British Columbia Transmission CORPORATION™

SEV Exciter Ceiling Voltage Reduction Impact Study For Unit 1, 2 and 3

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SYSTEM PLANNING AND PERFORMANCE ASSESSMENT

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Executive Summary

BC Hydro is concerned about the findings during commissioning that the newly installed Basler exciter for the Seven Mile Generator 2 (SEV G2) can not meet the existing ceiling voltage of 1470 Vdc due to electronic device stressed conditions. The concern would be mitigated if the exciter ceiling voltage is allowed to be lowered to 1065 Vdc, which still meets the BCTC generator transmission interconnection requirement on excitation system. As requested by BC Hydro, BCTC conducted the impact study to see if the 1065 Vdc ceiling voltage for G2 and for G1 to G3 is acceptable from system performance perspective.

Based on BCH provided the new exciter and PSS models the different system conditions and critical system contingencies are studied. Although reducing the ceiling voltages of SEV excitation system will degrade system transient performance, the study has concluded that:

- The ceiling voltage for SEV G2 excitation system can be reduced to 1065 Vdc from 1470 Vdc. With the reduced ceiling voltage, the system transient performances including SEV generator rotor angle stability and bus voltage recovery are acceptable.
- By using the same excitation system as G2 for the existing G1 and G3 and with the reduced ceiling voltage of 1065 Vdc for G1 to G3, the simulation also indicates that system performances are acceptable.

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1 Introduction

Seven Mile Generation Station (SEV) consists of 4 Hydro units. The powerhouse was originally designed for four units but only the first three units with 225 MVA generators and Francis Type Mitsubishi Turbines and Brown Boveri Unitrol exciters were installed. The fourth unit was added in April 2003 with a 233.3 MVA generator and Francis Type General Electric turbine and Cutler Hammer exciter.

The existing units 1 to 3 exciters have high 1470 V ceiling voltages with 4 parallel bridges, while the fourth unit exciter has 900 V ceiling voltage with 2 parallel bridges.

Due to aging problems, BC Hydro has changed the SEV G2 exciter in April 2008.The replaced new exciter was designed to have the similar ceiling voltage of the existing one. However, during the commissioning of the newly installed Basler exciter it was found out that there were some over voltage problems with the power electronic components. This means that the Basler exciter can not achieve the ceiling voltage of 1470V dc due to electronic device stressed conditions. This will not be a concern if the exciter ceiling voltage is allowed to be lowered to 1065 Vdc, which still meets the BCTC generator transmission interconnection requirement on excitation system. As requested by BC Hydro, BCTC conducted this study to see if the 1065 Vdc ceiling voltage is acceptable for SEV G2 and other two units (1 & 3) from system performance perspective.

2 Study Conditions and Criteria

2.1 Conditions

- SEV G1, G2 and G3: new dynamic model and data for exciter and PSS with High (1470Vdc) and Low (1065Vdc) exciter ceiling voltages as provided by BC Hydro. Please refer to Appendix A for the models and their associated parameters.
- The generator VAR capability (supporting and absorbing) will not change due to the ceiling voltage reduction.
- System operational restrictions and generation shedding for contingencies: per SOO 7T-34 dated 5 June 2008.
- BCH spring load range: 8000 MW for heavy spring and 5000 MW for light spring.
- BC to US and BC to AB transfers are adjusted based on the requirements of the System Operating Orders. The adjustment is to setup stressed system conditions.
- Generation pattern: SI high generation, including the maximum SEV generation, high generation in KCL, ALH, BRX, FBC River Plants, BRD, WAN and BDY. MCA and REV are also set to high to cover the stressed operation conditions for the studied contingencies.

2.2 Criteria

- "BCTC System Operating Limits methodology", SPA Report No. SPA2008-02, 4 January 2008.

- "BCTC 69 kV to 500 kV interconnection requirements for power generators", December 2006.

3 Conclusion

In this study, three different pre-fault conditions with high transfer from Selkirk (SEL) to Nicola(NIC): heavy spring and light spring with system normal configuration and light spring with 5L91 (SEL to NIC) out of service, along with critical contingencies 2L222 (SEV to SEL), 5L76 (ACK o NIC) & 5L79 (ACK to NIC), and 5L81 (NIC to ING) & 5L82 (NIC to MDN) are studied to meet the criteria and methodology as described in the document "BCTC System Operating Limits Methodology" (Report No. SPA2008-02, dated 4 January 2008). The study has showed that although reducing the ceiling voltages of SEV excitation system will degrade system transient performance, but the degradations are acceptable based on the system performance requirement. The conclusions are:

- The ceiling voltage for SEV G2 excitation system can be reduced to 1065 Vdc from 1470 Vdc. With the reduced ceiling voltage, the simulation indicates that the system transient performances including SEV generator rotor angle stability and bus voltage recovery are acceptable.
- By using the same excitation system as G2 for the existing G1 and G3 and with the reduced ceiling voltage of 1065Vdc for G1 to G3, the simulation also indicates that system performances are acceptable.

The above conclusions are based on the follows:

- The dynamic models and data of SEV G2 listed in Appendix A, which were provided by BC Hydro.
- The generator VAR capability (supporting and absorbing) will not be reduced due to the ceiling voltage reduction.

Any deviations from of the above conditions may require reassessment of the impact and the conclusions are subject to change.

Appendix A: New Exciter and PSS Models and their associated Parameters

Seven Mile G2 Model Data (GE PSLF Format)

1 UNIT NAMEPLATES AND GENERATOR DATA

1.1 GENERATOR

Manufacture:	Hitachi	Type	VTFKW
Field Volts:	356V	Field Amps:	1890A
Volts:	13 800V	Amps:	9 413A
kVA:	225 000kVA	kW:	202 500kW
PF:	0.9	Phase:	3
Cycles:	60Hz	Speed:	94.7rpm
Poles:	76		
Ins Class:	Stator: B		
Standard:	ANSI C50.12.1965	Date:	1980

Table 1: Generator Name Plate rating

1.2 EXCITER

Manufacture:	Basler Electric		
Model:	ECS2100		
Voltage:	1470 V (Ceiling)	Current:	3840 A
Bridges:	3 Parallel	Continuous:	2400 A
Transformer:	13 800 V:1190 V Y:Δ Δ 3x1347 kVA		

Table 2: Exciter Name plate rating

SEV G2 1 PU Values				
E_{field}	I_{field}	MVA	$V_{terminal}$	I_{stator}
197.9 V	1050A	225 MVA	13.8 kV	9 413 A

Table 3: Base Values

1.3 GENERATOR MODEL PARAMETERS

Parameter	Reported As:
Generator Model: GENSAL	
Tpdo (T'do)	**5.0**
Tppdo (T''do)	**0.05**
Tppqo (T''qo)	**0.13**
H	**4.4**
D	**0**
Ld (Xd)	**0.82**
Lq (Xq)	**0.54**
Lpd (X'd)	**0.27**
Lppd (X''d)	**0.22**
Ll	**0.16**
S10	**0.126**
S12	**0.458**
Ra	**0**
Rcomp	**0**
Xcomp	**-0.033**

Table 4: Generator Model Parameters

1.4 EXCITER MODEL PARAMETERS

Parameter	Reported As:
Exciter Model: EXST1	
Tr	**0.001**
Vimax	**10**
Vimin	**-10**
Tc	**0.05**
Tb	**0.025**
Ka	**70**
Ta	**0.03**
Vrmax	**7.5**
Vrmin	**-5.5**
Kc	**0.15**
Kf	**0**
Tf	**1**
Tc1	**0**
Tb1	**0**
Vamax	**100**
Vamin	**-100**

Parameter	Reported As:
Xe	**0.05**
Ilr	**0**
Klr	**0**
PSS Model: PSS2A	
TW1	**5.00**
TW2	**5.00**
TW3	**5.00**
TW4 (Bypassed)	**0**
KS2	**0.568**
KS3	**1.00**
KS4	**1.00**
T6	**0**
T7	**5.00**
T8	**0.25**
T9	**0.10**
M	**3.00**
N	**2.00**
KS1	**3.00**
T1	**0.3413**
T2	**0.0742**
T3	**0.3413**
T4	**0.0742**
Vstmax	**0.10**
Vstmin	**-0.10**

Table 5: Exciter & PSS Model Parameters