[redacted] Bridge River #2
Unit 5 - Unit 8 Generators Upgrade Project

Interconnection System Impact Study

Report #: T&S Planning 2016-053

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British Columbia Hydro and Power Authority

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Revision Table

Revision Number	Date of Revision	Revised By

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Executive Summary

[redacted], the Interconnection Customer (IC), is planning the Bridge River #2 Generating Station Unit 5 to Unit 8 Generators Upgrade project, which would replace the existing Bridge River #2 (BR2) generating units 5, 6, 7 and 8 with four new 75 MW units. A system impact study (SIS) documented in this report was performed to assess transmission system impact of the proposed BR2 Upgrade project. The point of interconnection (POI) for the upgraded BR2 generating station is at the BR2 ends of the two 360 kV transmission lines 3L13 and 3L14 between BR2 and the Bridge River Terminal (BRT). The commercial operation date (COD) for the generator upgrade project is November 30, 2020, and the in-service date for the units 5 and 6 is scheduled to be September 30, 2018.

There are some pre-existing transmission constraints on the 230 kV line 2L90 between BRT and Kelly Lake (KLY) substation and on the Rosedale (ROS) transformer as well. These constraints have been mitigated by restricting generation outputs at Bridge River #1 (BR1) and BR2. With additional power generated from the BR2 upgraded units, the constraints in the area transmission grid will be exacerbated. The SIS has identified the following conclusions and requirements:

1. The BR2 Upgrade project will make it necessary to increase the rating of the existing single 230 kV line 2L90 (BRT- KLY) to a 90°C rating. With the 2L90 upgrade in place and in system normal operating conditions some generation restriction will still be needed.
2. For the purpose of this SIS, it has been assumed that line 2L90 will be uprated for operating at 90°C and that the line upgrade will be delivered with a separate project, not associated with the BR2 Upgrade interconnection.
3. Two transmission reinforcement options with certain variations to remove those pre-existing constraints are discussed in this report. The final transmission solution to strengthen the 230 kV transmission link between BRT and KLY will be determined in a separate Transmission Planning study. The selected solution will be delivered with a separate transmission project.
4. With the necessary upgrade on the transmission link between BRT and KLY, the Bridge River region would be more strongly connected to the BCH backbone system via KLY, which would improve the region's stability and reliability performance, increase system operation flexibility, and reduce transmission losses. This would also facilitate future generation developments in the region from Cheekye (CKY) to BRT and to ROS/Wahleach (WAH).
5. With adequate generation shedding specified in Operating Order 7T-14, stability performance for the BR2 upgraded units was shown to be acceptable.
6. BR2 is not required to have black start (self-start) capability. Each of the four new units should be capable of synchronous condenser operation to support the transmission system voltage.

There are no costs allocated to the interconnection Network Upgrades for this interconnection request, and thus no cost estimate of the interconnection Network Upgrades was produced in the SIS. It has been assumed that any costs associated with the generator commissioning process as well as coordination with Fraser Valley Office (FVO) and field personnel will be

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included in the overall Generation budget for the BR2 upgrade and will be identified during the Facilities Study phase.

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1. Introduction

[redacted], the Interconnection Customer (IC), is planning to replace the existing Bridge River #2 (BR2) generating units 5, 6, 7 and 8 with new ones rated 75 MW or 83 MVA each. The existing BR2 generating station has four generating units, each rated 65.25 MVA, and is connected to the BC Hydro integrated system at the Bridge River Terminal (BRT) via two 360 kV transmission lines 3L13 and 3L14 (BR2-BRT). The 360 kV connection of the plant remains unchanged with the generation upgrade.

A system impact study (SIS) is required to assess the transmission system impact of the proposed generation upgrade. The commercial operation date (COD) for the Bridge River #2 Unit 5 to Unit 8 Generators Upgrade project is November 30, 2020, and the in-service date (ISD) for the units 5 and 6 is scheduled to be September 30, 2018. The project reviewed in this SIS is summarized in Table 1 below.

Table 1: Summary of Project Information

Project Name	Bridge River #2 Unit 5 to Unit 8 Generators Upgrade Project	
Interconnection Customer	[redacted]	
Point of Interconnection	The BR2 ends of 3L13 and 3L14 (BR2 – BRT)	
IC Proposed COD	November 30, 2020 (ISD of Units 5-6: Sept 30, 2018)	
Type of Interconnection Service	NRIS ☒	ERIS ☐
Maximum Power Injection (MW)	300 (Summer)	300 (Winter)
Number of Generator Units	4	
Plant Fuel	Hydro	

At BRT, another [redacted] generating plant Bridge River #1 (BR1) is connected via the 360 kV lines 3L15 and 3L16 (BR1 – BRT). The existing BR1 generating station has four 50 MVA generating units. A 230 kV circuit 2L19 between BR1 and BRT is used to collect surplus generation from the local 60 kV network, in which Seton (SON), Walden North (WDN), Lajoie (LAJ) and Jamie Creek (JME) generating stations are connected. There are two 230/60 kV transformers at BR1. The IC is also contemplating to upgrade the existing units at BR1, LAJ and SON in a foreseeable future, but no interconnection study has been requested. Thus in this SIS, the capacity of the existing units in those plants is considered only.

BRT is connected to the integrated system through three 230 kV and one 360 kV transmission lines, named as 2L1, 2L41 (both from BRT towards Cheekye substation or CKY), 2L90 (from BRT to Kelly Lake substation or KLY) and 3L2 (from BRT to Upper Harrison Terminal or UHT). The transmission lines transmit electricity from the Bridge River region's generators to the

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integrated system via three different paths, one towards CKY via 2L1 and 2L41/2L2, one toward UHT and Rosedale (ROS) via 3L2/3L5, and the third towards KLY via 2L90. Refer to Figure 1 below.

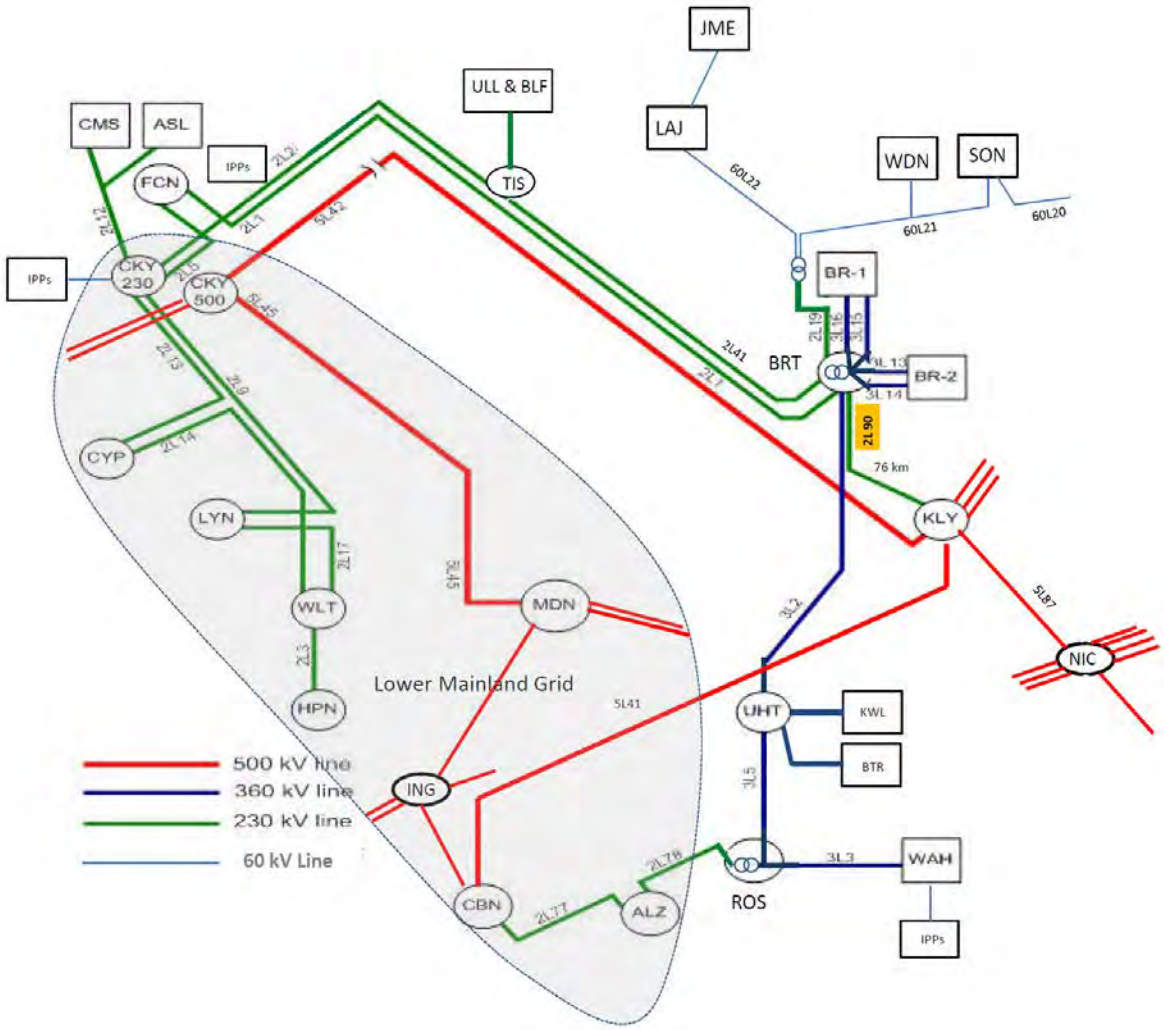

Figure 1: Bridge River and adjacent transmission system

KLY is one of the key 500 kV substations in the BC Hydro backbone system. Although geographically distant from Lower Mainland, it is connected to the Lower Mainland load center via multiple compensated 500 kV lines and thus is electrically very close to the load center. The path from BRT to the load center via KLY also offers low transmission losses in both real power and reactive power compared to the other two paths. However, line 2L90 has been highly congested with generation additions (the Kwalsa cluster or KWL, the Upper Lillooet cluster or ULL, and others) from BCH's Clean Power Call, which had been concluded in the previous interconnection studies for the Clean Power Call projects.

The existing line 2L90 has a low thermal rating of 203 MVA in Summer ambient temperature conditions, and is therefore easily getting overloaded during high generation outputs from the region. In the real time operation, 2L90 is opened when necessary to prevent an overload. Two

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congested segments identified in the previous studies for the Clean Power Call projects are the 230 kV line 2L90 and the ROS transformer T1. Line 2L90 could be severely overloaded and was required to be upgraded for 90°C operation. The ROS T1 could be overloaded slightly during high generation outputs if 2L90 is upgraded and in closed operation. It was suggested in those studies that the ROS T1 overloading could be mitigated by manual generation re-dispatch via system operators.

The line 2L90 was planned to be upgraded for 90°C operation in 2010, but the project was canceled in 2014 and generation restriction at the existing BR1 and BR2 was chosen to mitigate the 2L90 overloading problems and also prevent overloading the ROS transformer. It can be expected that with increasing power injections from the new BR2 units, the area transmission grid will be stressed further.

2. Purpose of Study

The purpose of this SIS is to assess the impact of the interconnection of the proposed project on the BCH Transmission System. This study will identify constraints and suggest Network Upgrades options to obtain adequate performance for the reliable operation of the Transmission System, which is in compliance with the North American Electric Reliability Corporation (NERC) and Western Electricity Coordinating Council (WECC) reliability standards, and the BCH transmission planning criteria.

However, determination of a final transmission solution to remove some pre-existing transmission constraints is beyond this SIS scope, which will be addressed in a separate Transmission Planning study.

3. Terms of Reference

This study investigates and addresses the voltage and overloading issues of the transmission networks in the vicinity of the BR2 project as a result of the proposed interconnection. Topics studied include equipment thermal loading and rating requirements, system transient stability and voltage stability, transient over-voltages, protection coordination, operation flexibility, telecom requirements and high level remedial action scheme requirements. BCH planning methodology and criteria are used in the studies.

The SIS does not investigate the operating restrictions and other factors for the possible second contingency outages. Subsequent internal network studies will determine the requirements for reinforcements or operating restrictions/instructions for those kinds of events. Impact to the 500 kV transmission systems is not included in the SIS and will be covered in a separate study.

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4. Assumptions

The power flow conditions include generation, transmission facilities, and load forecast representing the queue position applicable to this project. Applicable seasonal conditions and the appropriate study years for the study horizon are also incorporated. BC Hydro 2021 light summer (LS), heavy summer (HS) and 2020 heavy winter (HW) system configuration and load/generation conditions were selected and modelled in the cases used for this study. Facilities with higher queue priority are also represented in these cases. The study is based on the latest model, data, and information received from the Interconnection Customer (IC) on September 5, 2015.

The BRT-KLY line 2L90 existing Summer thermal rating is 203 MVA. The BRT to KLY transmission link reinforcement will be available when all BR2 new units are on line. The final solution to reinforce that transmission link will be determined in a separate Transmission Planning study and delivered with the separate transmission project.

The existing fault clearing times are used in this SIS and listed together with the generation shedding times in Tables 2 and 3.

Table 2: Fault Clearing Time

Contingency	Multiphase Fault Clearing Time (Cycles)	
	Near End	Far End
230 kV lines	6	7
3L2	5	6
3L5	5	6

Table 3: Generation Shedding Time

Generation Shedding at	Generation Shedding Time (Cycles)
BR1 &BR2	12
KWL Cluster	12
Bremner/Trio	12

5. System Studies

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5.1 Transmission Planning Study

Power Flow Results

Power flow analyses under system normal and single contingency conditions were performed to evaluate whether BR2 units 5-8 upgrade project would cause any adverse impact in the nearby area. Selected transmission study results in various system scenarios are listed in Table 4. In Table 4, OOS in the column of System Conditions is short for "out of service".

Table 4: Power Flow Results with 2L90 only

Scenarios	System Conditions	BR1 & BR2 Outputs in MW	BCH Load + Losses in MW	2L90 Flow (MVA)	ROS T1 Flow MVA	2L90 Loading Percentage		ROS T1 Loading Percentage
						(Existing Rating)	(Uprated Rating)	
1	2021 LS Normal	490	5688	373	477	183.3%	94.4%	106.1%
2	2021 LS Normal	0	5673	210	297	103.3%	53.2%	66.1%
3	2021 LS 2L90 OOS	490	5716	N/A	631	N/A	N/A	140.2%
4	2021 LS 2L90 OOS	130	5687	N/A	453	N/A	N/A	100.7%
5	2021 HS Normal	490	7730	296	491	145.5%	75.0%	109.0%
6	2021 HS Normal	200	7725	205	389	100.8%	52.0%	86.5%
7	2021 HS 2L90 OOS	490	7752	N/A	614	N/A	N/A	136.4%
8	2021 HS 2L90 OOS	160	7730	N/A	454	N/A	N/A	100.8%
9	2020 HW Normal	490	10974	224	476	63.0%	46.0%	105.8%
10	2020 HW 2L90 OOS	490	10989	N/A	548	N/A	N/A	121.8%
11	2020 HW 2L90 OOS	255	10982	N/A	452	N/A	N/A	100.4%

Note 1. 2L90 existing rating: summer 203.2 MVA; winter 354.6 MVA.
Note 2. 2L90 uprated rating: summer 394.4 MVA; winter 486 MVA.

<u>System Normal (N-0)</u>

With the existing 2L90 thermal rating (203 MVA) under the system normal condition (N-0), in both light summer and heavy summer load scenarios, and during high generation outputs in the arch area from CKY to BRT and to WAH, 2L90 would be overloaded severely (at 183% of rating in Case 1 for light summer conditions and 145% in Case 5 for heavy summer conditions). Overloading on ROS T1 has also been observed under system normal conditions (at 106% of rating in Case 1, and 109% in Case 5).

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In light summer cases in this study, it has been observed that the total output from BR1&BR2 would need to be reduced down to zero MW to avoid overloading 2L90 (Case 2) for summer weather conditions (ambient temperature of 30°C, as in Operating Order 5T-10). In heavy summer load cases, the output from BR1&BR2 would need to be reduced to 200 MW (Case 6) for summer weather conditions.

If 2L90 is opened under the above considered conditions, the remaining transmission lines (2L1, 2L41, 3L2 and etc.) will carry all the generation outputs in the area, and severe overloading of ROS T1 will occur (Case 3). In this case, the transmission system losses will increase by up to 28 MW compared to operating with 2L90 closed. In this operating condition with 2L90 open the ROS T1 overload problem will be more severe and require BR1 & BR2 generation to be restricted. In light summer condition the BR1&BR2 total generation output would be limited to 130 MW (Case 4) to avoid overload on ROS T1. In heavy summer condition the BR1&BR2 total generation output would be limited to 160 MW (Case 8) to avoid overload on ROS T1. Cases 7, 9, 10 and 11 show the transformer overloads in other loading conditions with or without generation restrictions at BR1 and BR2.

From the power flow studies, it has been found that reducing generation at BR1 & BR2 is only partly effective in reducing the 2L90 loading. To reduce flow on 2L90 by certain amount, approximately three times that amount of generation has to be reduced at BR1&BR2. Generation reductions at other locations such as at WAH, CMS and LAJ/SON were also investigated and found even less effective for 2L90 flow reduction.

Based on the above BR1 & BR2 output limitations the IC assessed the impact on its generation operation and expressed that it would be inappropriate to continue restricting BR1&BR2 generation output to control loading on 2L90. It has been assumed for this SIS purpose that 2L90 will be uprated for operating at 90°C as a Transmission capital project.

With the assumption of 2L90 Upgrade in place, 2L90 can be kept in closed operation and generation restrictions for 2L90 overload are eliminated. However, ROS T1 can still be overloaded in system normal conditions. Two options for the ROS T1 overloading problems are described below:

Option 1: No further upgrade will be needed after the 2L90 upgrade mentioned above.

Overloading on ROS T1 under system normal can still occur and would continue to be handled by generation restrictions. If generation restriction at BR1&BR2 is used, 75 MW reduction in light summer and 120 MW reduction in heavy summer would be needed under the considered system conditions. If WAH is chosen, reduction would be 40 MW in light summer and 65 MW in heavy summer.

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Option 2: Restore 2L91 and operate in parallel with 2L90. This will remove the ROS T1 overloading problem in system normal. Same as the 2L90 upgrade, restoration of 2L91 if selected would be a Transmission capital project.

There are two sub-options under Option 2. One is to upgrade 2L91 together with 2L90 for 90^{o}C operation, and the other is to rebuild 2L91 as a brand new circuit and keep 2L90 operating at its present ratings. Refer to Section 6.3 Transmission Line Upgrade for more details.

It has been suggested that restoration of 2L91 strategically should be delivered together with the 2L90 upgrade if both lines are needed in the future. Restoring line 2L91 will also significantly reduce transmission losses. With 2L91 in parallel operation with 2L90, more power flow from BRT in this case would be transmitted towards KLY which is electrically very close to the Lower Mainland load center. The path from BRT via KLY towards Lower Mainland results in lower losses in real power and reactive power compared to the other two paths. The power flow results with 2L91 restored are listed in Table 5 below. It can be observed from a comparison between the results in Tables 4 and 5 that the transmission losses with both circuits in operation would be lower by 4-9 MW in different system load conditions.

Table 5: Power Flow Results with 2L90 & 2L91 both in service

Scenarios	System Conditions	BR1 & BR2 Outputs in MW	BCH Load + Losses in MW	2L90 & 2L91 flow in MVA	ROS T1 flow in MVA	2L90 & 2L91 Loading Percentage	ROS T1 Loading Percentage
1	2021 LS Normal	490	5679	498	420.6	63.1%	93.5%
2	2021 HS Normal	490	7725	400	452	50.7%	100.5%
3	2020 HW Normal	490	10970	297	449	37.7%	99.8%

Note 1. 2L90 & 2L91 uprated rating: summer 788 MVA; winter 972 MVA.

The restoration of 2L91 will also provide additional benefits. Line 2L91 will provide future generation development opportunities in the adjacent areas, increase transmission system reliability under all system conditions, and increase operation flexibility for Generation and Transmission.

Replacing or upgrading the existing ROS transformers T1 with higher rating units may be one of the effective solutions to remove the transformer overload concern. However, this transformer upgrade would need to also be considered in relation to possible long-term changes to the 360 kV transmission configuration, which is beyond this SIS scope and should be included in separate Transmission Planning studies.

<u>Single Contingencies (N-1):</u>

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In both Option 1 and Option 2 scenarios, single contingencies can still cause transmission system overloads. The existing Bridge River system generation shedding scheme will be relied on to resolve the overloading issues under various contingencies. The Bridge River 2 new units 5-8 are required to join the generation shedding schemes. It can be expected that the required amount of generation shedding will be significantly less in Option 2 which has line 2L91 restored.

Transient Stability Study Results

Transient stability simulations with 3 phase transmission line faults and normal fault-clearing time were performed on the 2021 light summer load scenarios with the 2L90 upgrade and kept in service. The stability simulation cases used the existing Bridge River area generation shedding actions where necessary. A few selected transient stability study results are listed in Table 6 below. With adequate generation shedding specified in Operating Order 7T-14, stability performance for the BR2 upgraded units was shown to be acceptable.

Table 6: Selected transient stability results for 2021 Light Summer case

Case	Contingency	3-Ph Fault Location	Fault Clearing (Cycles)		Performance of new BR2 units	Min. Transient Voltage (p.u.)	Shedding at KWL, BR1&2 and others?
			Near End	Far End			
1	3L2	UHT	5	6	Acceptable	0.86	Yes
2	3L5	UHT	5	6	Acceptable	0.81	Yes
3	2L41	BRT	6	7	Acceptable	0.92	Yes
4	2L78	ROS	6	7	Acceptable	0.89	Yes
5	2L90	BRT	6	7	Acceptable	0.85	Yes

With 2L91 in parallel operation with 2L90, the generation in the Bridge River region would be tightly connected into the BCH backbone system via KLY, which would increase the region’s stability performance as well. It is expected that stability performance with 2L91 restored would be improved, which would greatly reduce the amount and also likelihood of generation shedding, especially for a 2L90 line fault.

5.2 Analytical Studies

The BR2 unit 5-8 upgrade will not raise additional concerns of overvoltage in the Bridge River transmission system.

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5.3 Fault Analysis

The short circuit analysis for the System Impact Study is based upon the latest BC Hydro system model, which includes project equipment and impedances provided by the IC. The model included higher queued projects and planned system reinforcements but excluded lower queued projects. Thevenin impedances, including the ultimate fault levels at POI, are not included in this report but will be made available to the IC upon request.

6. Upgrades for the BRT-KLY Transmission Options

6.1 Remedial Action Scheme (RAS)

For Option 1, there is no new RAS function required. If ROS T1 is thermally overloaded for steady state normal operation, Energy Management System (EMS) shall give an alarm and operators will need to take manual actions so that ROS T1 will not be overloaded. The shedding requirement for the existing BR2 G5 to G8 is applicable to the upgraded BR2 G5 to G8.

For Option 2, 2L91 contingency is required to be added as an input signal to the existing Bridge River area generation shedding RAS programmable logic circuits (PLC) at BRT. The shedding requirement for the existing BR2 G5 to G8 is applicable to the upgraded BR2 G5 to G8.

6.2 Station Upgrade Requirements

For Option 1, no additional station work is needed.

Option 2 will require station upgrades:

At KLY:

- Add a 230 kV circuit breaker, capacitive voltage transformers, and surge arrestors for line 2L91;
- Remove 2L91 terminal grounding switch and the lock open restriction on incomer disconnect switch.

At BRT:

- Add a 230 kV circuit breaker and surge arrestors for 2L91.

6.3 Transmission Line Upgrade Requirements

Line 2L90 and 2L91 were built around 1963 -1965. In 2002 and 2004, forest fires destroyed sections of 2L90 and 2L91. As a result the circuits were ‘spliced’ together in this area and currently only 2L90 is energized.

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Two options with some variations in sub-options are listed below and were assessed to determine magnitude of the associated upgrade works.

Option 1: Upgrade 2L90 to 90°C

- 1A: using the existing alignment
- 1B: using the original 2L90 alignment

Option 2: Restore 2L91 to operate in parallel with 2L90

- 2A: Upgrade both circuits to 90°C
- 2C: Rebuild 2L91 with a large conductor and leave 2L90 operating at its present ratings

It has been assumed in the assessment that all existing conductors can be re-used for the upgrade options (1A, 1B and 2A). However, both of these circuits were built in the early 60's so they are already reaching the end of design life, and more detailed studies in the future will be needed to determine their performance conditions. A preliminary study indicates that both 2L90 and 2L91 do not meet the current BCH radio interference standards. This can be addressed by installing conductor Narcissus (644.5mm ASC), larger than the existing one, which has been captured in Option 2C.

No detailed assessment information is presented in this SIS report due to the fact that the 2L90/2L91 Upgrade will be delivered with another project.

6.4 Protection and Control Requirements

Protection

For Option 1, review or remove line thermal settings in 2L90 protection at BRT.

For Option 2, provide new line protection for 2L91 at BRT and KLY. New telecommunication WECC Class 2 38,400 bps RS-232 circuits between BRT and KLY are required for the new 2L91 line protection. Review or remove the line thermal settings in 2L90 protection at BRT. Make wiring changes in 2L1, 2L19, T4, 2B4 protections and Zone C tripping scheme at BRT. Make wiring changes in 2L86 and 2L94 line protection at KLY.

Control

For Option 1, there is no control work in the BCH transmission system.

For Option 2, make wiring changes required to add 2L91 contingency input into the RAS arming PLC. Provide metering via new relays at BRT and KLY. Also, provide remote access for the new

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relays at BRT and KLY. At Control center, update the database and displays to accommodate the addition of new 2L91 between BRT and KLY. Bridge River Area RAS will have to be re-presented to WECC to get their confirmation that this scheme is a LAPS (Local Area Protection Scheme).

6.5 Telecommunications

For Option 1, no additional Telecommunication work is needed.

For Option 2, add WECC Class 2 PY & SY RS-232 38.4 kbps circuits between BRT and KLY for “BRT-KLY 2L91 DIGITAL TELEPROT”.

6.6 Cost Estimate and Schedule

No cost has been allocated to interconnection Network Upgrade works, and no cost estimate is needed for the BR2 unit 5-8 upgrade project.

7. Additional Requirements

7.1 Islanded Operation

There are some operating conditions that the BR2 units (perhaps also with other generators) can be left in an islanded operation with nearby loads. In such operating scenarios, the system voltage and the frequency could experience wider variations than those in normal operation. To properly handle such situations, minimum number of generating units at BR1 and BR2 is required on line before certain anticipated islands form. Those operating requirements have been specified in Operating Oder 7T-14 for the existing BR2 units, and will need to be updated for the upgraded BR2 units.

7.2 Black Start Capability

The existing BR2 or BR1 does not have black start (self-start) capability. A nearby BCH generating plant SON is equipped with black start capability for remote operation in an islanding mode, which can be used to initiate a system restoration for the region. Thus, black start capability is not required at the upgraded BR2.

It should be noted that SON could lose its black start capability during the period when the plant undergoes its considered upgrade, which means that the region would lose the initiating point for system restoration. It may also be beneficial to add black start capability at BR1 or BR2 with its unit upgrade project, which could facilitate system restoration for the region.

7.3 Transmission Voltage Support

Each of the four existing units is capable of synchronous condenser operation, and the upgraded generators are required to have this feature to support the transmission system voltage.

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8. Revenue Metering

No Revenue Metering is required for this project.

9. Conclusions and Discussions

This System Impact Study has identified the following issues and requirements:

With the existing 2L90 thermal rating (203 MVA) under system normal condition (N-0), in both light summer and heavy summer load scenarios, and during high generation outputs in the area from CKY to BRT and to WAH, 2L90 would be overloaded severely. Overloading on ROS T1 has also been observed under system normal conditions.

If 2L90 is opened under the above considered conditions, the remaining transmission lines (2L1, 2L41, 3L2 and etc.) will carry all the generation outputs in the area, and severe overloading of ROS T1 will occur. In this case, the transmission system losses will increase significantly compared to operating with 2L90 closed. In this operating condition with 2L90 open the ROS T1 overload problem requires BR1 & BR2 generation to be restricted.

It has been found that reducing generation at BR1 & BR2 is only partly effective in reducing the 2L90 loading. To reduce flow on 2L90 by certain amount, approximately three times that amount of generation has to be reduced at BR1&BR2. Generation reductions at other locations such as at WAH, CMS and LAJ/SON were found even less effective for 2L90 flow reduction.

It has been assumed for the purpose of this SIS that line 2L90 will be uprated for operating at 90^{o}C and that the line upgrade will be delivered with a separate project, which is not associated with the new BR2 interconnection. With the assumption of 2L90 Upgrade in place, 2L90 can be kept in closed operation and generation restrictions for 2L90 overload are eliminated. However, ROS T1 can still be overloaded in system normal conditions.

Two transmission reinforcement options with certain variations are discussed in this SIS to strengthen the 230 kV transmission link between BRT and KLY. The final transmission solution to remove those pre-existing constraints will be determined in a separate Transmission Planning study and the selected solution will be delivered with a separate transmission project.

With a strengthened transmission link between BRT and KLY, the Bridge River region would be tightly connected into the BCH backbone system via KLY, which would improve the region's stability and reliability performance, increase system operation flexibility and reduce transmission losses. This would also facilitate future generation additions in the arch region.

An ongoing transmission project is to relocate a portion of the existing 60 kV line 60L20, and that portion is currently using a segment of line 2L91. There may be some synergy between

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the 60L20 relocation and the 2L90 link upgrade, which should be investigated in the separate Transmission Planning study.

With adequate generation shedding specified in Operating Order 7T-14, stability performance for the BR2 upgraded units was shown to be acceptable. It is expected that stability performance with 2L91 restored would be improved, which would greatly reduce the amount and also likelihood of generation shedding, especially for a 2L90 line fault.

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Appendix A:

Generator, exciter, compensator, stabilizer, governor models and parameters

Generator G5-8 each: Unit Rating 83.0 MVA, 74.7 MW, 13.8 kV; +0.9, -0.9 pf
And Ra= 0.0032 pu

Unit	Model	T'do	T"do	T'qo	T"qo	H	D	Xd	Xq	X'd
G5-8	GENTPJU1	7.67	0.06	0.0	0.15	3.188	0.0	0.93	0.68	0.31
		X'q	X"d	X"q	Xl	$S_{G1.0}$	$S_{G1.2}$	K_{is}		
		0.67	0.27	0.27	0.20	0.176	0.471	0.0		

Voltage Regulator current Compensating Model (COMP) Settings:

Unit	Xe
G5-8	+0.0718

Stabilizer Model (PSS2A) Settings: Input signals: #1 rotor speed deviation (pu)
#2 generator electrical power on MBASE (pu)

Unit	M	N	T_{W1}	T_{W2}	T_6	T_{W3}	T_{W4}	T_7	K_{S2}	K_{S3}
G5-8	5	1	5.0	5.0	0.0	5.0	0.0	5.0	0.762	1.0
	T_8		T_9	K_{S1}	T_1	T_2	T_3	T_4	V_{STMAX}	V_{STMIN}
	0.5		0.1	7.0	0.187	0.013	0.233	0.3	0.10	-0.10

Excitation System model EXST1 - as submitted:

Unit	Model	TR	Vimax	Vimin	Tc	Tb	Ka	Ta	VRmax	VRmin
G5-8	EXST1	0.001	0.037	-0.0315	8.3	18.675	450.	0.003	7.40	-6.29
		Kc	Kf	Tf						
		0.0	0.0	0.001						

Turbine/Governor model PIDGOV – not used, but best available model and data & settings are:

Unit	Model	Rperm	Treg	Kp	Ki	Kd	Ta	Tb	Dturb		
G5-8	PIDGOV	0.041	0.05	2.8	2.0	0.0	0.01	0.15	0.09		
G0	G1	P1	G2	P2	P3	Gmax	Gmin	Atw	Tw	Velmax	Velmin
0.032	0.35	0.11	0.88	0.92	1.15	1.0	0.0	0.25	1.22	0.008	-0.13
	Feedback signal										

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