Operational Planning Study Report

RTA to BCH transfer limit updates

For Kitimat 4 Capacitor Banks

Report No. T&S Planning 2013 - 062

British Columbia Hydro and Power Authority

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Executive Summary

Rio Tinto Alcan (RTA) has requested BCH Transmission Planning to conduct operation planning study to update RTA to BCH transfer limits for KIT 4 shunt capacitor bank scenario.

Study results indicated that, RTA to BCH transfer limits from transient performance perspective, with KIT 4 shunt capacitor banks, can be increased to higher numbers which are similar to the scenario with KIT 5 shunt capacitor banks. The current transfer limits containing in the BC Hydro's operating order 7T-30 (issued on March 21, 2012) were estimated based on a conservative approach.

Detailed study results are summarized in Appendix A and will be used for updating operating order 7T-30.

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1. Background

RTA has requested BCH to conduct operational planning study to update RTA to BCH transfer limits for 4 shunt capacitor bank scenario under system normal conditions due to:

(1) Changes in RTA System

- The shunt capacitor associated with potline 8 has de-rated to 36.8 MVAR from 55 MVAR when potline 8 was shutdown, around August 2010.
- The shunt capacitor associated with Potline 2 was blown out in April 2013, and may not be available in the future.

(2) Deficiency in existing OO 7T-30

- RTA to BCH transfer limits for the case of 4 shunt capacitor banks in service under system normal condition were not studied. The transfers in 7T-30 were estimated based on a conservative approach and very restrictive.

2. Study Conditions and Assumptions

The studies are conducted based on the following conditions and assumptions:

- Base case: Bulk system 2013 light summer base case
- North Coast region system normal – All major transmission system equipment in service
- 5 shunt capacitor banks available while one bank maybe out of service at KIT
- Three generation patterns at KMO:
  - 8 units with a total maximum generation of 880 MW,
  - 7 units with a total maximum generation of 840 MW,
  - 6 units with a total maximum generation of 720 MW.
- KIT load range from 302 MW to 480 MW
- MIN load range from 0 MW to 50 MW
- KIT Separation Scheme in service
- Out-of-step Protection on 2L103 (KIT-MIN) in service

3. Study Criteria

- Separation Scheme Protection
  The separation scheme consists of two relays installed by RTA at KIT to detect multi-phase faults in the RTA system and in the BCH system. If either relay detects a multi-phase fault, then the KIT to MIN line 2L103 will be tripped immediately.

- Out-of-Step protection
  The MIN terminal of 2L103 is equipped with an Out-of-Step relay that will detect power swings between the KMO generators and the BCH system, and the MIN Out-of-Step settings are as follows:

Protection	Settings
Out-of-Step Relay	Apparent impedance looking from MIN to KIT: 0.18 – 0.16 p.u. Apparent impedance looking from MIN to SKA: 0.18 – 0.16 p.u. Apparent impedance crossing I 0.18 – 0.16 I gap time: 2 cycles Supervision voltage: 0.85p.u. Supervision voltage delay time: 5 cycles

The transfer limits and KMO generations shedding requirement are based on the Out-of-Step Relay setting as that the system performance in MIN area is protected.

4. Study Results

Study results indicate that

- From transient stability performance perspective with 4 shunt capacitor banks in service at KIT, RTA to BCH transfer limits can be increased to higher numbers, close to the case with 5 banks in service at KIT.
- In some situations, 4 capacitor banks at KIT would have better transient performance than 5 shunt capacitor banks due to the reduced KIT load (range between 302 MW to 480 MW) has reduced shunt compensation requirement, with 4 shunt capacitors in service would result in higher KMO unit terminal voltages to maintain KIT 287 kV bus voltage at 1.0 pu. As a result, KMO units have better transient performance.
- The existing generation shedding requirements for contingency of 2L101 (SKA to RUP) are still applicable for the new cases with 4 capacitor banks in service at KIT.

Detailed study results are summarized in Appendix A. Nomogram A-1 to A-3 are the updated RTA-BCH transfer limits

Appendix A: RTA to BCH Transfer Limits

The RTA to BCH transfer limit, with separation scheme at KIT, for system normal condition and one of Kemano - Kitimat lines OOS is defined as:

a) With RTA 420 GS RAS in-service:

PT (P_2L103) is the lesser of

- 420 MW, or
- 2L103 Rating , or
- (A + B* L_{MIN})

b) With RTA 420 GS RAS OOS:

PT (P_2L103) is the lesser of

- 420 MW, or
- Lesser of (2L103 Rating , 495 MW) - Largest Potline Load, or
- (A + B* L_{MIN})

Where Parameters A and B depend on L_{KIT} and are calculated in Table A -2.

Notes:

1. RTA 420 GS RAS is a RAS scheme implemented by RTA to avoid 2L103 from thermal overload, or from tripping by the excessive power relay on the loss of one of the Potlines at KIT (35 -100 MW) when KIT is connected to the BC Hydro system.

2. L_{KIT} is defined as the net power difference between power flowing into KIT on 87L (KMO-KIT) and 88L (KMO-KIT) and power going out of KIT on 2L103
   - L_{KIT} is assumed to vary between 302 to 480 MW.
   - If L_{KIT} < 302 MW, set L_{KIT} = 302 MW.
   - If L_{KIT} > 480 MW, the results are not applicable.

3. L_{MIN} is defined as the net power difference between power flowing into MIN on 2L103 and power going out of MIN on 2L99
   - L_{MIN} is assumed to vary between 0 to 50 MW.

Table A - 1 RTA to BCH Transfer limits (with separation scheme at KIT)

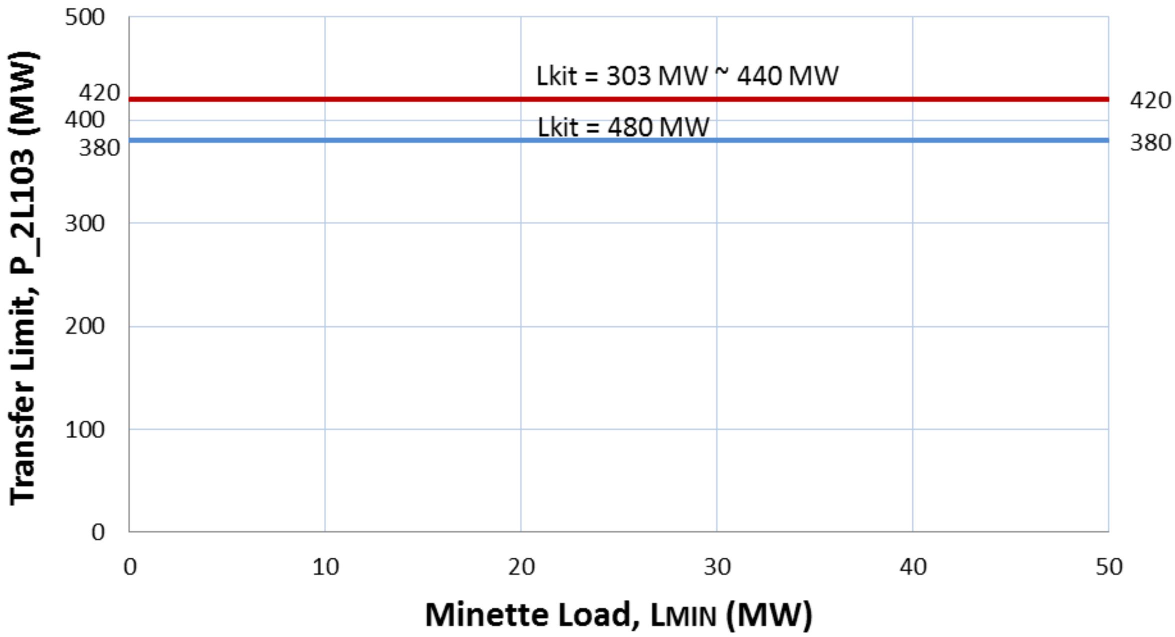
System Condition	Case Number	Number of Kitimat Capacitor Banks In-Service	Number of Kemano Units Online	Kitimat Load L_{KIT} (MW)	Kitimat to Minette Transfer Limit P_T (= P_2L103) range (MW)	Comments
System Normal **(with separation scheme at KIT)**	1	4	8	$302 < L_{KIT} \leq 440$	420 MW	
				$440 < L_{KIT} \leq 480$	380 MW ~ 420 MW	
	2	4	7	$302 < L_{KIT} \leq 318$	420 MW	
				$318 < L_{KIT} \leq 379$	380 MW ~ 420 MW	
				$379 < L_{KIT} \leq 420$	370 MW ~ 380 MW	
				$420 < L_{KIT} \leq 440$	350 MW ~ 370 MW	
				$440 < L_{KIT} \leq 480$	310 MW ~ 350 MW	
	3	4	6	$302 < L_{KIT} \leq 318$	380 MW ~ 395 MW	
				$318 < L_{KIT} \leq 348$	330 MW ~ 380 MW	
				$348 < L_{KIT} \leq 379$	310 MW ~ 330 MW	
				$379 < L_{KIT} \leq 420$	280 MW ~ 310 MW	
				$420 < L_{KIT} \leq 440$	260 MW ~ 280 MW	
				$440 < L_{KIT} \leq 480$	225 MW ~ 260 MW	

Table A - 2 Calculation formulas for Parameters A and B (with separation scheme at KIT)

System Condition	Number of Kitimat Capacitor Banks In-Service	Number of Kemano Units Online	Kitimat Load L_{KIT} (MW)	Calculation Formulas for A and B	
System Normal **(with separation scheme at KIT)**	4	8	$302 < L_{KIT} \leq 440$	$A = 420$	$B = 0.0$
			$440 < L_{KIT} \leq 480$	$A = 420 – 1.0 \times (L_{KIT} - 440)$	$B = 0.0$
	4	7	$302 < L_{KIT} \leq 318$	$A = 420$	$B = 0.0$
			$318 < L_{KIT} \leq 379$	$A = 420 – 0.66 \times (L_{KIT} - 318)$	$B = 0.0 - 0.8 \times (A - 420)/40$
			$379 < L_{KIT} \leq 420$	$A = 380 – 0.24 \times (L_{KIT} - 379)$	$B = 0.8 + 0.6 \times (A - 380)/10$
			$420 < L_{KIT} \leq 440$	$A = 370 – 1.0 \times (L_{KIT} - 420)$	$B = 0.2$
			$440 < L_{KIT} \leq 480$	$A = 350 – 1.0 \times (L_{KIT} - 440)$	$B = 0.2 + 0.2 \times (A - 350)/40$
	4	6	$302 < L_{KIT} \leq 318$	$A = 395 – 1.0 \times (L_{KIT} - 303)$	$B = 0.0$
			$318 < L_{KIT} \leq 348$	$A = 380 – 1.67 \times (L_{KIT} - 318)$	$B = 0.0 - 0.4 \times (A - 380)/50$
			$348 < L_{KIT} \leq 379$	$A = 330 – 0.65 \times (L_{KIT} - 348)$	$B = 0.4 + 0.1 \times (A - 330)/20$
			$379 < L_{KIT} \leq 420$	$A = 310 – 0.73 \times (L_{KIT} - 379)$	$B = 0.3 + 0.3 \times (A - 310)/30$
			$420 < L_{KIT} \leq 440$	$A = 280 – 1.0 \times (L_{KIT} - 420)$	$B = 0.0$
			$440 < L_{KIT} \leq 480$	$A = 260 – 0.88 \times (L_{KIT} - 440)$	$B = 0.0$

Nomogram A-1

RTA to BCH Transfer limit
Under system normal condition with 8 units at KMO and 4 capacitor banks at KIT

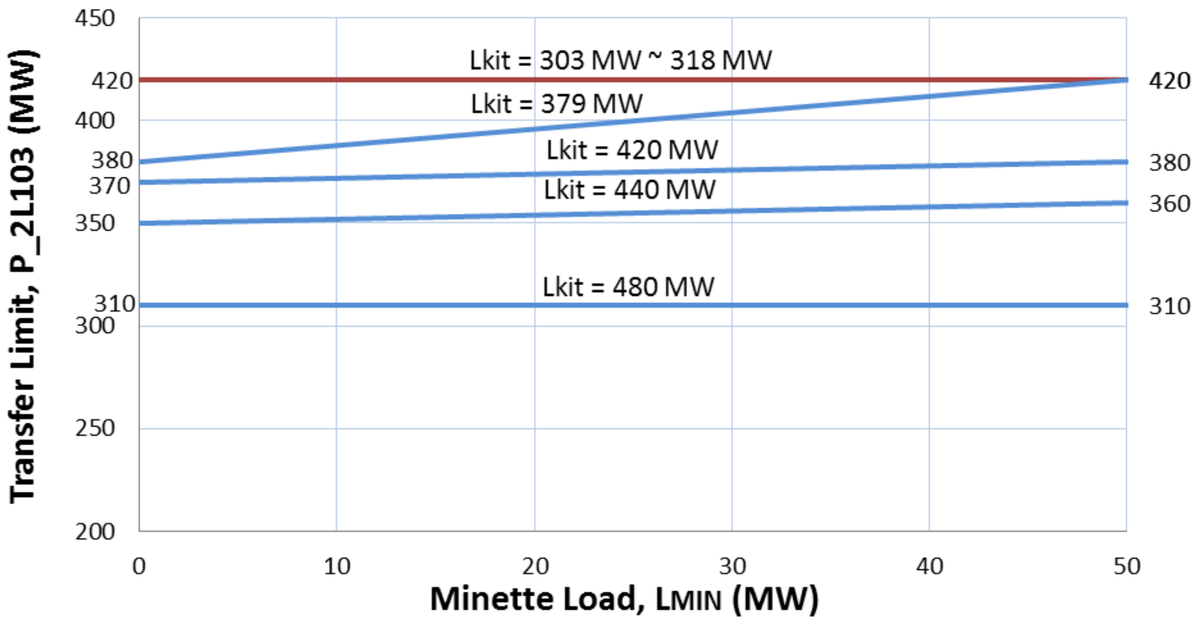


Limited by maximum allowable real power over 2L103

Limited by acceptable transient performance or KMO reactive power reserves

Nomogram A-2

RTA to BCH Transfer limit
Under system normal condition with 7 units at KMO and 4 capacitor banks at KIT

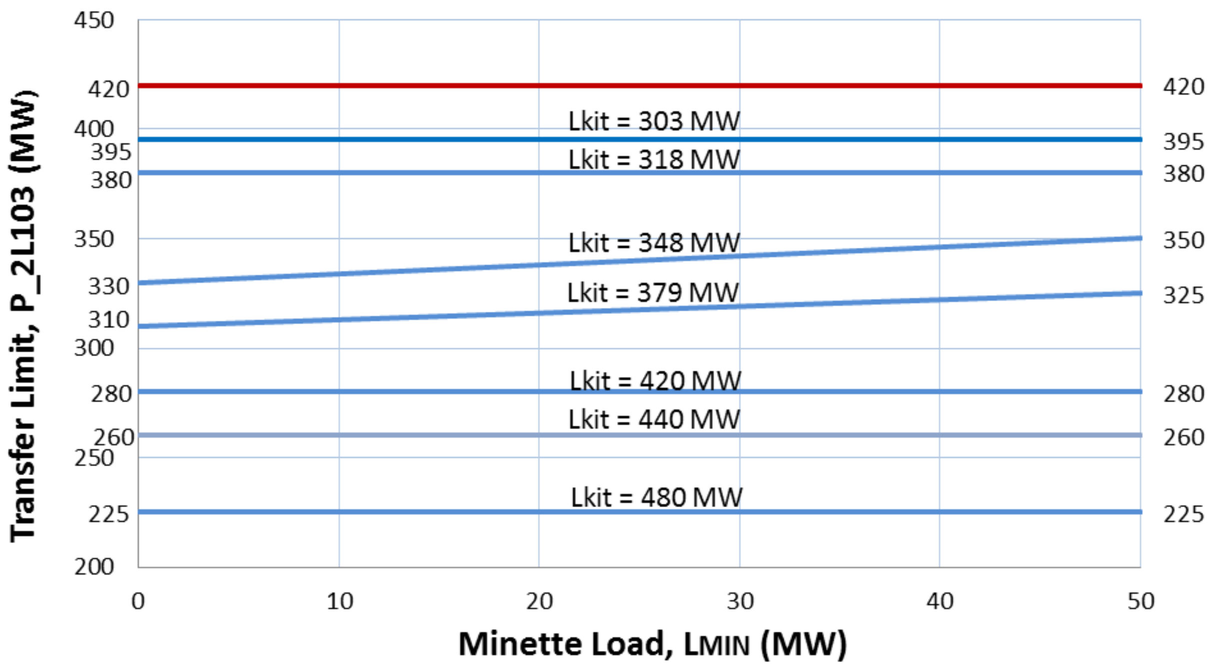


Limited by maximum allowable real power over 2L103

Limited by acceptable transient performance or KMO reactive power reserves

Nomogram A-3

RTA to BCH Transfer limit
Under system normal condition with 6 units at KMO and 4 capacitor banks at KIT



Limited by maximum allowable real power over 2L103

Limited by acceptable transient performance or KMO reactive power reserves

