Preliminary Feasibility Assessment For

The Rio Tinto Alcan to BCH Transfer Limit of 460 MW

With 50% Series Compensation on Both KMO – KIT lines

Report No: ASP2010-T001

July 2010

Asset Strategy & Planning, BC Hydro

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Executive Summary

Rio Tinto Alcan (RTA) has requested BC Hydro to conduct a preliminary assessment for the feasibility of increasing Rio Tinto Alcan to BCH transfer limit to 460 MW, with 50% series compensation on both of the KMO to KIT lines. Due to time and other constraints, only critical power flow and transient stability studies have been conducted to assess the feasibility of such transfer limit increase. This study does not cover detailed system analysis and studies for specifying all the necessary requirements to realize the increased transfer. These would have to be done separately.

The preliminary study results indicate that with KMO 8 units on line, it is feasible to increase RTA to BC Hydro transfer limit to 460 MW, with 50 % series compensation on both of the KMO to KIT lines.

The study is based on all existing North Coast transmission equipment and protection in service, and assuming that RTA will upgrade its system necessary to accommodate the recently established transfer limit of 420 MW.

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1 Introduction

Rio Tinto Alcan (RTA) has requested BCH to conduct a preliminary assessment for the feasibility of increasing its power transfer limit to 460 MW, with a 50 % series compensation on both of the KMO to KIT lines. Only critical power flow and transient stability studies have been conducted for this purpose.

2 System Assumptions

2.1 Existing North Coast System Protections

(1) Rio Tinto Alcan-BCH Tie (2L103) Tripping Scheme

Table 2.1 KIT-MIN (2L103) Tripping Scheme

Protections	settings
Under-frequency	57.5 Hz
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 |0.18 – 0.16| gap time 2 cycles • Supervision voltage 0.85 pu • Supervision voltage delay time 5 cycles
Under-voltage	KIT287 < 256 kV (0.89 pu) for 2.0 sec
Excess Power Flow to BCH	Power relay with KIT-MIN > 500 MW for 1.5 seconds

(2) Rio Tinto Alcan-KMO O/F Generation Shedding Scheme (temporary)

When KIT-MIN power flow transfer is above 150 MW, KMO three units will be armed for over frequency generation shedding at 61 Hz, 61.3 Hz and 61.6 Hz respectively. (Note that this is to be replaced with the permanent arrangement of applying direct generation shedding of KMO units upon detecting loss of some North Coast lines.)

2.2 Base Cases

The study is based on the 2010 light summer loading cases with the following system conditions:

- All existing BCH North Coast transmission equipment in service.
- KIT 287 kV bus pre-outage voltage: 285 - 287 kV

- KMO JVC in service
- KIT load: 400 MW
- 8 KMO units on line
- 5 KIT shunt capacitors in service
- Small generators/IPPs in North Coast and Peace system included in the study cases:
  - EUR generation is off line
  - BRL generation = 8 MW
  - FLS generation = 7 MW
  - MCM generation = 110 MW
  - DKW generation = 24 MW
  - BMW generation = 102 MW

2.3 RTA Updates

Assuming the following updates have been completed and are in effect, which are required to accommodate the RTA transfer limit of 420 MW:

- RTA Separation Scheme has been updated to trip multi phase fault only, from both KIT and MIN
- KMO generation shedding is available for loss of a KIT potline
- KMO generation shedding is available for loss of 5L4 (GMS-PCN) or 5L41(KLY-CKY)

2.4 Contingencies

This study only covers critical contingencies which were identified from the study results of RTA to BCH 420 MW transfer increase project (report No: SPPA 2009-154).

2.5 Generation Shedding

The existing generation shedding schemes at GMS and KMO are applied as required. Details are included in SOO 7T-13 and SOO 7T-30.

3 Study Results

Power flow and dynamic simulation studies have been performed for the following two cases:

- Case 1, system normal with KMO 8 units and KIT 5 capacitors on line, and a transfer of 420 MW on 2L103 from KIT, without series compensation on KIT to KMO lines;
- Case 2, system normal with KMO 8 units and KIT 5 capacitors on line, and a transfer of 460 MW on 2L103 from KIT, with 50% series compensation on both of KIT to KMO lines at KIT.

Table 3.1 summarizes the pre-outage voltage profiles for these two cases and Table 3.2 summarizes the transient stability and post-transient power flow study results for the selected critical contingencies.

Study results indicated that, the overall system performance for the case with RTA to BCH transfer of 460 MW and a 50% series compensation on both of KIT to KMO lines (case 2), is equal to or even better than the case of RTA to BCH transfer of 420 MW without series compensation on KIT to KMO lines (Case 1).

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Table 3.1 Pre-outage Voltage Profiles with the two study cases

Case	Voltage at KIT287 (pu) (Note 1)	Voltage at KMO287 (pu)	Total reactive power output from KMO	Comment
case 1	0.995	1.044	205.4 MVAR	In Case 2 the required reactive power support is much less than case 1 due to series compensations of KMO-KIT lines
case 2	0.995	1.022	148.7 MVAR	

Note 1: KMO regulates the voltage @ KIT287 at 0.995 pu

Table 3.2 Summary of KMO export study results
(BCH system normal with 2010 light summer loading, 8 KMO generators and 5 KIT capacitor banks on line)

#	Contingencies	KIT-MIN transfer 460 MW with 50% series compensation on both of the KMO to KIT lines (case 2)		KIT-MIN transfer 420 MW No series compensation on the KMO-KIT lines (case 1)		Comments
		Out of step relay trips 2L103 (Dynamic study)	Post-contingency overloading (Power flow study)	Out of step relay trips 2L103 (Dynamic study)	Post-contingency overloading (Power flow study)	
1	2L101 @SKA 287 bus, fault cleared @ 6 cycles, KMO gen shed 330 MW @ 11 cycles.	No	No	No	No	Existing KMO gen shed RAS
2	SKA 500kV/287kV/66kV transformer T2 & T4 3-ph fault @ SKA500 bus, 500 kV side cleared @ 5 cycles, 287 kV side cleared @ 6 cycles, 66 kV side cleared @ 11 cycles.	Note 1	Note 1	Note 1	Note 1	
3	SKA 500kV/287kV/66kV transformer T2 & T4 3-ph fault @ SKA287 bus, 500 kV side cleared @ 5 cycles, 287 kV side cleared @ 6 cycles, 66 kV side cleared @ 11 cycles.	Note 1	Note 1	Note 1	Note 1	
4	2L105 1-ph fault, @MIN 287 bus, fault cleared @ 6 cycles	No	No	No	No	
5	1L387 @SKA138 bus, fault cleared @ 8 cycles	No	No	No	No	
6	KIT potline 1, 287kV/13.2kV transformer HV 1-ph fault, cleared @ 6 cycles, potline 1 (90 MW) and shunt capacitor tripped.	No	2L103/2L99 overloading (see comments)	No	2L103/2L99 overloading (see comments)	The overloading will be resolved by KMO gen-shedding required for 420 MW transfer
7	KIT potline 1, 287kV/13.2kV transformer LV fault, cleared @ 6 cycles, potline 1 (90 MW) and shunt capacitor tripped.	No	2L103/2L99 overloading (see comments)	No	2L103/2L99 overloading (see comments)	The overloading will be resolved by KMO gen-shedding required for 420 MW transfer
8	KMO-KIT 87L 1-ph fault @KMO 287 bus, fault cleared @ 6 cycles, 1.43 second reclose successful	No	No	No	No	

#	Contingencies	KIT-MIN transfer 460 MW with 50% series compensation on both KMO to KIT lines (case 2)		KIT-MIN transfer 420 MW No series compensation on the KMO-KIT lines (case 1)		Comments
		Out of step relay trips 2L103 (Dynamic study)	Post-contingency overloading (Power flow study)	Out of step relay trips 2L103 (Dynamic study)	Post-contingency overloading (Power flow study)	
9	5L4 @GMS 500 bus, fault cleared @ 4 cycles, KMO gen shed @ 14 cycles, 0.53 second reclose unsuccessful	No (No gen shed required)	No	No (Gen shed of one KMO unit is required)	No	KMO generation shedding is required to prevent transient instability for the case without series compensation.
10	5L41 @KLY 500 bus, fault cleared @ 4 cycles, KMO gen shed @ 14 cycles, 0.48 second reclose @ KLY unsuccessful	No (No gen shed required)	No	No (Gen shed of one KMO unit is required)	No	KMO generation shedding is required to prevent transient instability for the case without series compensation.
11	5L61 1-ph fault @ GLN 500 bus, fault cleared @ 4 cycles, 0.63 second reclose @ WSN successful	No	No	No	No	
12	5L62 1-ph fault @ TKW 500 bus, fault cleared @ 4 cycles, 0.93 second reclose @ GLN successful	No	No	No	No	
13	5L63 1-ph fault @ SKA 500 bus, fault cleared @ 4 cycles, 0.93 second reclose @ TKW successful	No	No	No	No	

Note 1:

Gen shed 330 MW at KMO is required for loss of one of the SKA 500kV/287kV/66kV transformers. Currently there is no gen shed signal available for such contingencies, due to consideration of its low probability of the contingency on transformers.

4 Conclusions

A preliminary study has been conducted to assess the feasibility of increasing RTA to BCH transfer limit to 460 MW with 50% series compensation on both KMO to KIT lines. This study is a high level analysis, from power flow and transient stability perspectives only. Some selected critical contingencies have been studied, based on the assumption that all the system requirements to achieve the transfer limit of 420 MW have been implemented.

The study results, based on 8 KMO units, and 5 capacitors banks in service, indicate that it is feasible to increase RTA to BCH transfer limit to 460 MW, with a 50% series compensation on both KMO to KIT lines.

Further studies at a later date are required to determine the detailed technical requirements to accommodate the transfer limit of 460 MW.