Interconnection System Impact Re-Study

[redacted]

Pennask and Shinnish Creek Wind Project

Report No: T&S Planning 2015-050

October 2015

Final

British Columbia Hydro and Power Authority

ACKNOWLEDGEMENTS

This report was prepared and reviewed by T&D, Interconnection Planning and approved by both Interconnection Planning and Transmission Generator Interconnections.

Revision Table

Revision Number	Date of Revision	Revised By

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EXECUTIVE SUMMARY

[redacted] the Interconnection customer (IC), is proposing to develop the Pennask and Shinnish wind farms in the Thompson-Okanagan area of British Columbia. The project consists of two different sites at Pennask Creek (PWF) and Shinnish Creek (SWF). A System Impact Study was performed in late 2014 upon the IC's application at that time, and the results were documented in a report (Report No. T&S Planning 2014-072). In early 2015, the IC modified the technology of the wind turbines from Type 3 to Type 4, and other changes in a new submission. This study report documented the new study results and supersedes the previous study report.

The project Point of Interconnection (POI) is a line tap on the 138 kV circuit 1L244 between Nicola (NIC) and Westbank (WBK) substations, at a distance of 38 km from NIC. The maximum power injection at the POI from the two sites is about 29 MW. The Commercial Operation Date (COD) has changed to June 1 2016.

The proposed line tap connection has been accepted due to the fact that WBK is presently supplied only radially from NIC via a single 138 kV line 1L244. It needs to be noted that BC Hydro recently initiated West Kelowna Transmission Project to provide redundant electricity supply to West Kelowna. Under this project, a new transmission line to WBK would be constructed. The tap connection for this wind farm will need to be reviewed in a separate study later. In this SIS, West Kelowna Transmission Project was not taken into consideration.

This system Impact study has identified the following conclusions and requirements:

- The proposed line tap connection on 1L244 has been accepted based on the fact that WBK is supplied only radially from NIC.
- No overloads or unacceptable voltage conditions under system normal or single contingencies were observed for the proposed maximum power injection from Pennask Wind Farm (PWF) and Shinnish Wind Farm (SWF). No transmission element would need to be upgraded for this project.
- A 138 kV disconnect switch needs to be installed near the POI to connect the IC's tap line. Existing 1L244 line protection relays at NIC needs to be replaced.
- A direct transfer trip (DTT) from NIC to the IC's Pennask and Shinnish Wind station (PSW) 138 kV circuit breaker is needed to isolate PWF and SWF when 1L244 is disconnected from the system. A WECC Class 3 communication channel is required to support the DTT.
- The IC is responsible to provide a non-redundant WECC Class 3 communication facility for transfer trip and SCADA purposes. A microwave link is suggested between PSW and a nearby BCH microwave station Hamilton (HAM).
- The IC is responsible for transformer energization inrush mitigation control to avoid negative impact on the existing customers at Westbank and Brenda Mine (BDM).
- The induced voltage on the Shinnish 34.5 kV feeder with the proposed separation between the feeder and the 500 kV circuit 5L98 (NIC-VAS or Vaseux Lake) is acceptable.

The good faith non-binding cost estimate to complete the BCH Network Upgrades required for the PWF and SWF connection is $1.917 million. The Network Upgrades can be expected to be completed in approximately 12 months after the Standard Generation Interconnection Agreement (SGIA) is executed, receipt by BC Hydro of the Network Upgrade Security from the IC pursuant to the EPA Appendix 3, s.3(a) and the implementation funding is approved. The Interconnection Facilities Study report will provide greater details of the necessary requirements and estimated timeline for the interconnection project.

The estimated Revenue Metering cost is $202k, which does not include any costs for civil, structural, and electrical work of Revenue Metering (only the BCH Revenue Metering tasks, i.e., field and engineering). The Revenue Metering costs are accounted for separately from Network Upgrades and will be paid for by the Interconnection Customer directly in the form of a cash payment.

TABLE OF CONTENTS

1.0 INTRODUCTION

[redacted] is proposing to develop the Pennask and Shinnish wind farms in the Thompson-Okanagan area of British Columbia. The project consists of two different sites at Pennask Creek (PWF) and Shinnish Creek (SWF). Each of these two sites will have 5 Senvion type 4 wind turbines with a total capacity of 15.0 MW at each site. The combined output from PWF and SWF is 30.0 MW. The IC will build two 34.5 kV feeders to connect PWF and SWF to a common collector station. The PWF feeder is 3.22 km long and the SWF feeder is 41.25 km long.

A 2.5 Mvar DSTATCOM which controls two 5 Mvar mechanically switchable capacitor bands is installed on the 34.5 kV bus to provide additional reactive support. A 33 MVA 34.5/138 kV transformer at the collector station steps up the voltage from 34.5 kV to 138 kV. The IC's 138 kV station is referred to PSW in this study. The IC builds a 0.5 km 138 kV overhead line to connect PSW to a new tap point on 1L244 (NIC-WBK), 38 km from NIC.

The main difference between the current project and the one proposed in 2014 is the change of the turbine technology used. The current project uses a total of 10 (type 4) wind turbines at PWF and SWF whereas the original project uses a total of 14 (type 3) wind turbines. Generation capacity from both wind farms has been increased from 28.7 MW to 30 MW. The size of the DSTATCOM used is now 2.5 Mvar instead of 3.75 Mvar, and the switched capacitor banks are now 2x5 Mvar instead of 4x4 Mvar.

The following table provides a summary of the Pennask and Shinnish Wind Project:

Table 1: Pennask and Shinnish Project Information

Project Name	Pennask and Shinnish Wind Project	
Interconnection Customer (IC)	[redacted]	
Point of Interconnection (POI)	A tap on 1L244, 38.0 km from NIC	
IC Proposed COD	June 1 2016	
Type of Interconnection Service	NRIS ☒	ERIS ☐
Maximum Power Injection (MW) *	29.0 (Summer)	29.0 (Winter)
Number of Generator Units	10 Type 4 WTGs	
Plant Fuel	wind	

* *The maximum generation capacity of the project is 30.0 MW. But due to losses, only a maximum of 29.0 MW is achievable at the POI for injection into the grid.*

The figure below illustrates the configuration of the Pennask and Shinnish farm.

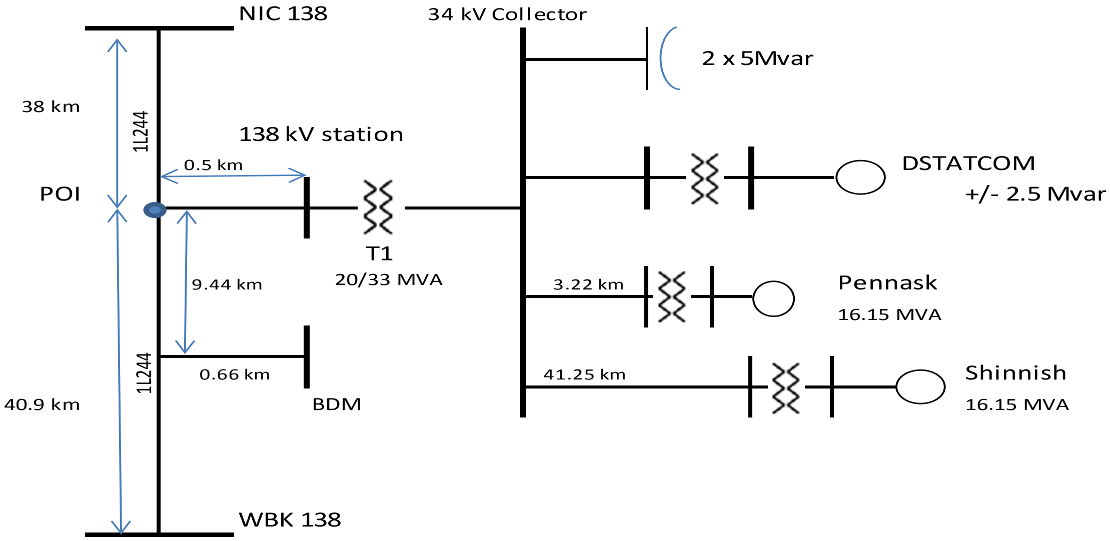


Figure 1: Sketch of Pennask and Shinnish Creek Wind Farm

Figure 2 below shows the approximate geographic location of the proposed Pennask and Shinnish Creek Wind Farm in the present day local area network configuration.

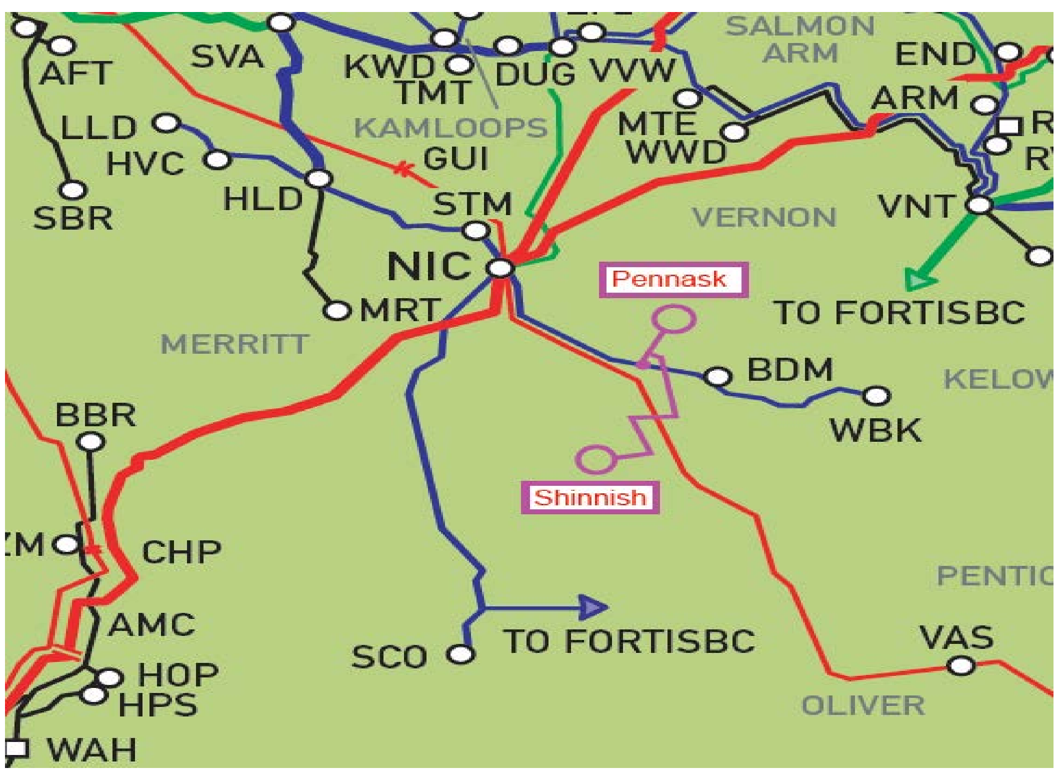


Figure 2: The South Interior Area network with the proposed Pennask and Shinnish Creek Wind Project

BCH recently initiated West Kelowna Transmission Project (WKTP) to provide redundant supply to West Kelowna, but the project scope has not been determined at this time. This SIS does not include WKTP in consideration, and a separate study will need to be performed later when the WKTP scope is finalized.

2.0 PURPOSE OF STUDY

The purpose of this study is to re-assess the impact on the BCH Transmission System due to the connection of the PWF and SWF when the number, type and output of wind turbines are changed from the original study. This study identifies constraints and Network Upgrades required for interconnecting the wind farms such that their performance is compliant with the North American Electric Reliability Corporation (NERC) and Western Electricity Coordinating Council (WECC) reliability standards, and the BCH transmission planning criteria.

3.0 TERMS OF REFERENCE

This study investigates and addresses the overloading, voltage deviation and stability issues of the transmission network in the South Interior region as a result of integrating Pennask and Shinnish Creek wind farms. Topics studied include equipment thermal loading and rating requirements, system transient stability and voltage stability, transient over-voltages, protection coordination, operating flexibility, telecom requirements and high level requirements for Remedial Action Schemes (RAS). BCH planning methodology and criteria are used in the studies.

The SIS does not investigate operating restrictions and other factors for possible second contingency outages. Subsequent BCH system studies will determine the requirements for reinforcements or operating restrictions/instructions for those kinds of events. Any use of firm or non-firm transmission delivery will require further analysis specific to the transmission service that may be requested later and will be reviewed in a separate study. Determination of any upgrades on the IC's facilities is beyond the SIS scope.

The work necessary to implement the network improvements identified in this SIS report will be described in greater detail in the Interconnection Facilities Study report for this project.

4.0 ASSUMPTIONS

This system impact study was carried out based on the model, data and information submitted by the IC in May 2015. Reasonable assumptions are made to complete the study whenever such information is unavailable.

The BCH 2016 transmission system models with summer light and winter heavy load/generation conditions are used in the studies. All interconnection projects ahead of this wind project in the Interconnection Queue are included in the study model.

This re-study is carried out based on present day system configurations (single source supply to Westbank from Nicola) as the scope of the West Kelowna Transmission Project is undetermined.

5.0 SYSTEM STUDIES AND RESULTS

Power flow, short circuit, and transient stability studies were carried out to evaluate the impact of the proposed interconnection. Studies were also performed to determine the protection, control and communication requirements and to evaluate possible over-voltage issues.

5.1 Steady State Power Flow Studies

The following figure is a single line diagram for the project and nearby area.

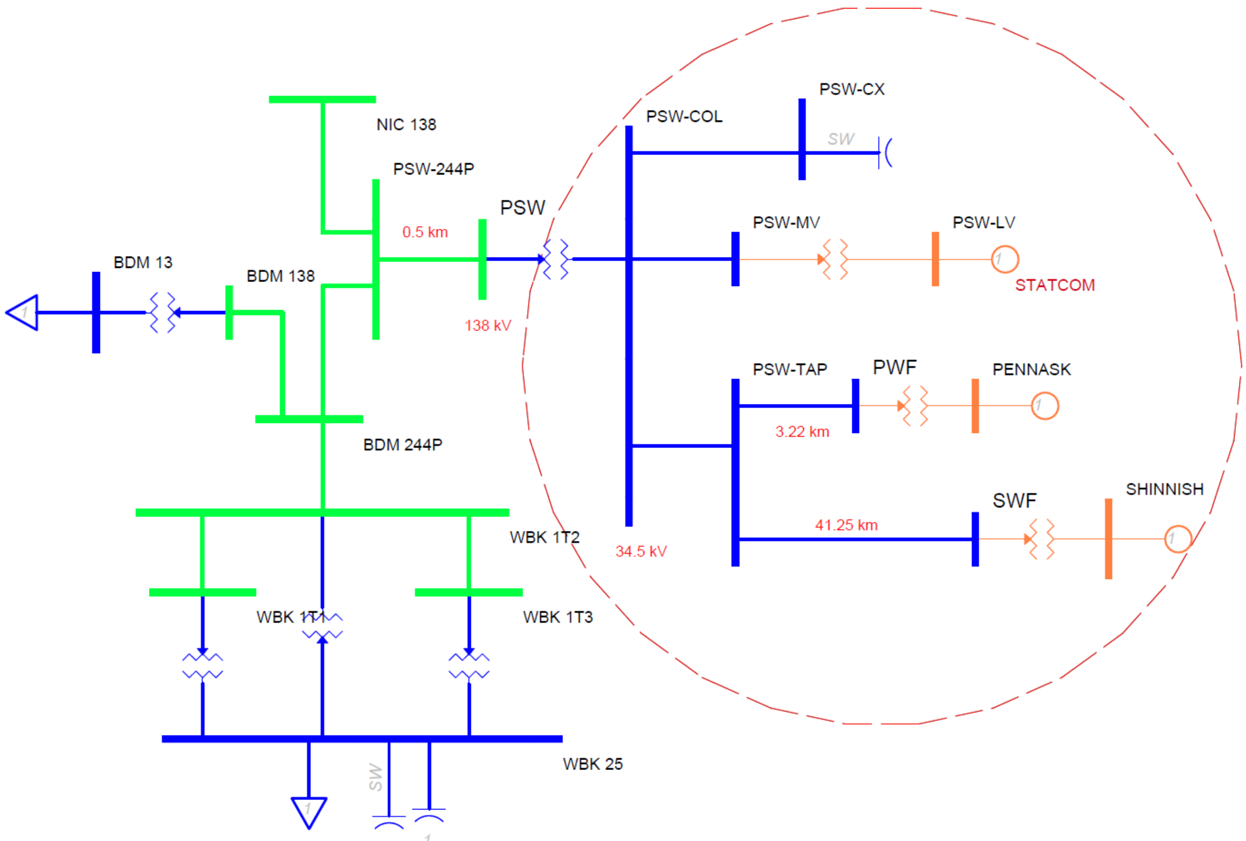


Figure 3: Pennask and Shinnish Wind Farm and nearby area Single Line Diagram

The wind farm is connected roughly half way between NIC and WBK and has a DSTATCOM and switchable capacitor banks to provide additional reactive support.

The minimum load at WBK is greater than the maximum combined output of the PWF and SWF. Once power is injected into the Transmission System via the tap point on the radial circuit 1L244, all wind farm output will flow towards WBK. Flows on 1L244 between the POI (tap point) and WBK will solely depend on the loads at Westbank and Brenda Mine and is not affected by the wind farm output. Loading on the NIC to POI section of 1L244 will be affected by the injection from the wind farm.

During system normal (N-0) and single contingency (N-1) conditions the wind farm is not observed to cause any voltage violation or equipment overloads in the transmission system.

In this study, the wind farm is observed to be able to control the voltage at the POI, and this should have a positive impact on West Bank 138 kV bus voltage regulation.

Load flow study results are shown below. Table 2 below shows the voltages at key stations in the project area and flows on 1L244 during system normal and selected contingencies.

Table 2: Load flow Results

2016 Summer Light Load Case:
Station Voltages

Contingency	NIC138	PWF 138	BDM 138	WBK 138	WBK 25
System Normal	1.031	1.025	1.021	1.009	1.021
Loss of NIC T5 & T3	1.029	1.025	1.021	1.009	1.021
Loss of 5L76 (NIC-ACK)	1.028	1.025	1.021	1.009	1.021
Loss of 1L243 (NIC-HLD)	1.034	1.025	1.021	1.009	1.021
Loss of 2L265 (NIC-VVW)	1.027	1.025	1.021	1.009	1.021

2016 Summer Light Load Case:
Circuit Loadings as % of MVA Rating

	1L244 (NIC-PSW Tap)	1L244 (PSW TAP - BDM)	1L244 (BDM-WBK)
Rating (MVA)	169.7	169.7	169.7
System Normal	7.9	24.3	24.0
Loss of NIC T5 & T3	7.8	24.3	24.0
Loss of 5L76 (NIC-ACK)	7.5	24.3	24.0
Loss of 1L243 (NIC-HLD)	8.4	24.3	24.0
Loss of 2L265 (NIC-VVW)	7.6	24.3	24.0

2016 Winter Heavy Load Case:
Station Voltages

Contingency	NIC138	PWF 138	BDM 138	WBK 138	WBK 25
System Normal	1.025	1.000	0.990	0.958	1.027
Loss of NIC T5 & T3	1.020	1.000	0.990	0.958	1.027
Loss of 5L76 (NIC-ACK)	1.016	0.995	0.985	0.953	1.021
Loss of 1L243 (NIC-HLD)	1.026	1.000	0.990	0.958	1.027
Loss of 2L265 (NIC-VVW)	1.029	1.000	0.990	0.958	1.027

2016 Summer Light Load Case:
Circuit Loadings as % of MVA Rating

	1L244 (NIC-PSW Tap)	1L244 (PSW TAP - BDM)	1L244 (BDM-WBK)
Rating (MVA)	191.2	191.2	191.2
System Normal	33.4	47.0	47.0
Loss of NIC T5 & T3	32.6	47.0	47.0
Loss of 5L76 (NIC-ACK)	34.0	47.0	47.0
Loss of 1L243 (NIC-HLD)	33.6	47.0	47.0
Loss of 2L265 (NIC-VVW)	34.5	47.0	47.0

The area one-line diagram is shown in Appendix A.

5.2 Transient Stability Study

A series of transient stability studies under winter heavy load and summer light load conditions are performed. A number of relevant contingencies in the area are used to test the dynamic performance of the subject project and its impact on nearby areas.

The selected contingencies and the results are summarized in Table 3 below:

Table 3: List of Contingencies and transient stability results

Case	**Fault Description**	**Fault Duration**	**Pennask & Shinnish Wind Farm**
1	Fault on the low side of NIC 230/138 TX or on one of the 138 kV lines near NIC other than 1L244.	8 cycle	Acceptable
2	Fault on the high side of NIC 500/230 TX	4 cycles	Acceptable
3	Fault on 1L243 (NIC-HLD) near HLD	9 cycles	Acceptable
4	Fault on 2L265 (NIC-VVW) near VVW	7 cycles	Acceptable
5	Fault on 5L76 (NIC-ACK) near NIC with unsuccessful re-close	4 cycles	Acceptable

Selected transient stability plots are attached in Appendix C.

For the contingencies listed above, PWF and SWF wind turbines are able to maintain stable and recovered to their pre-fault states. In addition, the wind farm was not observed to introduce any stability issues in the transmission system. The interconnected system performance is acceptable. During the re-study, it was observed that the type 4 wind turbines offer more robust reactive support and frequency performance than the type 3 turbines used in the previous study.

A transfer trip to the IC’s 138 kV circuit breaker from Nicola (NIC) will be used to isolate the wind farms when 1L244 is tripped due to protective or unintentional actions. The wind farms should not operate in an island.

5.3 Fault Analysis

The short circuit analysis for the System Impact Study is based upon the latest BCH 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.

BCH will work with the IC to provide accurate data as required during the project design phase.

5.4 Analytical Studies

Transformer energization voltage dip was expected to remain around 8% RMS (Root Mean Square) for uncontrolled energization. The IC is responsible for installing transformer energization inrush mitigation control in order to avoid a negative impact on existing customers at WBK and BDM. This can be achieved by implementation of Point On Wave controller with flux calculation, Point On Wave with controlled opening/closing the 138 kV circuit breaker or by fast motorized disconnects with arcing horns.

A transfer trip from NIC to the PSW 138 kV circuit breaker is required to isolate the wind farm for 1L244 protective and unintentional tripping. The transfer trip requirement is described with more details in Section 5.7 below.

5.5 Transmission Line Upgrades

No transmission line upgrade requirement has been identified.

Install a tap connection consisting of a 3-phase flying tap arrangement on 1L244. A 138 kV disconnect switch will be installed near the POI on the tap line between the POI and the IC's short line.

The IC has indicated that there are no changes to the layout of Shinnish 34.5 kV feeder which partially parallels with BCH's 500 kV circuit 5L98 (Nicola–Vaseux). Based on the original voltage induction study which does not consider a future NIC-VAX 500 kV line, the separation between the feeder and 5L98 is deemed acceptable.

5.6 BCH Station Upgrades or Additions

There is no additional BCH's station work identified.

5.7 Protection & Control and Telecommunications

Protection Requirements:

- Existing 1L244 line protection at NIC needs to be replaced with new primary and standby protection using SEL-421-4 relays.
- A Direct Transfer Trip (DTT) from NIC to PSW 138 kV circuit breaker needs to be installed to isolate the wind farm during an islanded scenario. A WECC Class 3 communication channel will be used to support the DTT.
- There is no protection work at Westbank (WBK) Substation.
- Due to the use of Type 4 wind turbines, an analytical model of the proposed wind farms needs to be developed to be used for testing of the protection scheme and protection relay settings.
- The IC must provide entrance protection, power quality protection, and redundant protection at PSW station in accordance with the requirements laid out in the BCH's 60 kV – 500 kV Technical Interconnection Requirements for Power Generators (TIR).
- Three phase Voltage Transformers at the PSW high voltage side are required for quality protection.

Control Requirements:

- The IC is required to provide telemetry, status and meteorological information via a DNP3 RTU/IED (Distributed Network Protocol 3, Remote Terminal Unit/Intelligent Electronics Device) to the BCH Control Centres in accordance with TIR requirements.
- The IC is responsible to provide a continuously reporting channel to the closest BCH station with appropriate telecom facilities
- Due to 1L244 protection relay replacement at NIC, control work is required at NIC. There is no control work required at WBK.
- The database and displays at BCH Control Centres will be updated to accommodate the SCADA points for the Pennask and Shinnish Wind Farm project.

Telecommunication Requirements:

The IC is responsible to provide a non-redundant WECC Class 3 communication facility for the implementation of the transfer trip from NIC to PSW, and to transmit wind farm SCADA data to BCH Control Centres.

The recommended non-redundant WECC Class 3 telecommunication facility is microwave communication channels. A line-of-sight path from the IC's PSW station to HAM (Hamilton Mountain Repeater Station) is required for this option to be feasible. This will depend on the exact location of the PSW station, the height of its antenna tower and the antenna mounting height at HAM. Once the location of 'PSW' is established, a radio path study would be required to determine microwave link feasibility.

A telecom Block diagram is attached in appendix D.

5.8 Islanding

Islanded operation is not arranged for Pennask Wind Farm and Shinnish Wind Farm. A direct transfer trip (DTT) scheme will be utilized to isolate the wind farms by opening the 138 kV circuit breaker at PSW when 1L244 is open at NIC. The back-up to the DTT are the wind farm's local protections which should disconnect itself from the system when an islanded condition is detected.

5.9 Black Start Capability

BCH does not require the proposed Pennask and Shinnish Wind farm to have black start (self-start) capability.

However, if the IC desires their facilities to be energized from the BCH system, the IC is required to apply for an Electricity Supply Agreement.

5.10 Cost Estimate and Schedule

The good faith non-binding cost estimate to complete the BCH Network Upgrades required for the Pennask and Shinnish Wind Farm connection is $1.917 million. This cost estimate has an accuracy range from +100% to -35%, and includes 20% contingency, 2.0% annual inflation, annual overhead and annual interest during construction.

The BCH Network Upgrade identified in this report can be expected to complete in approximately 12 months after the implementation phase funding is approved. This duration assumes that all necessary outages, if required, are available in time for line and station works.

The Interconnection Facilities Study report will provide greater details of the necessary requirements and the estimated timeline for this interconnection project.

This estimate does not include any costs associated with Revenue Metering, or any costs associated with 1L244 outages. The work required within the IC facilities is not part of this estimate and schedule.

6.0 REVENUE METERING

Three metering points are specified for this project. The main point of metering (POM) is located on the high voltage side of the main power transformer at PSW station. Additional points-of-metering are at Pennask Creek and at Shinnish Creek generation sites. The estimated Revenue Metering cost is $202k, which does not include any costs for civil, structural, and electrical work of Revenue Metering (only the BCH Revenue Metering tasks, i.e., field and engineering).

Measurement Canada (MC) approved and sealed Revenue Class meters will be supplied by BCH and installed at PSW and at the IC's Pennask Creek and Shinnish Creek generating sites. These meters are for metering purposes ONLY. Power Quality meters are to be supplied by the IC.

The IC is responsible for securing the real estate for the main point of metering. The IC is also responsible for supplying auxiliary power and telecom for revenue metering use. Metering equipment including CTs and VTs are provided by the IC and subjected to approval by BCH Revenue Metering department. The IC is responsible for the maintenance of the CTs and VTs, and BCH is responsible for the meters, metering cabinets, junction boxes and secondary terminations. Please refer to Appendix E for more detailed information.

The IC is required to update the single line diagram showing independent revenue meter and power quality meter installations at the three POMs (PSW, PWF and SWF), and submit this updated single line diagram for BCH Revenue Metering department approval.

Metering Points	PSW (Main POM) SWF (Shinnish POM) PWF (Pennask POM)
Customer Name	[redacted]
Project Name:	Pennask and Shinnish Wind Farms
Location	Long: 120 6' 45.08" W; Lat: 49 54' 41.76" N (Gen Station)
Private Power Line	0.5km Note1
Single-line Diagram	Input based on SLD HN200079-0001-70-082-0001-Rev E supplied by the proponent, an updated SLD is required.
POI location:	1L244 – 38km from BCH Nicola Substation
POD/R location:	Assumed to be POI
Primary Voltage(kV)	138kV (main POM) 34.5 kV (Shinnish POM) 34.5 kV (Pennask POM)
Metering Voltage (kV)	138kV (main POM) 34.5 kV (Shinnish POM) 34.5 kV (Pennask POM)
Peak Demand	30 MW (main POM) 15 MW (Shinnish POM) 15 MW (Pennask POM)
Max Current	~125 A@ 138 kV, 30 MW (main POM) ~251 A@ 34.5 kV, 15 MW (Shinnish POM) ~251 A@ 34.5 kV, 15 MW (Pennask POM)
<u>Point-of-Metering 1</u>	138 kV – at IC's substation (PSW) on the primary side of the main transformer T1 (main POM)
<u>Point-of-Metering 2</u>	34.5 kV – at the PG Substation on the primary side of the main transformer (SWF) (Shinnish POM)
<u>Point-of-Metering 3</u>	34.5 kV – at the PG Substation on the primary side of the main transformer (PWF) (Pennask POM)
Voltage Transformers (supplied by PG)	3 x VTs (L-Grd) – 78000 : 120V or 115V, MC Approval Number to be informed by the IC (main POM) 2 or 3 x VTs – xxxx : 120V or 115V; MC Approval Number to be informed by the IC (Shinnish POM) Note 2 2 or 3 x VTs – xxxx : 120V or 115V; MC Approval Number to be informed by the IC (Pennask POM) Note 2
Current Transformers (supplied by PG)	3 x CTs- 200:5-5 A – Ratio – MC Approval Number to be informed by the IC (main POM) 2 or 3 x CTs- 300:5-5 A – Ratio – MC Approval Number to be informed by the IC (Shinnish POM) Note 2 2 or 3 x CTs- 300:5-5 A – Ratio – MC Approval Number to be informed by the IC (Pennask POM) Note 2
Estimate ISD	June 2016 (construction power required)

Notes:

- The IC shall provide accurate private line installed length including sags and shall provide installed line parameters in a letter signed/stamped by a professional engineer.

- If the main transformer for PWF and SWF is delta, ungrounded wye or impedance grounded wye, 2 element metering scheme (L-L, 2 VTs, 2 CTs) shall be used.

The IC is requested to work closely with BCH Revenue Metering Department for more detailed information and requirements.

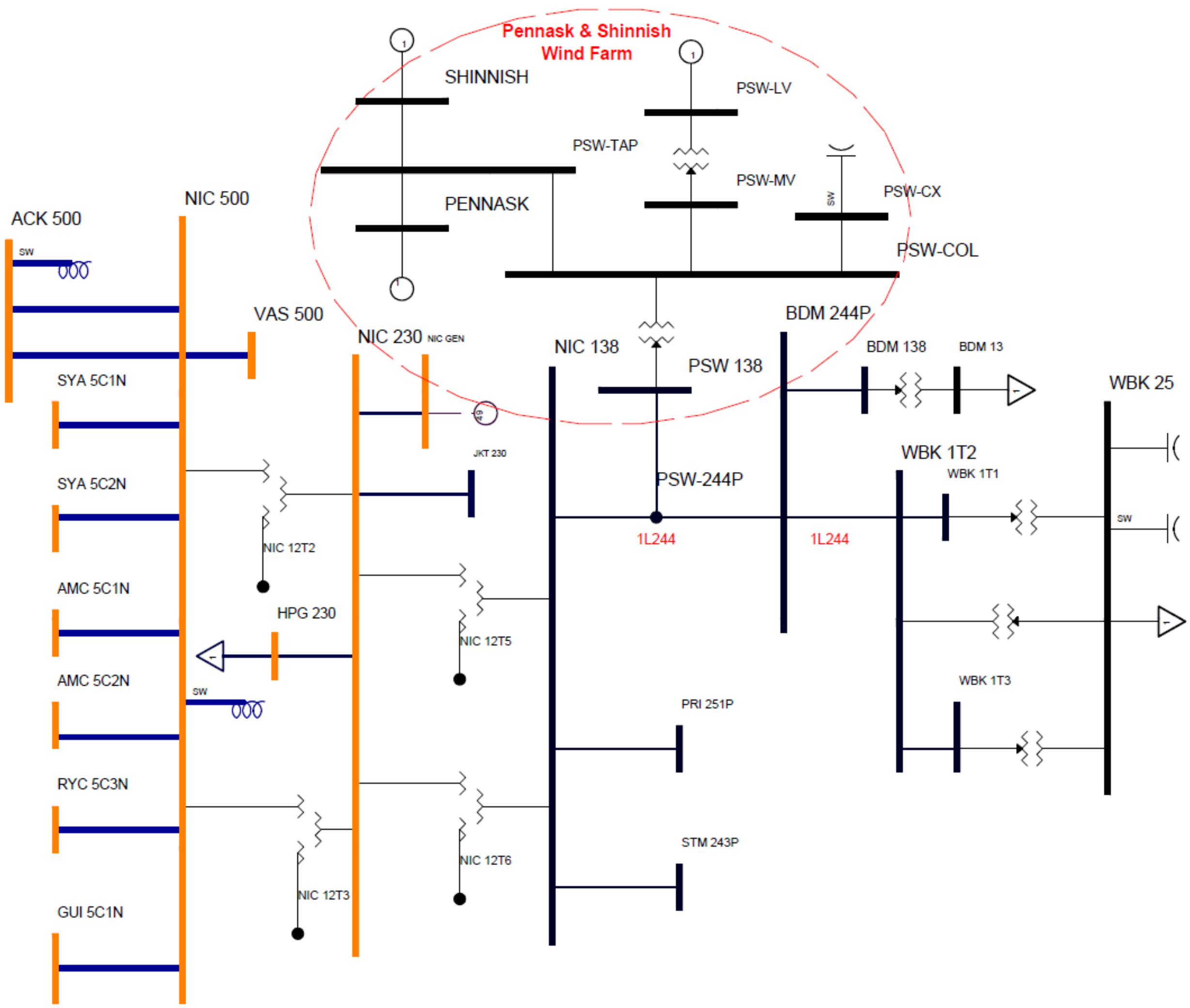
7.0 CONCLUSIONS & DISCUSSION

In power follow and transient stability studies, Pennask and Shinnish Wind Farm was not observed to cause any equipment overload, voltage violation and instability concerns under no contingency or single contingencies. No transmission element upgrade has been identified.

1L244 line protection relays at NIC will need to be replaced and a direct transfer trip from NIC to PSW will be added. The IC is required to provide non-redundant WECC Class 3 telecom facility for transfer trip and SCADA purposes. The suggested telecom facility is to establish a microwave link to a nearby BCH's repeater station HAM.

To avoid any adverse impact on the customers at WBK and BDM, the IC must provide mitigation for its transformer energization inrush so that the voltage dip during transformer energization is within the acceptable limit and does not impact BCH customers.

APPENDIX A – Area Single-line Diagram

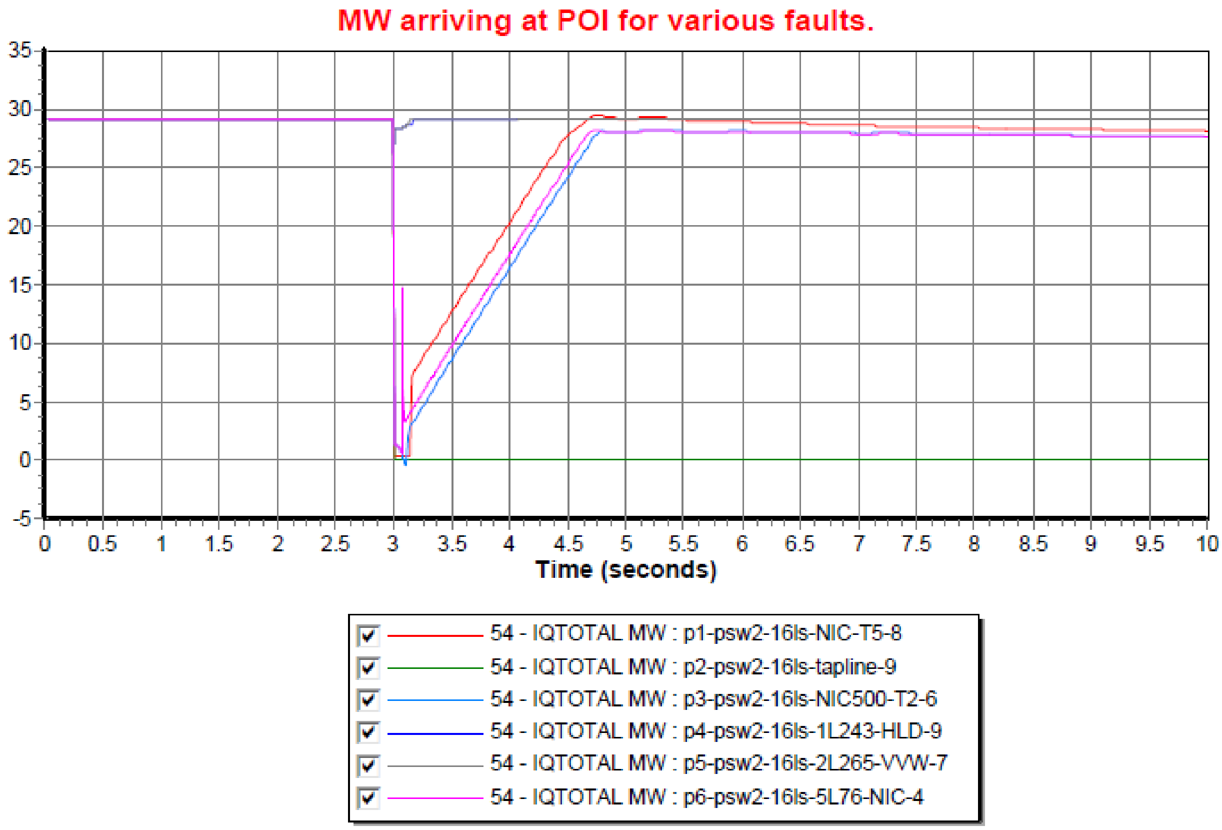


APPENDIX B – Dynamics Data

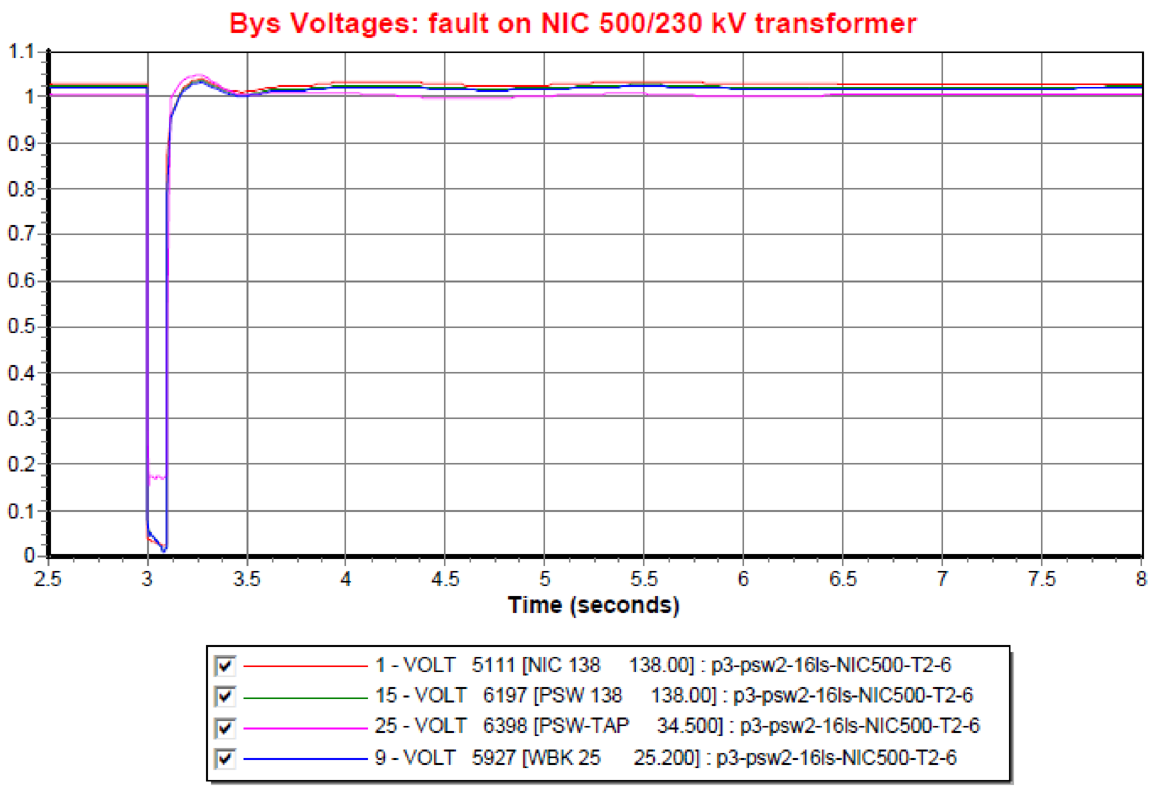
Pennask and Shinnish wind farms use a total of 10 Senvion 3.2M114 type 4 wind turbines and an S&C DSTATCOM. The PSSE models for this equipment are proprietary user written models. Their data and settings are not presented here.

APPENDIX C – Selected PSSE Dynamic Results

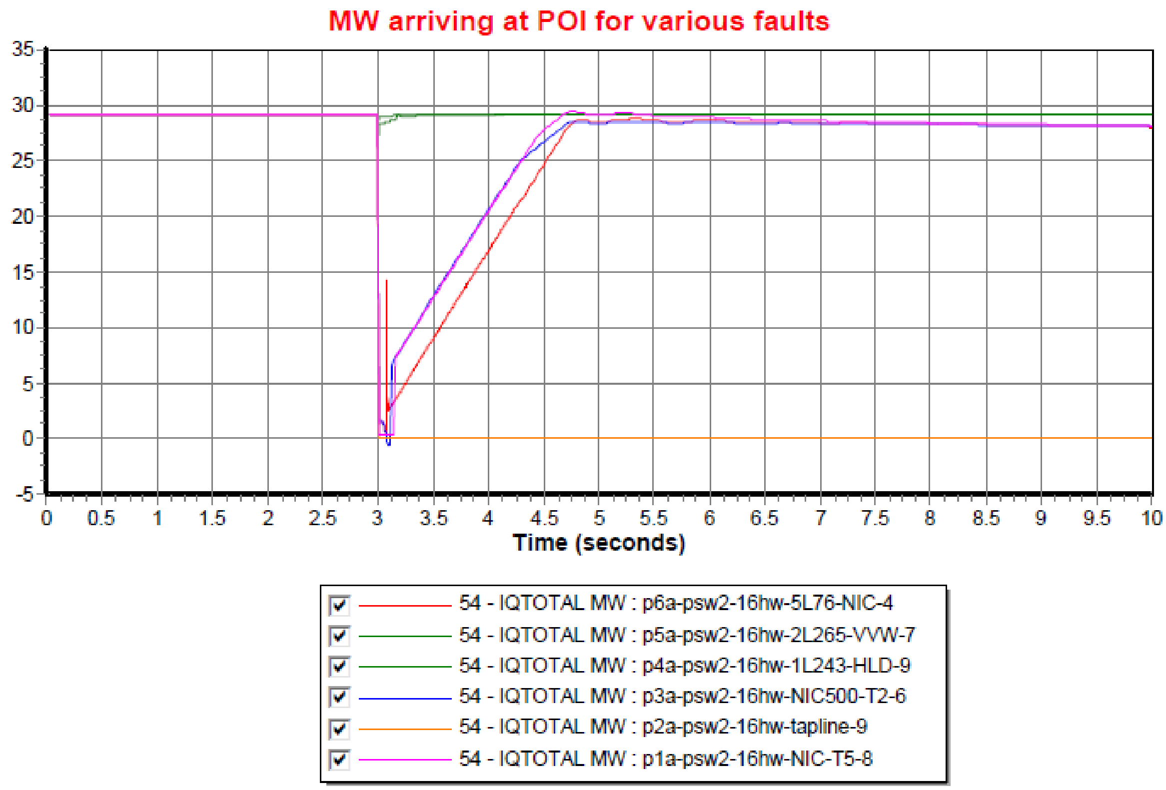
Summer Light Condition



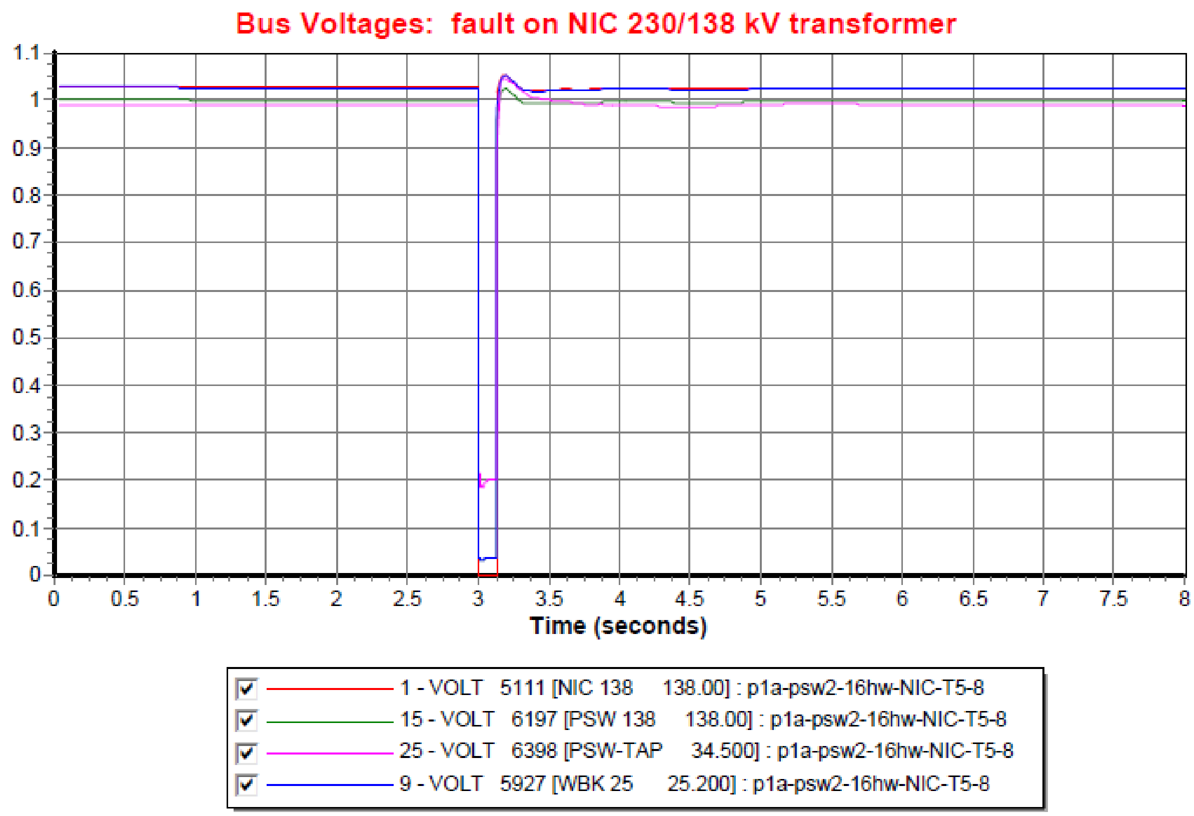
Summer Light Condition



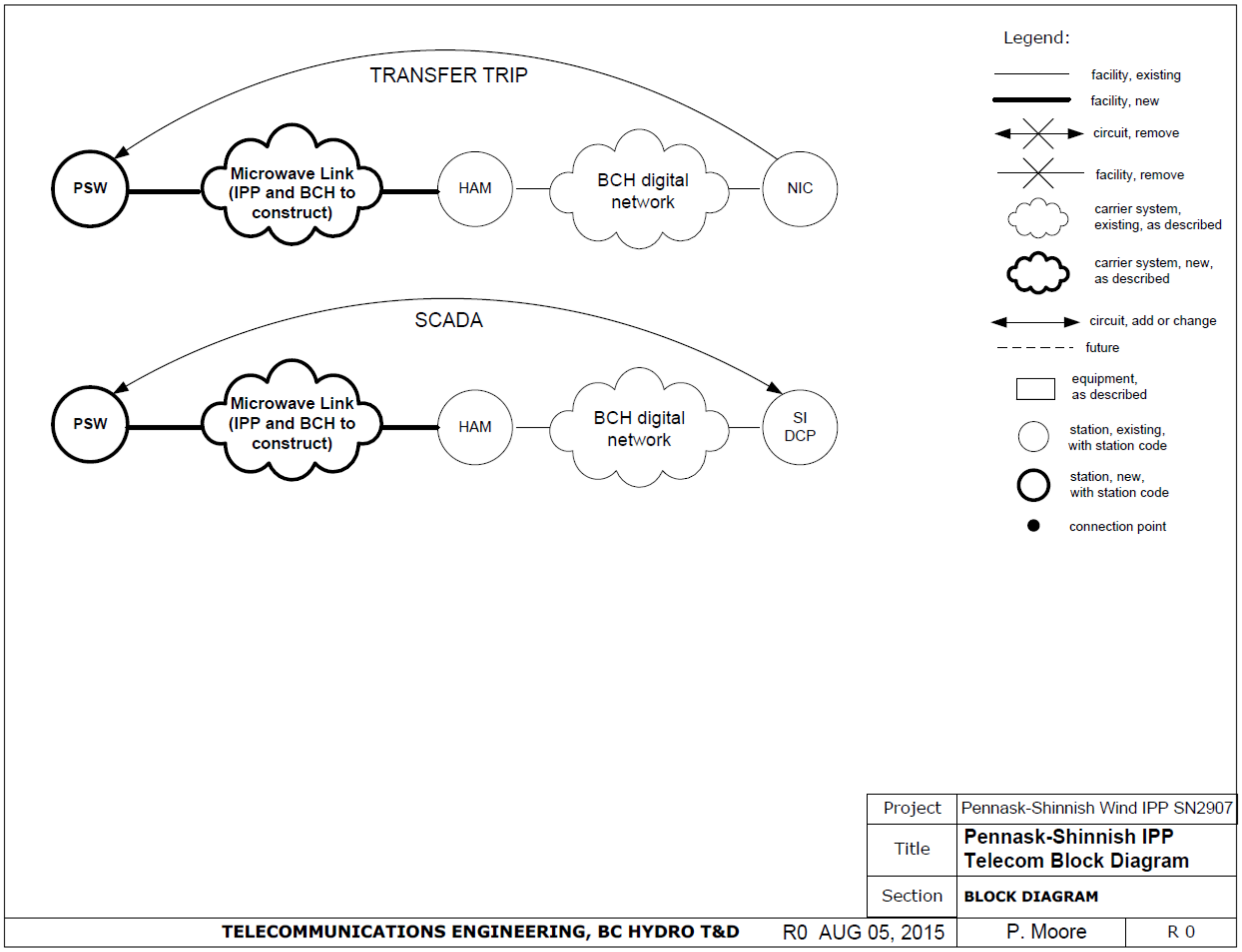
Winter Heavy Condition



Winter Heavy Condition



APPENDIX D – Telecom Block Diagram



APPENDIX E – REVENUE METERING REQUIREMENTS

Telecommunications for Revenue Metering - Power Generators:

A telecommunications channel is required for remote read/download data from the main and the backup meters. The design, supply and installation of the communications equipment shall be coordinated between BCH Revenue Metering, BCH Telecom, the Power Generator and the Telecommunications Service Provider. The PG should provide a terminal / connector inside the BCH meter cabinet. Where the POI is on a 69 kV voltage class or higher BC Hydro transmission system **and** where a conventional wire-line telephone is installed, ground potential rise (GPR) protection shall be provided. Alternative technologies may be used, e.g. cellular, fiber optic, microwave, satellite etc. however these solutions must be discussed and approved by BCH before installation. For more details, please, refer to Section 8 of BCH Revenue Metering Requirements for Complex Metering published at the Revenue Metering webpage and at the BC Hydro external website.

Revenue Metering:

The remote read load profile revenue metering installation should be in accordance with Canada federal regulations and BC Hydro Requirements for Complex Revenue Metering. The latest version of this document is published at BC Hydro's webpage under Forms and Guides. The revenue metering responsibilities and charges shall be in accordance with Section 10 (10.1 and 10.2). For details about the specific responsibilities, see table on pages.23-25.

Revenue class meters (main and backup) approved and sealed by Measurement Canada (MC) will be installed to register the energy delivered and received from the power generator. The meters will be supplied and maintained by BC Hydro. The main meter will be leased by BCH to the PG. As per federal regulations, the meter will be periodically removed and re-verified in a MC authorized laboratory. Main and backup bi-directional load profile interval meters are required to measure the power received and the power delivered (by BCH to the PG) during each 30 minute time period. The meters will be programmed for 5 minutes interval and will be remotely read each day by BCH/ABSU Enhanced Billing Group using MV-90.

The POM shall have a dedicated communications line (landline or alternative technologies e.g. cellular, fiber optic, microwave, satellite etc. subject to BCH approval) available for revenue metering use only. If there is digital cell phone coverage for data, BCH will supply the wireless communications. In this case, there will an incremental cost for the PG. BCH MV-90 Server must be able to access and download data from the revenue meters remotely as they do when they dial in a site using a standard phone line (wireless or landline). For more details, please, refer to Section 8 of BCH Revenue Metering Requirements for Complex Metering.

The CTs and VTs used on the metering scheme will be supplied by the Power Generator and should be of a model/type approved by Measurement Canada. A 3-element metering scheme with 3 CTs and 3 VTs connected L-N (Ground) shall be used. The CTs and VTs must be pre-approved by BC Hydro's Revenue Metering Department. The PG should send an email to BCH RMSM stating the model/maker/ratio/MC approval numbers, etc. A list of approved models is available at Measurement Canada (MC) website under "Notice of Approval Database Section". For Stand-Alone VTs and CTs, the H1 terminal of the VTs shall be connected on the BC Hydro side of the CTs. The revenue metering VT and CT secondary windings are not permitted to be shared with any other equipment therefore no other devices shall be connected to the revenue metering VT and CT secondary windings.

For generation applications, all instrument transformer compartment doors shall be **key interlocked** with a BC Hydro side disconnect device and a Power Generator side disconnect device(s). The key interlocks shall prevent opening instrument transformer compartment door(s) unless all disconnect devices are visibly open. Where the POM is on the Power Generator side of the power transformer, the BC Hydro side disconnect device shall be on the BC Hydro side of the power transformer to insure no-load losses.

If the impedance and losses between the POM and the PODR are significant, the meters will be programmed to account for the line and/or transformer losses between the POM and PODR. The PG or its consultant shall provide the line parameters data and the power transformer testing data to BC Hydro.

During the planning phase, BCH Revenue Metering department should be contacted to discuss the specifics of the project. The applicant should send drawings to BCH Revenue Metering Department showing the 1-line diagram (SLD) and informing the planned metering scheme, communication scheme, meter cabinet location, as well as any other metering related document. BC Hydro's Revenue Metering department can be contacted via email: metering.revenue@bchydro.com.

Information required in the design stage includes:

1. Length of secondary cables
2. Single Line Diagram showing CTs, VTs, cabinets, all generating stations connecting to the POI
3. Identify whether revenue metering cabinets are indoors or outdoors - implication on whether cabinets need to be insulated
4. Communication medium contemplated to relay revenue metering data
5. 3-line diagram of the interconnection of the revenue metering CT & VT
6. Scaled Site Plan showing the relative location of the meter cabinet to the CT & VT (drawing showing the footprint for the sub)
7. Private power line parameters data and/or the power transformer testing data signed and stamped by a professional engineer (if applicable)
8. A set of manufacture switchgear drawings showing the installation of the revenue metering CT & VT (ensure the installation of the metering CT & VT complies with section 5.4 of BCH Requirements for Remotely Read Load Profile Revenue Metering, published at BCH website)
9. A simplified version of the lockout access steps to the revenue metering CT & VT (if applicable)

10. Location of the Meter Cabinet and verification of dedicated 120V AC 15A circuit for the meter cabinet - as per section 6.4 of BCH requirements
11. Contact name/phone on site for equipment/material delivery.
12. Mailing Address for the site (normal mailing address)
13. Interconnection Customer Billing Information
14. Operational Site Access for BC Hydro Meter Tech (for metering installation, maintenance, etc.)

