Interconnection System Impact Re-Study

[redacted]
Septimus Creek Wind Project

Report No: T&S Planning 2015-065

February 2016

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 Septimus Creek Wind Project in the Peace Region of British Columbia. The wind farm will consist of five Senvion 3.0 MW Type 4 wind turbine generators for a total capacity of 15 MW. The proposed point of interconnection (POI) is a tap on the existing 138 kV circuit 1L377 between Taylor (TAY) and Dawson (DAW) substations in the Peace Region, and is located on 1L377 9.5 km from TAY. The Commercial Operation Date (COD) proposed by the IC in its data submission for this system impact restudy was September 1 2016, and was revised during finalizing this report to summer 2017.

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 2014-068). 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 documents the new study results and supersedes the previous study report.

In the Peace Region, BC Hydro plans to develop the Site C generating project and a transmission project called the "Peace Region Electricity Supply (PRES)". The scheduled in-service dates for both projects are around 2024. With the two projects in service, the Peace Region power grid configuration will be substantially different from the present. The System Impact Study for connecting Septimus Creek Wind Farm to the transmission grid has been performed for both pre and post Site C and PRES scenarios.

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

- No overloads or unacceptable voltage conditions under system normal or single contingencies were observed for the proposed maximum power injection from Septimus Creek Wind Farm. No major 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. The existing 1L377 line protection relays at Taylor (TAY) and Dawson (DAW) stations need to be replaced.
- Direct transfer trip (DTT) will be initiated from DAW/TAY to the IC's 138 kV Septimus Creek station (SCW) to isolate Septimus Wind Farm when 1L377 is disconnected from the system. A WECC Class 2 telecommunication channel to SCW is acceptable.
- The IC is responsible to provide a non-redundant communication facility to receive DTT signals from the BCH System. The communication facility will also be used for SCADA purposes. A microwave link is suggested between SCW and the nearby Septimus Microwave Repeater Station (SUR).

The good faith non-binding cost estimate to complete the BCH Network Upgrades required for the Septimus Wind Farm connection is $2.495 million, with an accuracy of -35% to +100%, and includes annual overhead, annual interest during construction, annual inflation and contingency. The Network Upgrades can be expected to be completed in approximately 20 months after the implementation phase funding is approved. The estimated schedule may be shortened with more detailed works in the next stage - Facilities Study. 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 $64k. This cost is accounted for separately from Network Upgrades and will be paid for by the Interconnection Customer (IC) directly in the form of a cash payment.

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1.0 INTRODUCTION

[redacted] the Interconnection Customer (IC), is proposing to develop the Septimus Creek Wind Project in the Peace Region of British Columbia. The project consists of 5 Senvion type 4 wind turbines with a total capacity of 15.0 MW. An IC built 34.5 kV feeder, 24.2 km long, connects the generating site to a collector station.

A 4.0 MVar mechanically switchable capacitor bank is installed on the 34.5 kV collector bus to provide additional reactive support. A 16.7 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 SCW in this study. The IC builds a 0.5 km long 138 kV overhead line to connect SCW to a new tap point on 1L377 (Taylor–Dawson, or TAY-DAW), 9.5 km from TAY.

The main difference between the current project and the one studied in 2014 (Report No: T&S Planning 2014-068) is the change of the turbine technology used. The current project uses a total of five 3.0 MW type 4 wind turbines whereas the original project uses a total of seven 2.05 MW type 3 wind turbines. The mechanically switched capacitor banks used for additional reactive support have also been reduced from 2x2.6 Mvar to 1x4.0 Mvar for the present project.

The following table provides a summary of the Septimus Creek Wind Project:

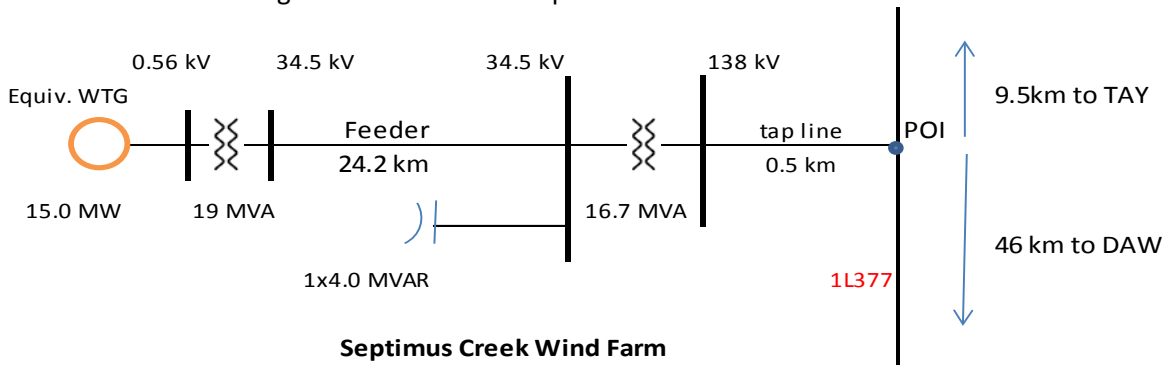
Table 1: Septimus Creek Wind Project Information

Project Name	Septimus Creek Wind Project	
Interconnection Customer (IC)	[redacted]	
Point of Interconnection (POI)	A tap on 1L377, 9.5 km from TAY	
IC Proposed COD	Summer 2017	
Type of Interconnection Service	NRIS ☒	ERIS ☐
Maximum Power Injection (MW) *	14.5 (Summer)	14.5 (Winter)
Number of Generator Units	Five 3.0 MW Type 4 Senvion WTGs	
Plant Fuel	wind	

* *The maximum generation capacity of the project is 15.0 MW. But due to losses, approximately a maximum of 14.5 MW is achievable at the POI for injection into the grid.*

The configuration of the Septimus Creek Wind farm is shown in Figure 1 below:

Figure 1: Sketch of Septimus Creek Wind Farm



To support significant load growth in the South Peace area, a major transmission upgrade project called Dawson-Chetwynd Area Transmission Project (DCAT) is planned and currently under construction. The DCAT project is presently in service. The DCAT project will build:

1. A new 230 kV Sundance station (SLS) at the existing intersection of 2L312 (Sukunka –Louisiana Pacific, or SNK – LAP) and 1L358 (Bear Mountain Terminal – Chetwynd, or BMT – CWD).
2. A new 230 kV double circuit from SLS to BMT and extended towards DAW. The 230 kV section from BMT – DAW will be operated at the 138 kV level.
3. The two existing 138 kV lines, 1L358 (section from SLS – BMT) and 1L362 (BMT – DAW) will be decommissioned. The existing 138 kV circuit from SLS to CWD will be renamed 1L349.

Figure 2 shows the Peace Region grid with the DCAT facilities:

Figure 2: Peace Region with DCAT

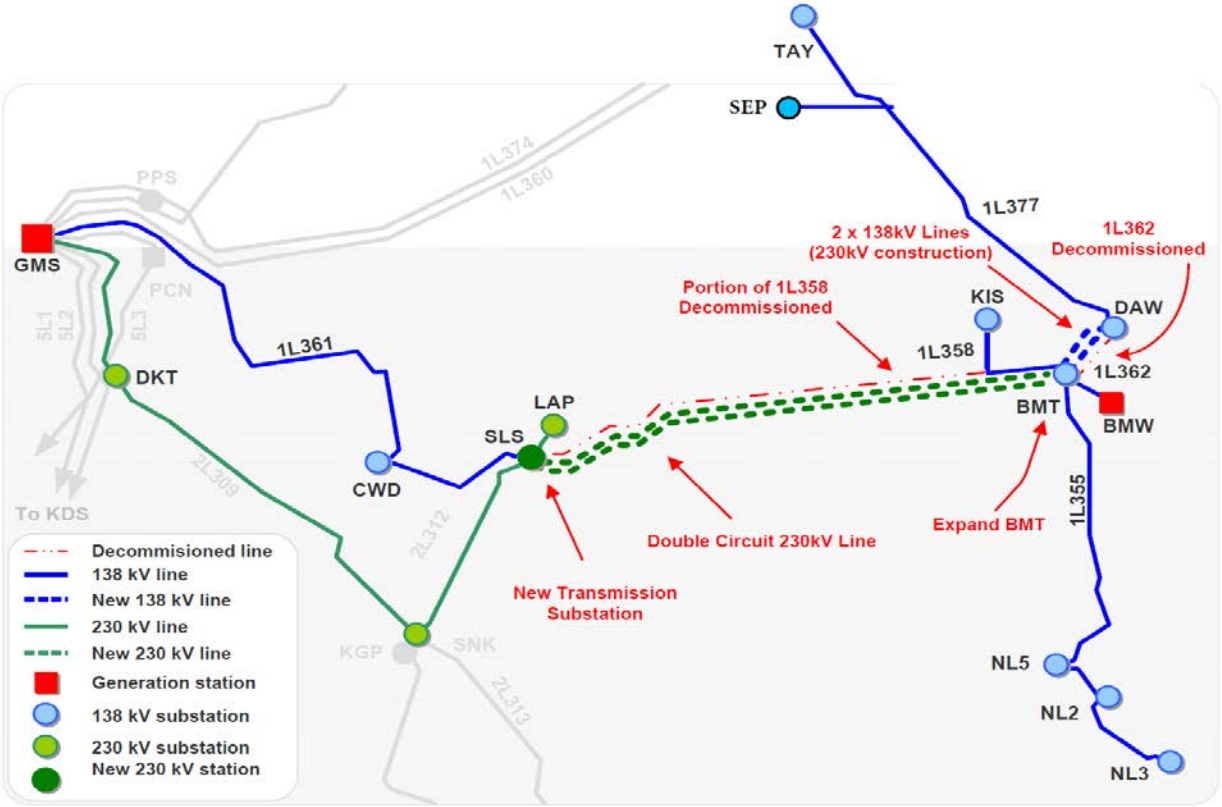
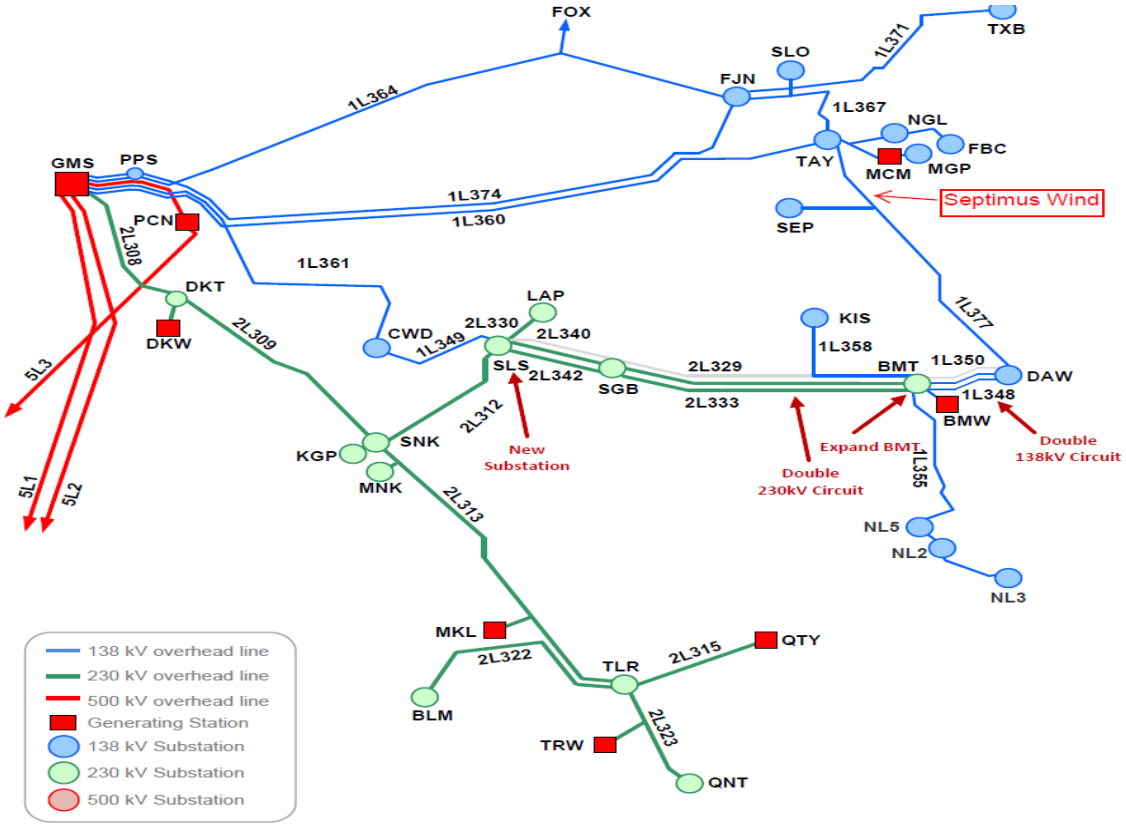


Figure 3 shows the geographic location of the Septimus Creek Wind Project in the Peace Region with DCAT in service.

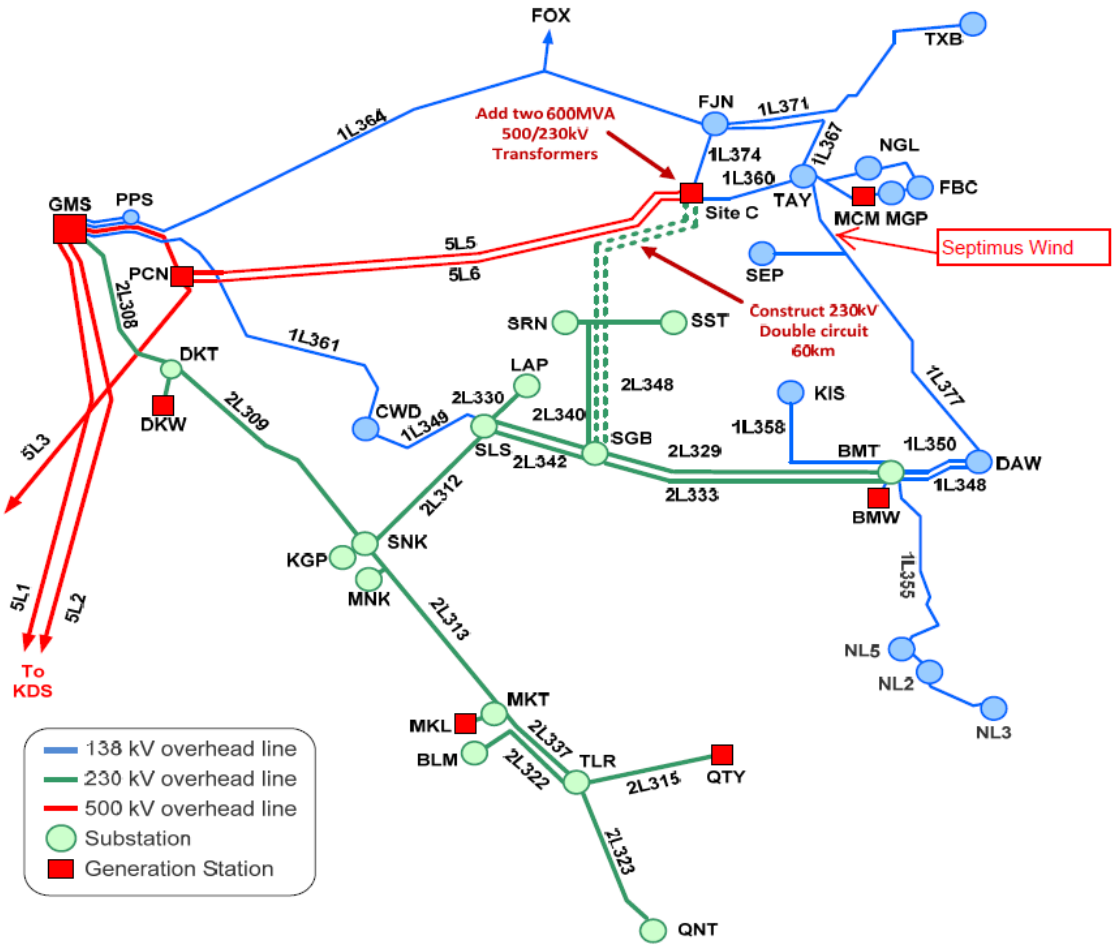
Figure 3: Septimus Wind Farm Regional Location with DCAT in-service



Another major project, Site C generating project, will add an 1100 MW generating facility and build two 500 kV circuits (5L5 and 5L6) from the Site C switchyard (STC) to Peace Canyon (PCN) generating station. With continuous load additions anticipated in the Peace Region, a new transmission project, Peace Region Electricity Supply (PRES), has been initiated to support the anticipated growth. There are a number of reinforcement options under consideration for PRES. The most technically leading option at the time of this System Impact Study is to build double 230 kV circuits from Site C (STC) to Shell Groundbirch (SGB) substation. Site C and PRES are expected to be in service by 2024.

Figure 4 shows the geographic location of the Septimus Creek Wind Project in the Peace Region with DCAT, Site C and most technically leading option of PRES in service.

Figure 4: Septimus Wind Farm Regional Location with DCAT, STC and PRES Option



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 Septimus Wind Farm when the number, type and output of wind turbines used are changed from the original study. This study identifies constraints and Network Upgrades required for interconnecting the wind farm such that its 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 Peace region as a result of integrating Septimus Creek Wind Farm. Topics studied include equipment thermal loading and rating requirements, system transient stability and voltage stability, transient over-voltages, protection coordination, operating flexibility and telecom requirements. 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 transmission system models with 2016 and 2024 winter heavy, and 2017 and 2024 summer light load/generation conditions are used in the studies. All interconnection projects ahead of Septimus Wind project in the Interconnection Queue are included in the study model. Generation in the Peace Region used in the study is shown in the following table.

Table 2: Area Generation

Quality Wind	142 MW
Meikle Wind	185 MW
Dokie Wind	144 MW
Bear Mountain Wind	102 MW
Septimus Wind	15 MW
MCM	105 MW
Site C	1100 MW

The following assumptions are also made for this study:

- Peace Region Generation Shedding RAS and its telecommunication facilities are required, which is already in service.
- The telecommunication facilities being implemented in the Peace Region Load Shedding RAS Project will be completed by November of 2016, which is required to be in-service prior to the Septimus Wind COD.
- Site C project, with its 1100 MW generating plant and two 500 kV circuits between STC and PCN, are in service by 2024.
- The technically leading option (two 230 kV circuits between STC and SGB) of PRES are in service by 2024.

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

A series of pre and post contingency power flow analysis are performed with the 2017 and 2024 base cases to confirm that area voltages and facility loadings are within acceptable performance limits under steady state and single contingency conditions. Prior to Septimus Wind Project, there are existing thermal overloads in the Peace Region under single contingency situations. Peace Region Load Shedding and Generation Shedding RAS are being implemented to address these overloads. Due to the size and location of Septimus Wind Farm, these pre-existing overloads are only slightly exacerbated. This system impact study does not show any new equipment overloads when Septimus Wind Farm is added into the system, and Septimus Wind Farm is not selected to participate in the RAS scheme.

Peace Region Load/Generation Shedding RAS will continue to be relied on to address these thermal overloads that occur during single contingency conditions. When STC and PRES are in service, existing thermal overload on the 138 kV circuits no longer exist.

In Load flow studies, no voltage violation or thermal overload due to the interconnection of Septimus Wind Farm was observed under system normal and single contingency conditions in both pre and post STC and PRES scenarios.

Single line diagrams for the pre STC/PRES scenario (2017) and post STC/PRES scenario (2024) are shown in Appendix A.

5.2 Transient Stability Study

A series of transient stability studies were performed using relevant contingencies in the area to test the dynamic performance and voltage ride through capabilities of the Septimus Wind Farm, and its impact on nearby areas.

Wind turbines inside Septimus Wind Farm are found to be able to maintain stability and recover close to their pre-fault state after fault clearing. In addition, the wind farm is not observed to introduce instability issues in the transmission system. After the fault is cleared, the area voltages/angles and frequencies recovered close to their pre-fault states within a reasonable time period. The interconnected system performance is acceptable.

The contingencies used for stability testing and the stability study conclusions are shown in the following table:

Table 3: Transient Stability Contingencies and Study Results

Case	Contingency	3Φ Fault Location	Fault Clearing Time (Cycles)		Septimus Wind Farm Performance
			Close End	Far End	
1	1L350 (DAW – BMT)	Close to DAW	BMT 8	DAW 9	Acceptable
2	1L348 (DAW – BMT)	Close to DAW	DAW 8	BMT 9	Acceptable
	2L308 (DKT – GMS)	Close to DKT	DKT 7	GMS 9	Acceptable
3	1L360 (GMS – TAY)	Close to GMS	GMS 8	TAY 9	Acceptable
4	1L360* (GMS – TAY)	Close to TAY	TAY 8	GMS 41	Acceptable
5	1L367 * (TAY – FJN)	Close to TAY	TAY 8	FJN 26*	Acceptable
6	1L367 * (TAY – FJN)	Close to FJN	FJN 8	TAY 14*	Acceptable
7	BMW T2	138 kV side of T2	8		Acceptable

* the fault clearing time listed for 1L360 and 1L367 are those before the Peace Area Load Shed RAS project. The protection for these lines will be updated with communication assisted protection system for faster fault clearing after Peace Area Load Shed RAS project.

Selected transient stability plots are attached in Appendix C.

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

The following requirements were identified for connecting the Septimus Wind Farm into the transmission network:

- A Transfer Trip from DAW/TAY to SCW is required when 1L377 is disconnected from the system due to protective and non-protective tripping actions. If the transfer trip is initiated from DAW, the transfer trip signal will be relayed to SCW via TAY.
- The existing 144kV rated 1L377 line terminal Surge Arresters at Dawson are replaced with a 132kV rated SA IEC class 3.
- A disconnect is added to the new 132kV rated Surge Arrester to allow for a quick line restoration in case of SA operation in failure mode.

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.

At the POI on 1L377, either a three pole tap or a flying tap connection is installed for connecting the IC's 0.5 km tap line. Also a 138 kV non-load break switch on the tap line near the POI is needed. Additional right of way may be required to accommodate the above tap.

5.6 BCH Station Upgrades or Additions

As stated in 5.4, the existing 144kV surge arrestor (1SA16) at Dawson Creek Station will be replaced with a 132kV rated surge arrestor IEC class 3.

5.7 Protection & Control and Telecommunications

In order to connect Septimus Wind Farm using a tap on 1L377, 1L377 line protection needs to be replaced. The following Protection Requirements are identified:

- The Primary (PY) & Secondary (SY) line protection relays at TAY and DAW will be replaced with SEL-411L Replays. The IC to provide two SEL-411L relays at SCW as PY and SY protection for 1L377.
- As part of this line protection replacement, telecommunication facilities will be required at TAY, DAW and SCW.
- The preferred telecommunications required for 1L377 protection is WECC Class 1 64 kbps synchronous circuits for 1L377 PY & SY line differential protections, and Mirrored Bits communications between Taylor and Dawson, Taylor and SCW, and DAW and SCW. Since the Septimus Wind Farm is not part of a generation shedding RAS scheme, WECC Class 2 64 kbps digital telecom facility is also acceptable.
- A Direct transfer trip (DTT) signal is required from TAY/DAW to SCW for 1L377 protective and non-protective tripping when an island is formed inadvertently. The DTT will disconnect SCW from the system by opening the entrance breaker at SCW.

- The IC will provide entrance protection, power quality protection and compatible line protection in accordance with BC Hydro's "*60 - 500 kV Technical Interconnection Requirements for Power Generators*".

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 required to provide to BCH their protection event records from their line protection relays under the following circumstances:
    - Fault on the interconnecting line
    - Relay mis-operation for faults outside of interconnecting line
    - Relay operation due to Power Quality Protection elements.
- Due to 1L377 protection relay replacement at TAY and DAW, associated control work is required at TAY and DAW.
- The database and displays at BCH Control Centres will need to be updated to accommodate the SCADA points for the Septimus Wind Farm.

Telecommunication Requirements:

For SCADA, Protection and Revenue Metering purposes, the following telecommunication requirements have been identified:

- 9600 bps continuous link between SCW and a selected nearby BCH station to relay wind farm SCADA data to the Control Centres.
- Remote IP Access to new relays at DAW.
- Remote IP Access to new relays at TAY.
- Metering circuits for revenue and PPIS meters at SCW will be required.
- WECC Class 1 or Class 2 C37.94 64 kbps circuits, PY & SY between TAY and DAW for 1L377 line differential protection
- WECC Class 1 or Class 2 38.4 kbps RS-232 circuits, PY & SY between TAY and DAW for 1L377 mirrored bits technology teleprotection
- WECC Class 1 or Class 2 C37.94 64 kbps circuits, PY & SY between SCW and TAY for 1L377 line differential protection.
- WECC Class 1 or Class 2 C37.94 64 kbps circuits, PY & SY between SCW and DAW for 1L377 line differential protection
- PY T1 SCW to TAY.
- SY T1 SCW to DAW.

To implement the above facilities, Telecommunication works are needed at the following stations:

Work at DAW (All work to be done by BC Hydro)

- Install a PY T1 link to SCW.
- Install RFL FSU devices for the C37.94 circuits.
- Install line differential protection circuits, MBT (Mirrored Bits) circuits and one remote access IP circuit.

Work at TAY (All work to be done by BC Hydro)

- Install an SY T1 link to SCW.
- Install two RFL FSU devices for the C37.94 circuits.
- Install line differential protection circuits, MBT circuits and one remote access IP circuit.

Work at SCW (All work to be done by the IC)

- Install tower, antenna, waveguide, and frequency-diversity microwave terminal for microwave link to SUR.
- Install one PY T1 link to DAW and an SY T1 to TAY.
- Install a Class 1 DACS.
- Install RFL FSU devices for the C37.94 circuits (if the DACS does not have native C37.94 support).
- Install line differential protection circuits and one SCADA circuit.

Work at SUR (Septimus Microwave Repeater Station) (All work to be done by BCH)

- Install a microwave terminal facing SCW.
- Perform a tower study and upgrade if required for the new antenna facing SCW
- Establish microwave link between SUR-DAW, and between SUR-TAY.

A telecom Block diagram is attached in appendix D.

5.8 Islanding

Islanded operation is not arranged for Septimus Wind Farm. A direct transfer trip (DTT) scheme will be utilized to isolate the wind farms by opening the 138 kV circuit breaker at SCW when 1L377 is out of service. 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 Septimus 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 Septimus Creek Wind Project connection is $2.495 million. This cost estimate does not include Revenue Metering Costs, has an accuracy range from +100% to -35%, and includes 20% contingency, 2.0% annual inflation, annual overhead and annual interest during construction. This estimate does not include costs associated with 1L377 outages. The work required within the IC facilities is not part of this estimate and schedule.

The BCH Network Upgrade identified in this report can be expected to complete in approximately 20 months after the implementation phase funding is approved, which may be shortened with more detailed works in the next stage – Facilities Study. This duration assumes that all necessary outages, acquisition, permits and materials are available in time.

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

The estimated Revenue Metering cost is $64k which covers the electrical work only. These Revenue Metering costs will be paid for by the IC directly in the form of a cash payment.

6.0 REVENUE METERING

The main point of metering (POM) is located on the high voltage side of the main power transformer at SCW station.

Measurement Canada (MC) approved and sealed Revenue Class meters will be supplied by BCH and installed at SCW. 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.

Metering Points	SCW (Main POM)
Customer Name	[redacted]
Project Name:	Septimus Creek Wind Project
Location	Long: 120:55:17.4 W; Lat: 56:4:17.76 N (Gen Station)
Private Power Line	0.5km
Single-line Diagram	Input based on SLD H200079-0001-70-082-0007-Rev B supplied by the proponent, an updated SLD is required.
POI location:	1L377 – 9.5km from BCH Taylor Substation
POD/R location:	Assumed to be POI
Primary Voltage(kV)	138kV (main POM)
Metering Voltage (kV)	138kV (main POM)
Peak Demand	15 MW (main POM)
Max Current	~63 A@ 138 kV, 15 MW (main POM)
Point-of-Metering	138 kV – at IC's substation (SCW) on the primary side of the main transformer T1 (main POM)

Voltage Transformers (supplied by PG)	3 x VTs (L-Grd) – 138kV/1.73: 120V or 115V. MC Approval Number to be informed by the IC.
Current Transformers (supplied by PG)	3 x CTs- 100x200:5-5 A. MC Approval Number to be informed by the IC.
Estimate ISD	September 2016 (construction power required)

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

7.0 CONCLUSIONS & DISCUSSION

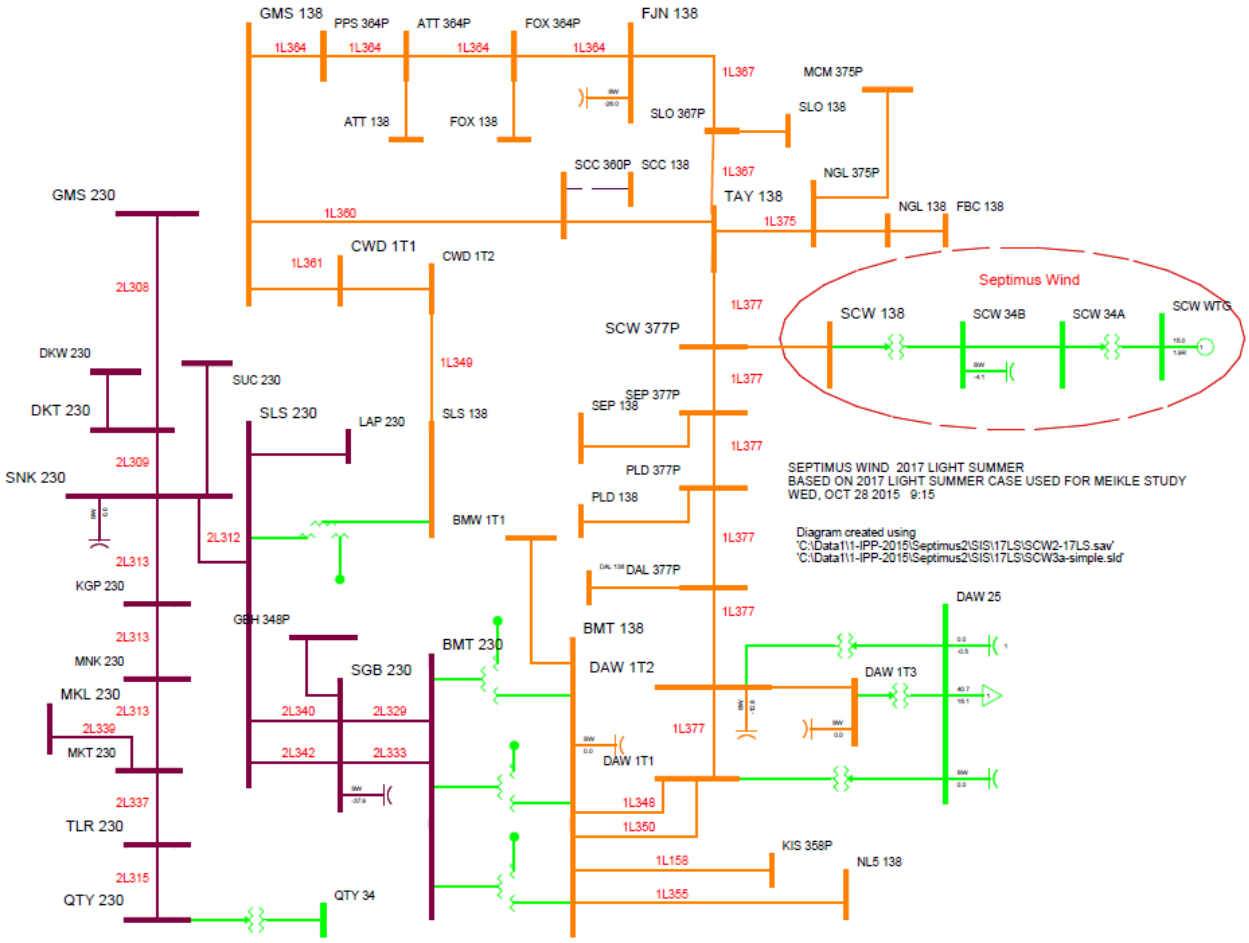
In power follow and transient stability studies, Septimus Wind Project was not observed to cause any equipment overload, voltage violation and instability concerns under system normal and single contingencies conditions. No major transmission element upgrade has been identified.

The existing 1L377 line protection relays at TAY and DAW will need to be replaced and a direct transfer trip from TAY/DAW to SCW will be added. WECC Class 1 telecom facility is preferred for the transfer trip, but WECC Class 2 telecom facility is acceptable. The suggested telecom facility is for the IC to establish a microwave link to nearby BCH's repeater station SUR. In addition, a switching disconnect will be added at the POI to connect the tap line, and the existing surge arrestors at the DAW line terminal will be replaced.

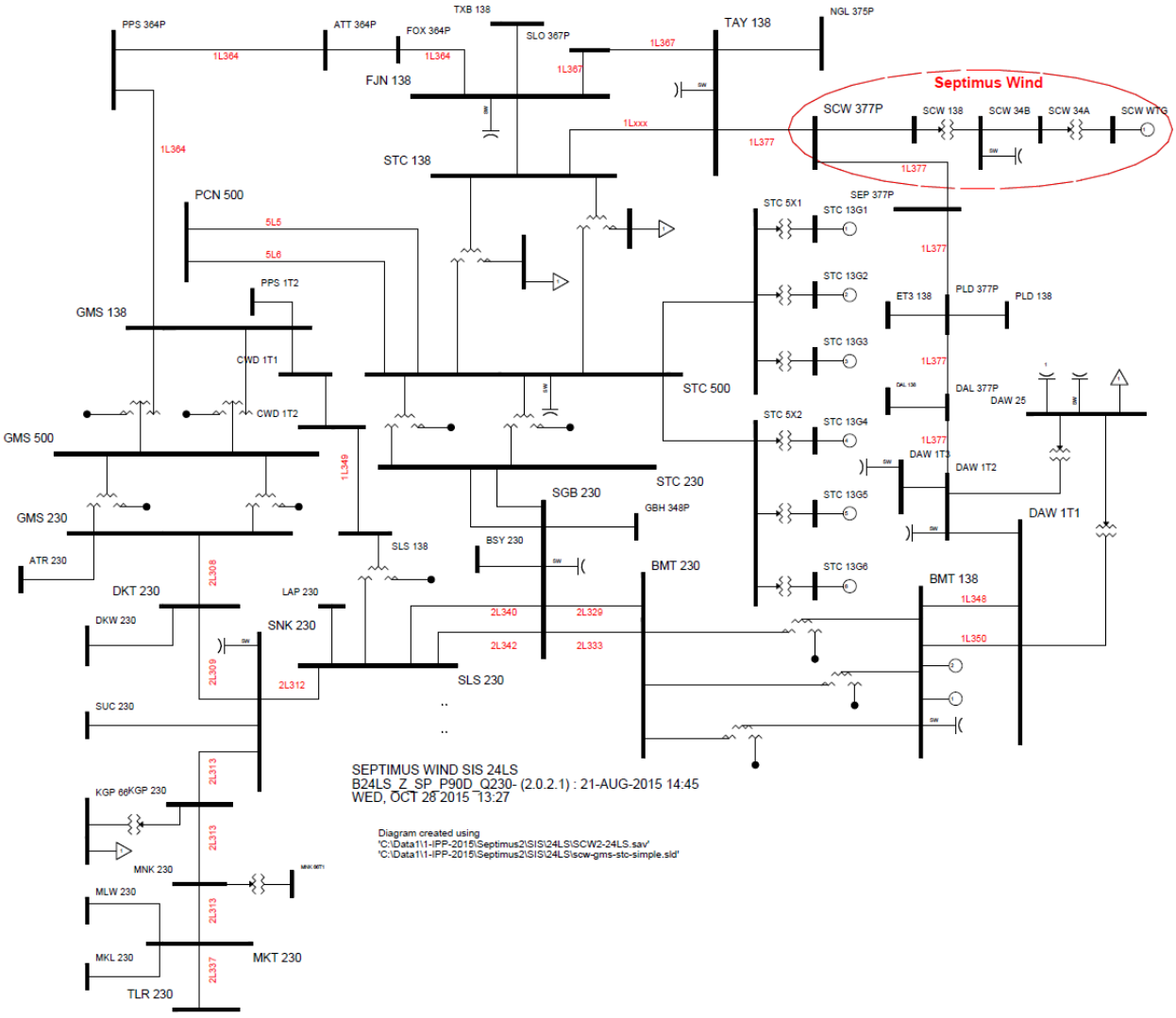
The BCH Network Upgrades identified in this report can be expected to complete in approximately 20 months after the implementation phase funding is approved. This estimated implementation duration may be shortened with more detailed works in the Facilities study stage. Some expediting measures such as an Early Engineering and Procurement Agreements (EEPA) can be used to speed up the funding approval process.

APPENDIX A – Area Single-line Diagram

2017 Summer Light Load Condition with DCAT in service:



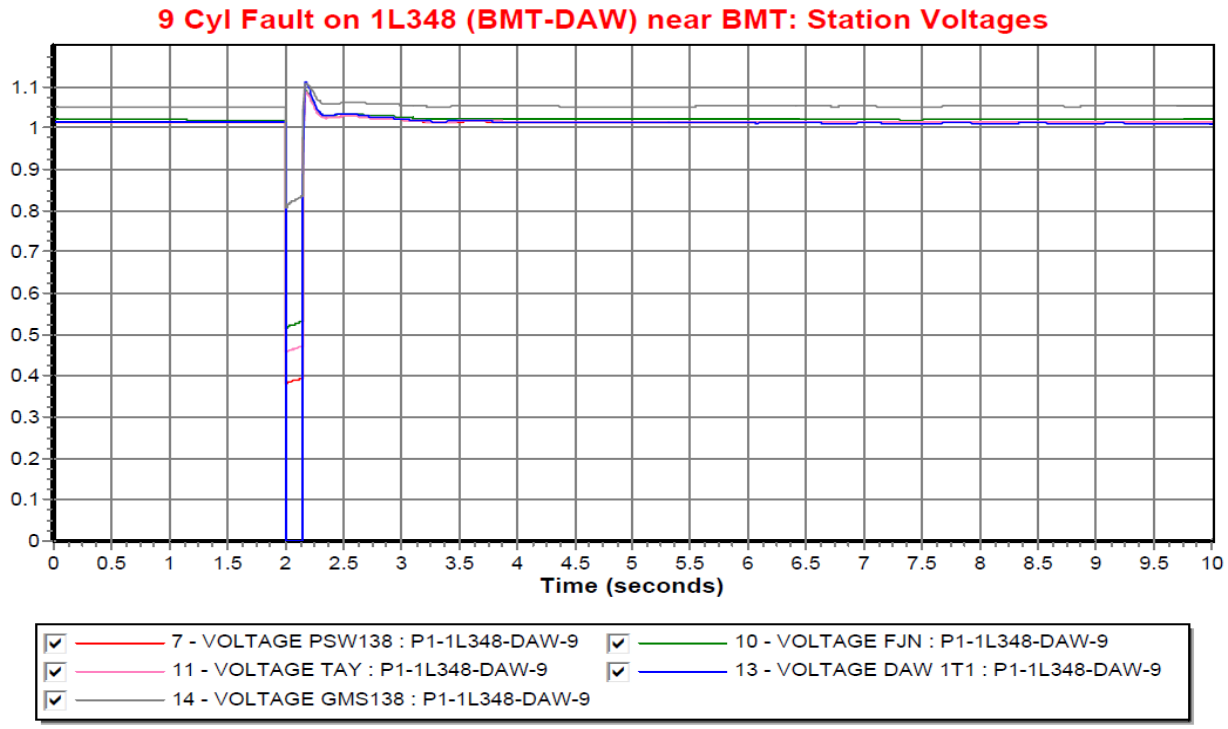
2024 Summer Light Load Condition with DCAT, Site C and PRES in service:

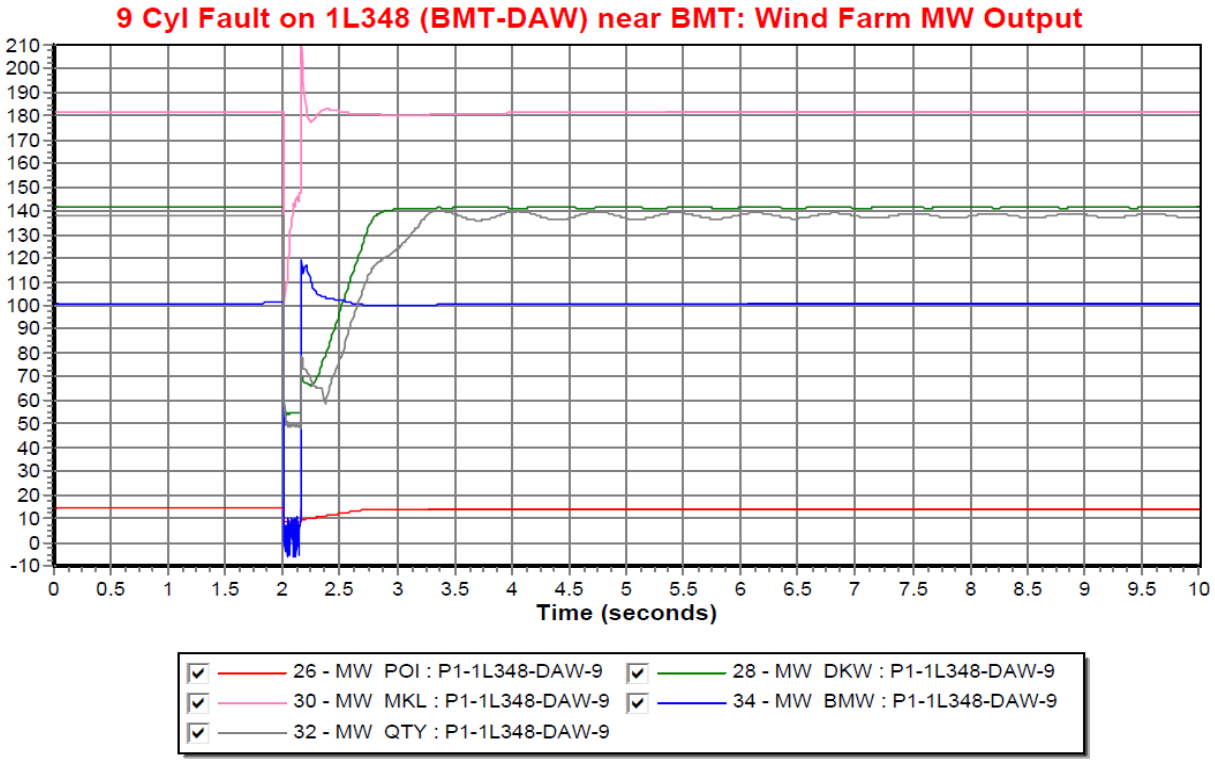


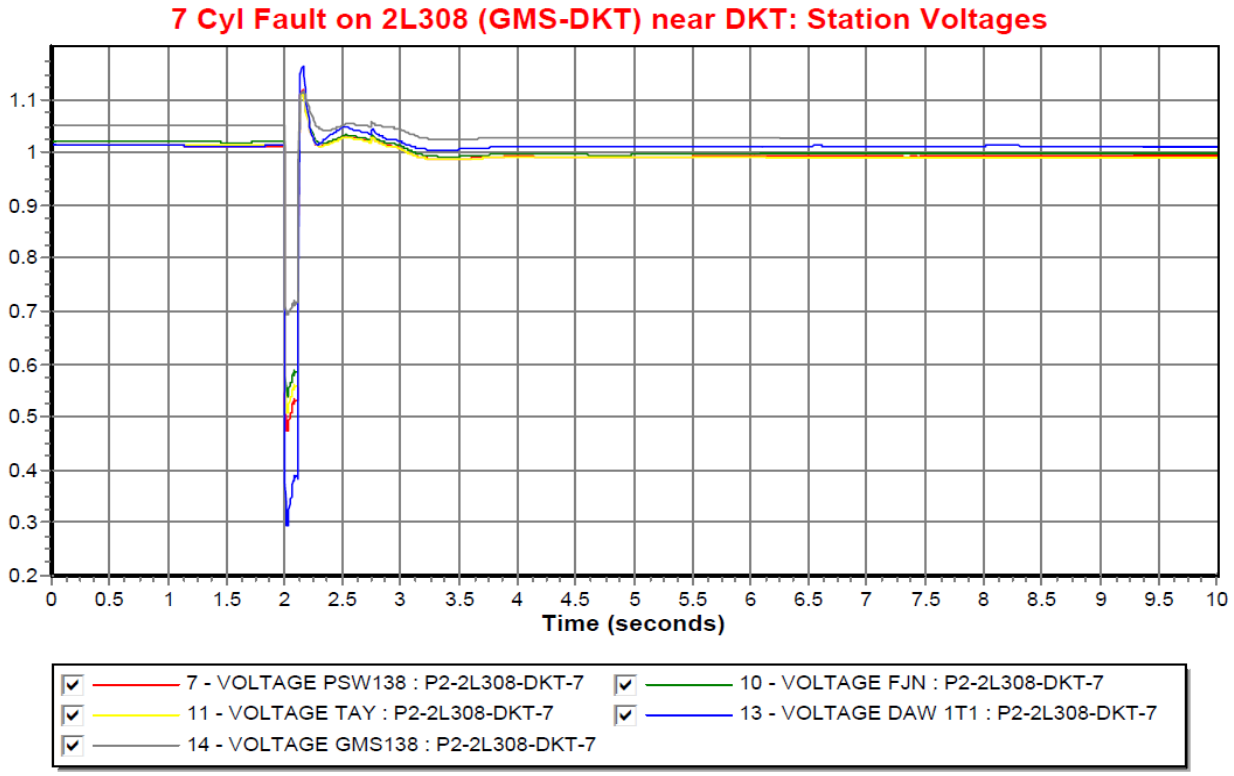
APPENDIX B – Dynamics Data

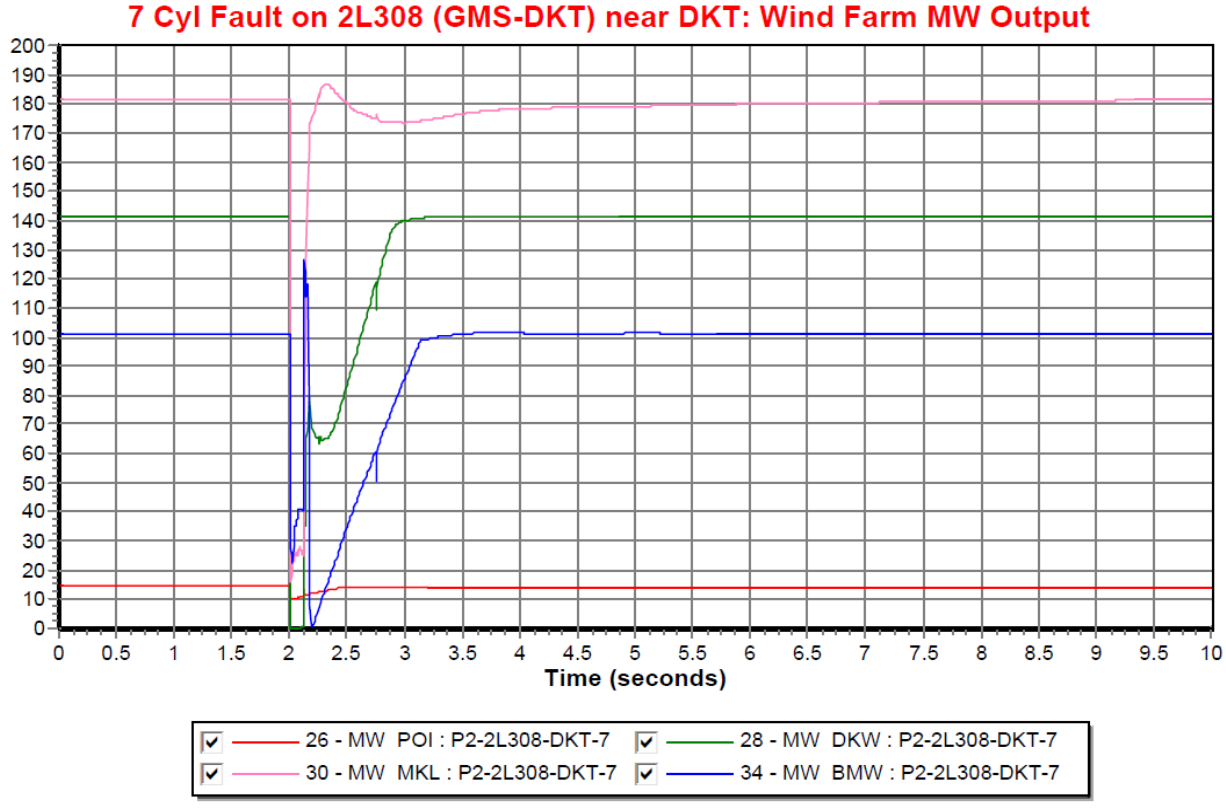
Septimus Wind Project uses a total of 5 Senvion 3.2M114 type 4 wind turbines. The PSSE models for this equipment are proprietary user written models. Their data and settings are not presented here.

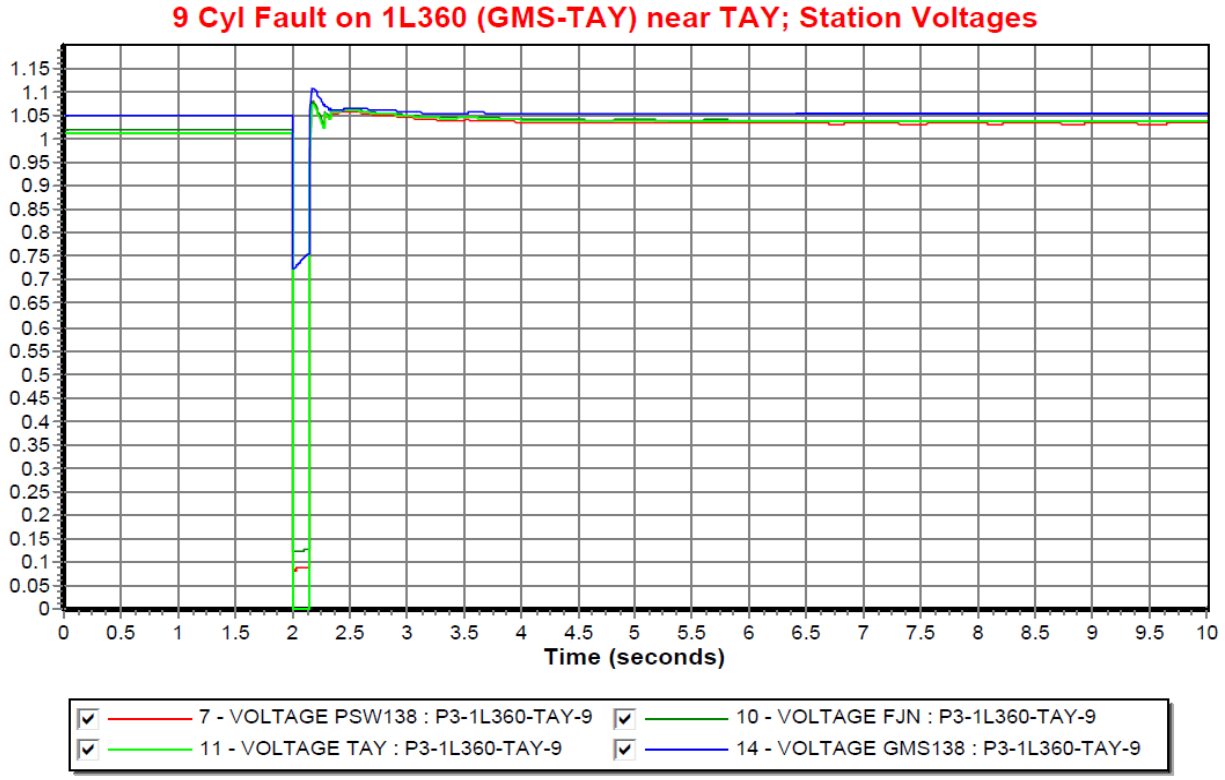
APPENDIX C – Selected PSSE Dynamic Results

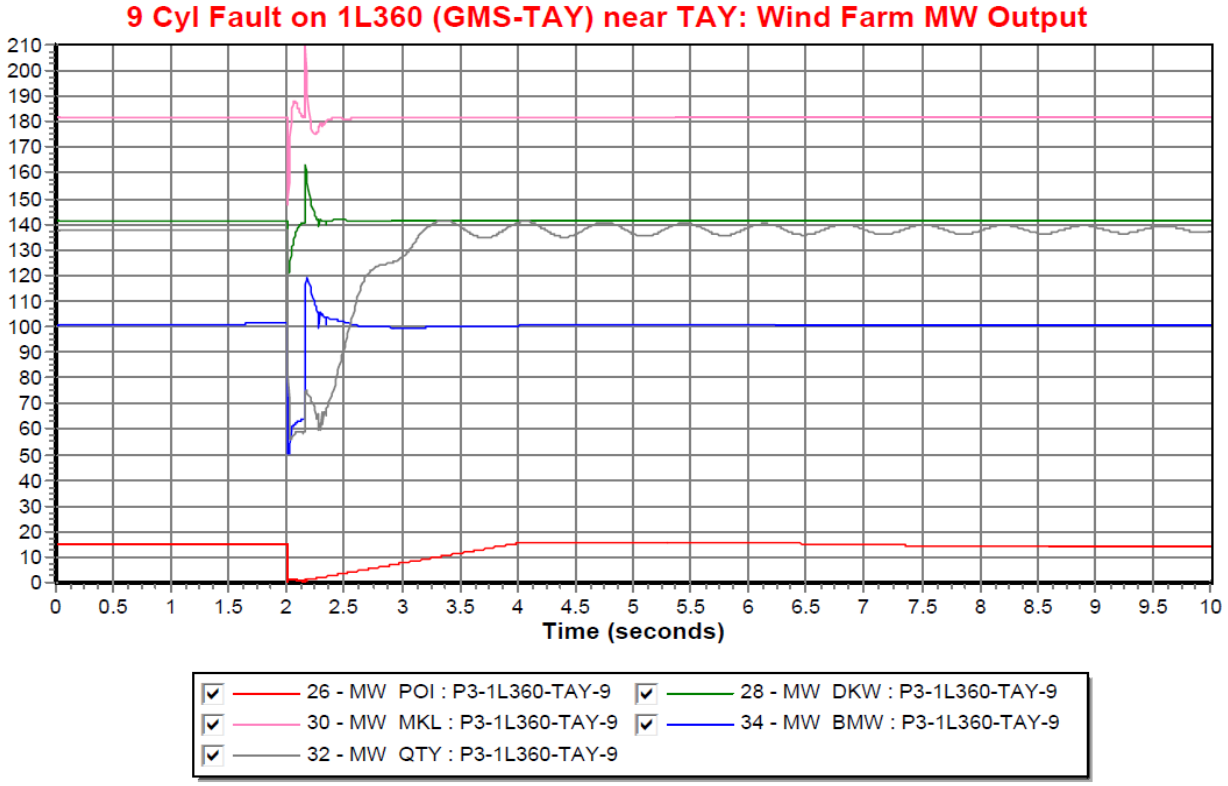


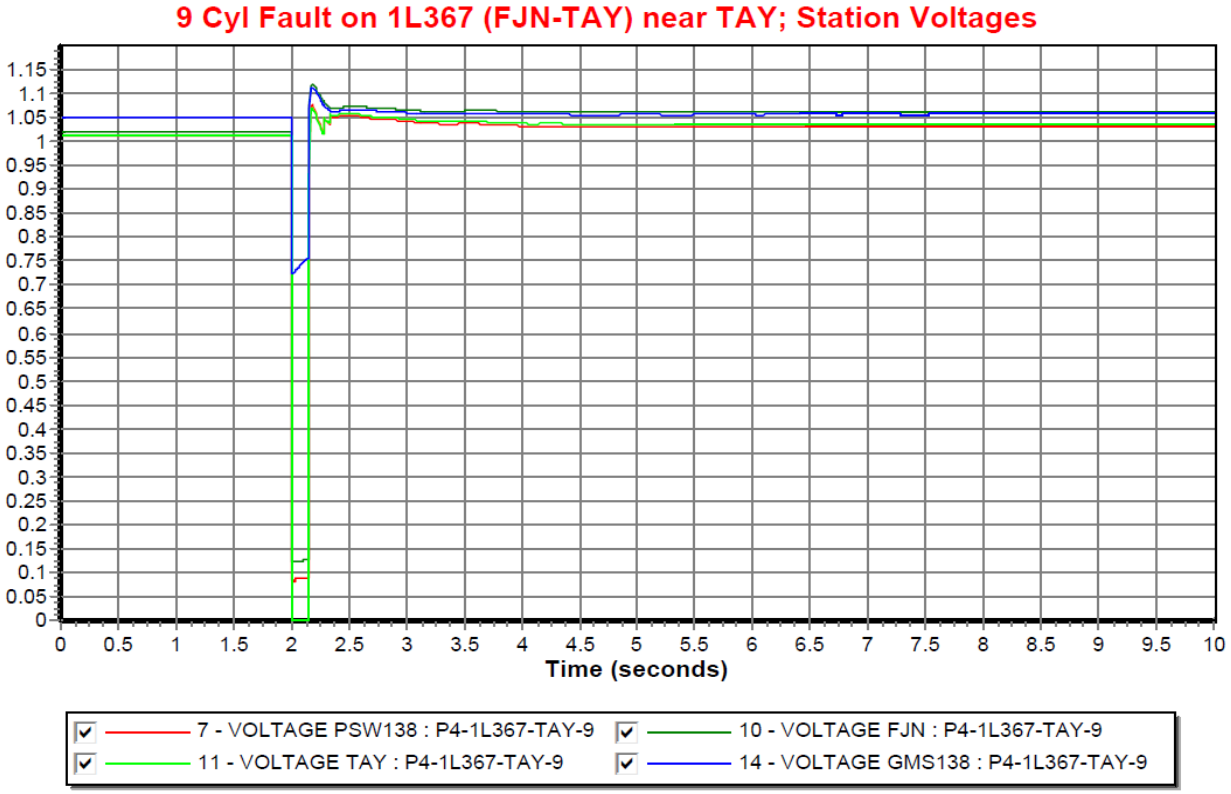


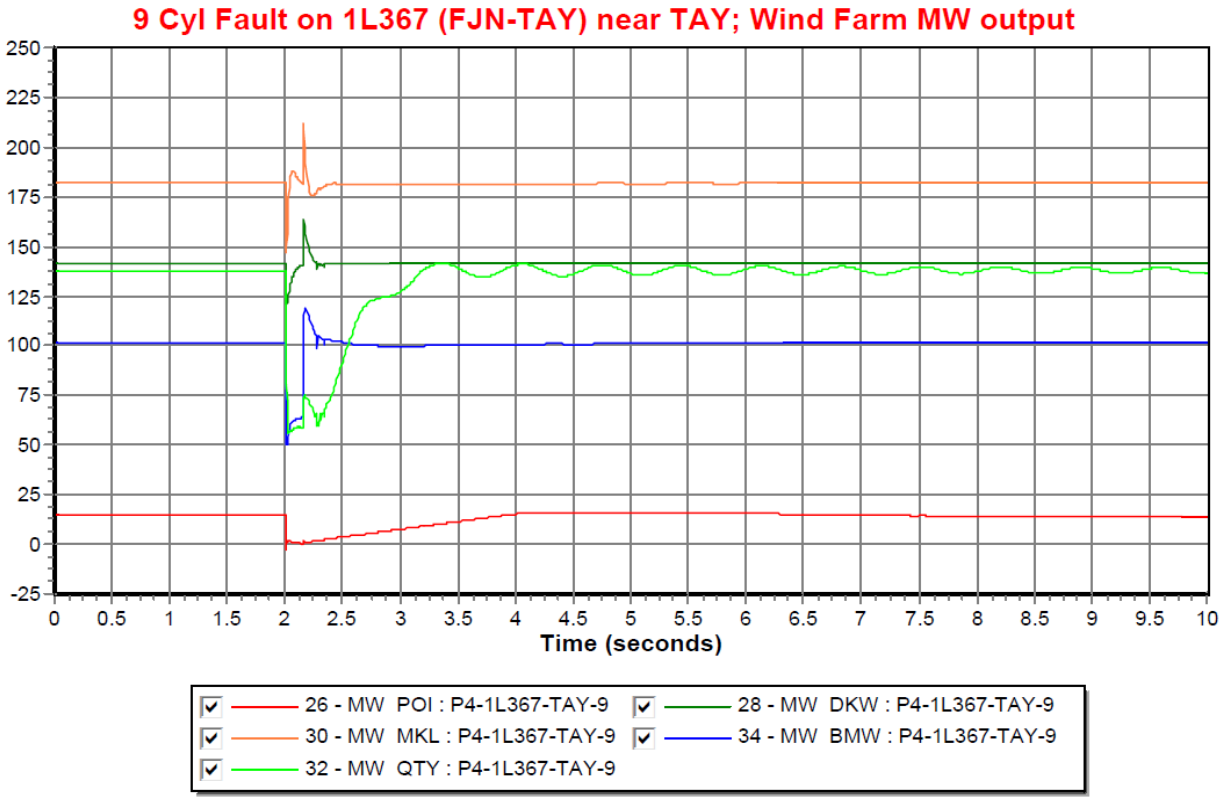




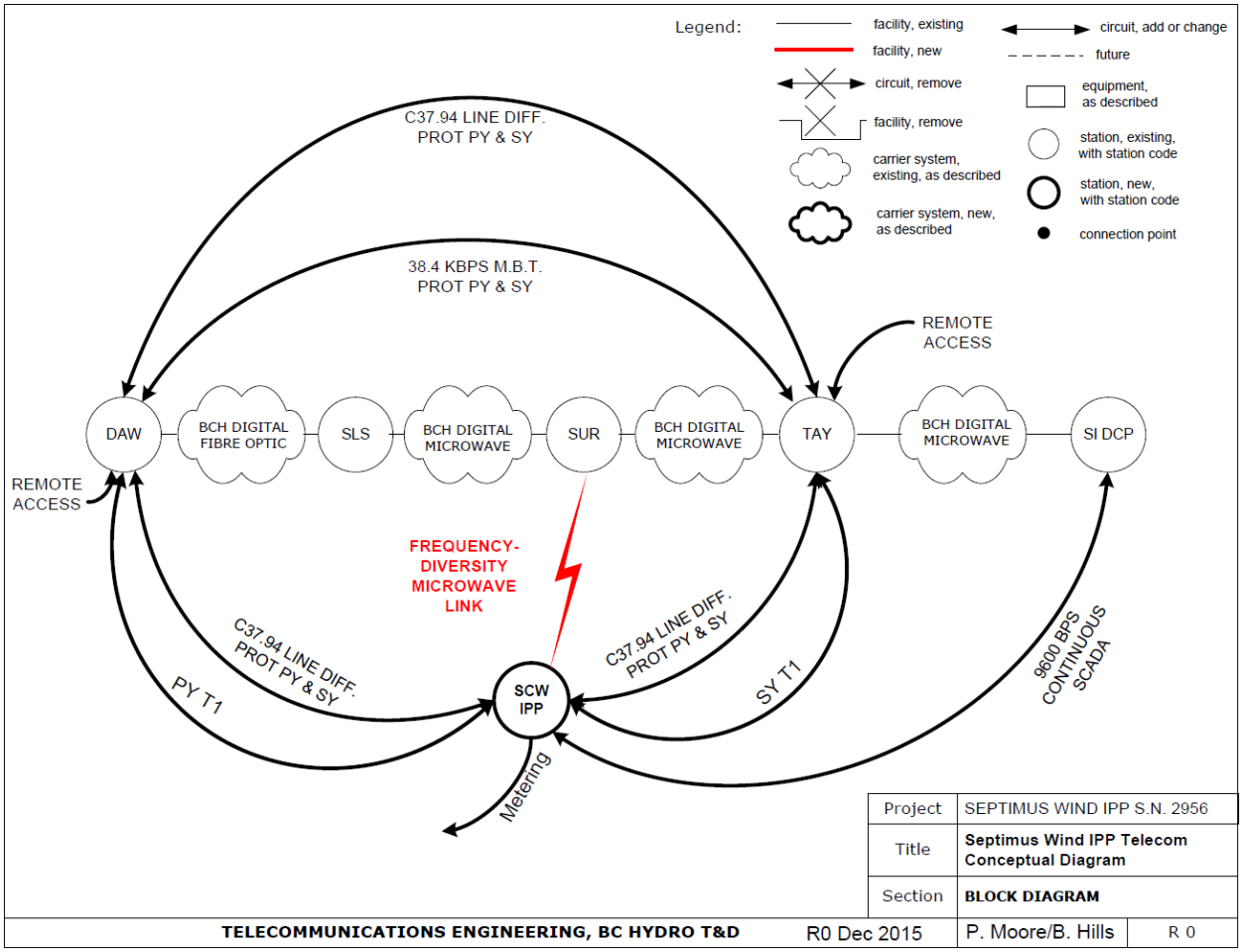








APPENDIX D – Telecom Block Diagram



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.)