scenario 3, but with a larger platform size and stronger bracing to support the future increase in the size of the capacitor banks. The incremental cost for the larger/stronger platforms would be small relative to the total project cost and is ignored because it would be well within the +100%/-50% estimate accuracy. Therefore, the transmission upgrade and cost estimate for Scenario 4 are same as those in Scenario 3.

Scenario 5

Similar to Scenario 2, but Mica Unit 5 and Unit 6 are advanced to September 30, 2014 and September 30, 2015 respectively. The transmission upgrades required would be the same as Scenario 2 but with different in-service dates:

5 a. A series capacitor station at Seymour Arm (approximately mid point of 5L71/72) with 50% series compensation to 5L71 and 5L72 and nominal rating of 2960 Amps would be required by September 30, 2014.

5 b. A 500 kV mechanically switched shunt capacitor bank (about 250 Mvar) at Nicola substation would be needed by September 30, 2015.

5 c. A load-shedding RAS to address the rare but severe double contingency of losing 5L71 and 5L72 simultaneously. It would be needed by September 30, 2015.

5 d. The total un-inflated direct project cost is $50M in 2008$ with +100%/-50% accuracy. The estimated cash flow is provided in Appendix 1.

In all five scenarios, the Mica plant will be able to operate continuously at its full output level (2876 MW at the 6-unit stage) during a prolonged outage to either circuit 5L71 or circuit 5L72 at any time in any season.

In all five scenarios, the Mica plant will be able to operate at its full output level (2876 MW at the 6-unit stage) without any generation shedding armed at any time in any season when both circuits 5L71 and 5L72 and their series capacitor banks are in service.

The 5L71/72 series capacitor station was proposed in BCTC's 2008-Nov-21 Transmission System Capital Plan[9] (TSCP) and the project definition phase was approved by BCUC. The schedule needed to achieve a 2014-Sep-30 in-service date will be challenging to meet.

4 Economic Evaluation Assumptions

For the purpose of transmission system reinforcement option comparison, Operating, Maintenance and Administration (OMA) costs are estimated to be 1.1% of project direct capital cost (ie, excluding inflation, overhead, OH, and interest during construction, IDC) for substation equipment such as MSC, series capacitor bank and protection, control and communications facilities (load-shedding RAS). In addition, taxes can be estimated to be 1.05% (= 70% * 1.5%) of project direct cost for substation facilities, for example, 5L71/72 series capacitor station, 500 kV MSC at Nicola, and control devices of load shedding RAS.

[9] BCTC TSCP: http://www.bctc.com/regulatory_filings/capital_plan/

Appendix 1: Cash Flows of Un-inflated Direct Capital Cost in 2008$[10]

The direct project costs provided in Appendix 1 are in 2008$ with +100%/-50% accuracy if no specific notification is provided.

		Project Total	F2011	F2012	F2013	F2014	F2015	F2016	F2017	F2018	F2019	F2020	F2021	F2022	F2023	F2024	F2025	F2026	F2027	F2028
Scenario 1	Scenario Total	$35,039												$216	$383	$1,176	$1,315	$9,055	$22,894	
	40% S.C. on 5L71/72	$35,039												$216	$383	$1,176	$1,315	$9,055	$22,894	
Scenario 2	Scenario Total	$50,251												$216	$383	$1,176	$1,315	$9,858	$32,602	$4,701
	50% S.C. on 5L71/72	$43,257												$216	$383	$1,176	$1,315	$9,055	$31,112	
	500kV 250 MVAR Cap at NIC	$4,995																$503	$791	$3,701
	Load-Shedding RAS*	$2,000																$300	$700	$1,000
Scenario 3	Scenario Total	$35,039	$216	$1,559	$1,315	$9,055	$22,894													
	40% S.C. on 5L71/72	$35,039	$216	$1,559	$1,315	$9,055	$22,894													
Scenario 4	Scenario Total	$35,039	$216	$1,559	$1,315	$9,055	$22,894													
	40% S.C. on 5L71/72	$35,039	$216	$1,559	$1,315	$9,055	$22,894													
Scenario 5	Scenario Total	$50,251	$216	$1,559	$1,315	$9,858	$32,602	$4,701												
	50% S.C. on 5L71/72	$43,257	$216	$1,559	$1,315	$9,055	$31,112													
	500kV 250 MVAR Cap at NIC	$4,995				$503	$791	$3,701												
	Load-Shedding RAS*	$2,000				$300	$700	$1,000												

Notes: * Without a RAS specification, the cost for implementing this load-shedding RAS is estimated based on BCTC's planning practice and engineering judgement only. The cost estimate accuracy is +200%/-50%

[10] All the project direct cost estimates are based on the cost estimates prepared by BC Hydro Engineering in 2008.