Interconnection Feasibility Study Report

GIP-225-FEAS-R4

System Interconnection Request #225

70 MW Wind Generating Facility

Pictou County (L-7019)

2010 07 13
Control Centre Operations
Nova Scotia Power Inc.

Executive Summary

The interconnection Customer submitted a Network Resource Interconnection Service (NRIS) Request to NSPI for a proposed 70 MW wind generation facility in Pictou Couty, and subsequently requested that it is concurrently studied as an Energy Resource Interconnection Service (ERIS). The Point of Interconnection requested by the customer and two other alternatives were investigated in this study:

- on 230kV transmission system via L-7019 (formerly L-7004) between 67N-Onslow and 91N-Dalhouise Mountain,
- on 230kV transmission system via L-7003 between 67N-Onslow and 3C-Port Hastings,
- on 138kV transmission system via L-6503 between 1N-Onslow and 51N-Michelin Tap.

Both NRIS and ERIS were studied for each option.

No concern regarding short-circuit or voltage flicker was found for this project on its own, provided that the project design meets NSPI requirements for low-voltage ride-through, reactive power range and voltage control system. Harmonics must meet the Total Harmonics Distortion provisions of IEEE 519.

The summary table below shows the facility changes and network upgrades that are required for the 70MW wind facility interconnect to the transmission system via 230kV or 138kV for both NRIS and ERIS types.

POI	NRIS		ERIS	
	Winter Peak	Summer Peak	Winter Peak	Summer Peak
L-7019	100 MVar Switched Capacitor, Reconfiguration of 67N Bus	Re-build L-7019	N/A	Gen. curtailed to 50MW Modification to SPS for CBX& ONI
L-7003	100 MVar Switched Capacitor	Re-build L-7003	N/A	Modification to SPS for CBX
L-6503	100 MVar Switched Capacitor, Reconfiguration of 67N Bus	N/A	N/A	N/A

The preliminary non-binding estimated cost of facilities required to interconnect IR#225 to the transmission line L-7019 as NRIS is $32.5 Million including a contingency of 10%. However, if the POI is brought into 91N-Dalhousie Mountain substation, the preliminary non-binding estimated cost is $ 25.7 Million plus the required compensation to the existing Interconnection Customer at 91N based on the pro rata use of the interconnection facilities and as agreed by the parties.

The preliminary non-binding estimated cost of facilities required to interconnect IR#225 to the transmission line L-7003 as NRIS is $28.5 Million including a contingency of 10%. The preliminary non-binding estimated cost of facilities required to interconnect the IR#225 to the transmission line L-6503 as NRIS is $20.8 Million including a contingency of 10%.

These non-binding estimates will be further refined in the System Impact Study and the Facility Study.

Table of Contents

1 Introduction

The Interconnection Customer submitted an Interconnection Request for Network Resource Interconnection Service (NRIS) to NSPI for a proposed 70 MW wind generation facility interconnected to the NSPI transmission system. The Point of Interconnection (POI) requested by the customer and two other alternatives were investigated and they are:

- on 230kV transmission system via L-7019 (formerly L-7004) between 67N-Onslow and 91N-Dalhouise Mountain, approximately 21.8 km from 67N-Onslow. It also requires 10.8 km newly-constructed 230kV line tap from the customer generation in Pictou Couty,
- on 230kV transmission system via L-7003 between 67N-Onslow and 3C-Port Hastings, approximately 21.8 km from 67N-Onslow. It also requires 10.8 km newly-constructed 230kV line tap from the customer generation which will cross L-7019,
- on 138kV transmission system via L-6503 between 1N-Onslow and 51N-Michelin Tap, approximately 25 km from 1N-Onslow. This option requires 11.7 km newly-constructed 138kV line tap from the customer generation which will cross two 230kV transmission lines and the Trans-Canada Highway.

Both NRIS and Energy Resource Interconnection Service (ERIS) were studied for each option.

The Interconnection Customer signed a Feasibility Study Agreement to study the connection of their proposed generating facility to the NSPI transmission system dated 2010-06-07, and this report is the result of that Study Agreement. This project is listed as Interconnection Request #225 in the NSPI Interconnection Request Queue, and will be referred to as IR#225 throughout this report.

2 Scope

The Interconnection Feasibility Study (FEAS) consists of a power flow and short circuit analysis. Based on this scope, the FEAS report shall provide the following information:

1. Preliminary identification of any circuit breaker short circuit capability limits exceeded as a result of the interconnection;
2. Preliminary identification of any thermal overload or voltage limits violations resulting from the interconnection;
3. Preliminary description and non-bonding estimated cost of facilities required to interconnect the Generating Facility to the Transmission System, the time to construct such facilities, and to address the identified short circuit and power flow issues.

The Scope of this FEAS includes modeling the power system in normal state (with all transmission elements in service) under anticipated load and generation dispatch conditions.

In accordance with Section 3.2.2.2 of the Standard Generation Interconnection Procedures, as approved by the UARB on February 10, 2010 (RGIP), the Interconnection Study for NR Interconnection Service shall assure that the Interconnection Customer's Generating Facility meets the requirements for NR Interconnection Service and as a general matter, that such Generating Facility's interconnection is also studied with the Transmission Provider’s Transmission System at peak load, under a variety of severely stressed conditions, to determine whether, with the Generating Facility at full output, the aggregate of generation in the local area can be delivered to the aggregate of load on the Transmission Provider’s Transmission System, consistent with the Transmission Provider’s reliability criteria and procedures.

In accordance with Section 3.2.1.2 of RGIP, the FEAS for ERIS consists of short circuit/fault duty, steady state (thermal and voltage) analyses. The short circuit/fault duty analysis would identify direct Interconnection Facilities required and the Network Upgrades necessary to address short circuit issues associated with the Interconnection Facilities. The steady state studies would identify necessary upgrades to allow full output of the proposed Generating Facility and would also identify the maximum allowed output, at the time the study is performed, of the interconnecting Generating Facility without requiring additional Network Upgrades. It is therefore assumed that transmission interfaces limits will not be exceeded to avoid system upgrades in an ERIS study.

A more detailed analysis of the technical implications of this development will be included in the System Impact Study (SIS) report. The SIS includes system stability analysis, power flow analysis such as single contingencies (including contingencies with more than one common element), off-nominal frequency operation, off-nominal voltage operation, low voltage ride through, harmonic current distortion, harmonic voltage distortion, system protection, special protection systems (SPS), automatic generation control (AGC) and islanded operation. The impacts on neighbouring power systems and the requirements set by reliability authorities such as Northeast Power Coordinating Council (NPCC), North American Electric Reliability Corporation (NERC), and NSPI will be addressed at that time and will include an assessment of the status of the Interconnection Facility as a Bulk Power System element. The SIS may identify and provide a non-binding estimate of any additional interconnection facilities and/or network upgrades that were not identified in this FEAS.

An Interconnection Facilities Study follows the SIS in order to ascertain the final cost estimate to interconnect the generating facility.

3 Assumptions

The FEAS is based on the technical information provided by the Interconnection Customer. The Point of Interconnection (POI) and configuration is studied as follows:

1. Network Resource Interconnection Service type plus concurrent study as Energy Resource Interconnection Service type per section 3.2 of the RGIP.
2. 70 MW wind with 35 x 2MW Enercon E82 Wind Turbines.
3. The generation technology used must meet NSPI requirement for reactive power capability of 0.95 capacitive to 0.95 inductive at the Point of Interconnection (POI). The generator is specified for 70 MW at a rated power factor of 0.89. It is also required to have high-speed Automatic Voltage Regulation to maintain constant voltage at the generator terminals during and following disturbances.
4. The Interconnection Customer indicated generation interconnection point is on the 230kV line L-7019 with an alternative POI on L-7003, approximately 21.8 km from 67N-Onslow. The wind facility is located approximately 10.8 km from the line tap. A second alternative POI identified by the Interconnection Customer is on the 138kV line L-6503, approximately 25 km from 1N-Onlsow with an 11.7 km spur line. For this option the spur line has to cross two 230kV lines and Trans-Canada Highway to tap off L-6503.
5. Preliminary data was provided for the generator step-up transformer. Modeling was conducted using a 230kV-34.5kV 48/64/80 MVA transformer with a positive sequence impedance of 9% for POI on L-7019 or L-7003. A 138kV-34.5kV 48/64/80 MVA transformer with a positive sequence impedance of 9% was assumed for POI on L-6503. It was indicated that the step-up transformer has a grounded wye-wye-delta winding configuration with +/-10% off-load tap changer.
6. The FEAS analysis is based on the assumption that IR's higher in the Generation Interconnection Queue (Queue) that have completed a System Impact Study, or that have a System Impact Study in progress will proceed; As such, IR#8, IR #45, IR#56, IR #82, IR #114, IR #141 and IR#151 are included in this study.

4 Projects with Higher Queue Positions

All in-service generation is included in the FEAS.

As of 2010-07-13 the following projects are higher queued in the Interconnection Request Queue, and have the status indicated.

Per GIP Section 6.2 - Interconnection Requests -included in FEAS (Committed to study Base Case)

- IR #8 GIA in progress
- IR #45 Unexecuted GIA filed
- IR #56 FAC in progress
- IR #82 GIA executed
- IR #114 GIA executed
- IR #141 GIA executed

- IR #151 SIS in progress

Per GIP Section 6.2 – Interconnection Requests not included in FEAS

The following IRs either have SIS Agreements complete (but have not yet met the RGIP SIS progression milestones), or have Feasibility Study agreements complete. As such, they are not included in this FEAS.

IR #67	IR #68	IR #86	IR #115	IR #117	IR #126
IR #128	IR #130	IR #131	IR #140	IR #149	IR #156
IR #157	IR #163	IR #213	IR #219	IR #222	IR #223
IR #226					

If any of the higher-queued projects included in this FEAS are subsequently withdrawn from the Queue, the results of this FEAS may need to be updated. The re-study cost incurred as a result of the withdrawal of the higher-queued project shall be the responsibility of the Interconnection Customer that has withdrawn the higher queued project.

5 Objective

The objective of this FEAS is to provide a preliminary evaluation of the system impact and the cost of interconnecting the 70 MW generating facility to the NSPI transmission system at the designated location. The assessment will identify potential impacts on the loading of transmission elements, which must remain within their thermal limits. Any potential violations of voltage criteria will be identified and addressed. If the proposed new generation increases the short-circuit duty of any circuit breakers beyond their rated capacity, the circuit breakers must be upgraded. Single contingency criteria[1] are applied for the NRIS and ERIS assessments.

This FEAS is based on a power flow and short circuit analysis and does not include a complete determination of facility changes/additions required to increase system transfer capabilities that may be required to the Bulk Power System to meet the design and operating criteria established by NPCC and NERC or required to maintain system stability. These requirements will be determined by the subsequent interconnection System Impact Study (SIS).

6 Short-Circuit Duty

The maximum (design) expected short-circuit level is 5000 MVA on 138kV systems and 10000MVA on 230kV systems. The short-circuit levels in the area before and after this development are provided below in Table 6-1 and Table 6-2 for POI on L-7019 and L-

[1] The Single Contingency Criteria is defined by NPCC in its A-7 Document, and may involve more than one transmission element.

6503 respectively. The short-circuit levels in the area with IR#225 on L-7003 would be similar to the results with POI on L-7019.

Table 6-1: POI on L-7019. Short-Circuit Levels. Three-phase MVA (1)		
Location	**IR #225 in service**	**IR #225 not in service**
All transmission facilities in service		
230kV Interconnection Point	2669	2526
67N-Onslow 230kV	4220	4096
3C-Port Hastings 230kV	3010	2976
Minimum Conditions		
230kV Interconnection Point	2269	2126

* Short-circuit levels for POI on L-7003 similar to those for POI on L-7019

Table 6-2: POI on L-6503. Short-Circuit Levels. Three-phase MVA (1)		
Location	**IR #225 in service**	**IR #225 not in service**
All transmission facilities in service		
138kV Interconnection Point	1666	1527
1N-Onslow 138kV	2320	2250
50N-Trenton 138kV	2890	2840
Minimum Conditions		
138kV Interconnection Point	1503	1364

(1) Classical fault study, flat voltage profile

In determining the maximum short-circuit levels with this generating facility in service the generators have been modeled as conventional machines with reactance comparable to induction machines regardless of the type of generators proposed, which provides a worst case scenario. The SIS will refine the fault level based on the actual machine characteristics.

The maximum short-circuit level at the POI on L-7019 is presently 2526 MVA. After installing IR #225 the increase will bring the short-circuit level to 2669 MVA at the POI. Under summer light load conditions with certain generation units offline, the short-circuit level will be approximately 2126 MVA at the POI with IR#225. This translates into maximum equivalent system impedance at the POI of 0.047 per unit on 100 MVA base.

The maximum short-circuit level on L-6503 is presently 1527 MVA. After installing IR # 225 the increase will bring the short-circuit level to 1666 MVA at the POI. Similarly, under summer light load conditions with certain generation units offline, the short-circuit level will be approximately 1364 MVA at the POI with IR#225. This translates into maximum equivalent system impedance at the POI of 0.073 per unit on 100 MVA base. The interrupting capability of 138kV circuit breakers at 50N-Trenton and 1N-Onslow are at least 3500 MVA which will not be exceeded by this development on its own.

7 Voltage Flicker and Harmonics

The voltage flicker at the POI on L-7019 using IEC Standard 61400-21 and the published values for Enercon E82 machines is 0.004 under normal conditions and 0.005 under minimum generation conditions. These are both below NSPI's required limit of 0.25 for P_{st} and 0.35 for P_{lt} at the 230kV side of the 34.5/230kV. Therefore voltage flicker should not be a concern for this project with POI on L-7019 or L-7003. The full SIS will examine the requirements in detail.

Alternatively the voltage flicker at the POI on L-6503 is 0.007 under normal conditions and 0.008 under minimum generation conditions. Therefore voltage flicker should not be a concern for this project with POI on L-6503 either. The full SIS will examine the requirements in detail.

The generator is expected to meet IEEE Standard 519 limiting Total Harmonic Distortion (all frequencies) to a maximum of 5%, with no individual harmonic exceeding 1%.

8 Thermal Limits

POI on L-7019:

L-7019 and the sections of line L-7004 between Route 289 and 91N-Dalhousie Mountain are constructed with 556 kcm Dove ACSR conductor designed for maximum operating temperature of 60°C. The conductor has a thermal rating of 233 MVA summer and 307 MVA winter. The sections of L-7004 between Route 289 and 3C-Port Hastings are constructed with 795 kcm Drake ACSR conductors with a higher ampacity (294 MVA summer and 387 MVA winter).

Since power flows from East to West in this part of the Nova Scotia power system (from Cape Breton towards Onslow and Brushy Hill), the only concern for this IR#225 on L-7019 is the rating of the Dove conductor between the POI and 67N-Onslow.

IR #225 on L-7019 adds 70 MW to the Onslow Import (ONI) interface, which is currently limited to 1025 MW. If the interface is operated at 1095 MW (1025 + 70 – incremental losses), then loss of the double-circuit tower at the Strait of Canso, which trips L-8004 plus L-7005 results in line L-7019 being loaded to 130% of its normal summer rating. This overload occurs in spite of the activation of the Special Protection

System (SPS)[2] SPS #120 which trips two units at Lingan. Therefore the 22 km section of L-7019 between 67N-Onslow and POI should be re-built with the 795 Drake ACSR conductor.

When the Onslow Import interface transfer level is below the limit of 1025 MW and the SPS #120 has two Lingan units armed, loss of the double-circuit Strait of Canso can result in L-7019 loaded up to 117% of its normal summer rating. If the Interconnection Customer selects Energy Resource Interconnection Service (ERIS) type, IR#225 should be curtailed to 50 MW to avoid any network upgrade.

The present setting for the SPS #120 associated with the loss of the double-circuit Strait of Canso crossing requires tripping one Lingan unit when Cape Breton Export (CBX) exceeds 500 MW and two Lingan units when ONI exceeds 875 MW. The addition of 70 MW of flow on L-7019 due to IR#225 would require a modification to CBX arming level for one Lingan unit and to ONI arming level for two Lingan units for loss of L-8004 for any reason. The details of this modification will be developed in the SIS and FAC.

POI on L-7003:

Line L-7003 is primarily constructed with 556 kcm Dove ACSR conductor designed for maximum operating temperature of 60°C. The conductor has a thermal rating of 233 MVA summer and 307 MVA winter.

If the ONI interface is operated at 1095 MW (1025 + 70 – incremental losses), IR #225 on L-7003 would cause L-7003 to be overloaded to 115% of its normal summer rating with loss of the double-circuit tower at the Strait of Canso following activation of the SPS #120 which trips two units at Lingan. Therefore the 22 km section of L-7003 section between 67N-Onslow and the POI should be re-built with the 795 Drake ACSR conductor.

If the Interconnection Customer selects ERIS type, the addition of 70 MW flow on L-7003 due to IR#225 would cause L-7003 to be overloaded to 115% of its normal summer rating when CBX level is approaching 500 MW, which is the point at which the first Lingan unit is armed by SPS#120. Therefore the modification to CBX arming level is required to avoid any thermal overload violation. The details of this modification will be developed in the SIS and FAC.

POI on L-6503:

L-6503 is designed for 230kV operation but is currently operated at 138kV. It is not classified as Bulk Power System (BPS), but it might be upgraded in the future. This

[2] Also known as Remedial Action Schemes, SPS's are defined by NPCC as "A protection system designed to detect abnormal system conditions, and take corrective action other than the isolation of faulted elements." *NPCC Document A7 - Glossary of Terms.*

transmission line is constructed with 1113 kcm Beaumont ACSR conductor designed for maximum operating temperature of 100°C between 50N-Trenton and 51N-Michelin Tap (L-6503a) and 85°C between 51N-Michelin Tap and 1N-Onslow (L-6503b). The conductor on L-6503a has a thermal rating of 320 MVA summer and 363 MVA winter and the conductor on L-6503b has a thermal rating of 287 MVA summer and 335 MVA winter. However the ratings of circuit breakers at both 50N-Trenton and 1N-Onlsow terminals are both 1200A which restrict the rating of L-6503 to 287 MVA for both summer and winter rating.

During system summer peak with high Onslow interface operated at 1095(1025 + 70 – incremental losses), failure of 67N-812 resulting in the loss of L-8003& L-8002 would cause L-6001 to be overloaded to 112% of its thermal rating. This thermal violation could be eliminated by an addition of new 345kV circuit breaker at 67N-Onslow and swapping the connection points of L-8003 and 67N-T82.

9 Voltage Limits

This generating facility must be capable of providing both lagging and leading power factor of 0.95, measured at the high voltage terminals of the POI, at all production levels up to the full rated load of 70 MW. A centralized controller will be required which continuously adjusts individual generator reactive power output within the plant capability limits and regulates the voltage at the 34.5kV bus. The voltage controls must be responsive to voltage deviations at the terminals of the Interconnection Facility substation, be equipped with a voltage set-point control, and also have facility that will slowly adjust the set-point over several (5-10) minutes to maintain reactive power within the individual generators capabilities. The details of the specific control features, control strategy and settings will be reviewed and addressed in the SIS, as will the dynamic performance of the generator and its excitation.

The NSPI System Operator must have manual and remote control of the voltage set-point and the reactive power set-point of this facility to coordinate reactive power dispatch requirements.

The Onslow Import and Onslow South interfaces are both stability limited and voltage limited. IR #225 will increase flows across these interfaces, potentially exceeding present limits. Stability will be addressed in Section 10 below, and voltage violations are addressed in this section. The Onslow South interface limit is a function of the reactive power (Mvar) dispatch and associated reactive power reserve in the Metro area. Higher transfer levels are possible if reactive power is kept in reserve to respond to contingencies. However, as power transfer increases across the Onslow South Interface, the resulting increase in steady-state reactive power requirements reduces the available reserve. Therefore, it is required that 100 Mvar of switched reactive power be added in the Metro Area (FEAS assumed 120H-Brushy Hill 138kV bus) to ensure the existing reactive power is available to respond to contingencies. The cost of this capacitor bank and associated switchgear is estimated to be $2,760,000. Otherwise IR#225 would require curtailment or re-dispatch by NSPI system operators when the Onslow Import and Onslow South interfaces are stressed, which is consistent with ERIS.

10 System Security / Stability Limits

The NSPI transmission system has limited east to west transfer capability. Transmission corridors between Sydney and Halifax are often operated to security limits. This project increases flow across the Cape Breton Export, the Onslow Import, and the Onslow South interfaces. Generation rejection Special Protection Systems (SPS's) are utilized to increase system stability limits to maximize east to west power transfers. Depending on the impact of other generation additions ahead of this project in the Interconnection Request Queue, the additional generating capacity that this facility provides may not be integrated into the NSPI system under all dispatch conditions without system upgrades.

Under some dispatch conditions with certain contingencies, transmission corridors become overstressed, which may require network upgrades. The SIS will determine if this action solves the stability issues associated with the congested interfaces.

The two 345kV transmission lines L-8003 and L-8002 share a common circuit breaker 67N-812 at 67N-Onslow. NPCC requires that systems remain stable and all bulk power transmission voltages remain within emergency limits following a single phase fault on a circuit breaker, or a single phase fault on a transmission line combined with the failure of a circuit breaker to operate. Loss of L-8003 and L-8002 due to fault or failure of 67N-812 breaker is the most limiting fault for the Onslow Import and Onslow South interfaces.

Two alternatives were examined for IR #225 with POI on L-7019: addition of a Static Var Compensator (SVC) at 67N-Onslow or the reconfiguration of the 345kV bus at 67N-Onslow to eliminate the contingency of most concern. If an SVC is installed at Onslow, it would need to be rated at least 30 Mvar[3] at an estimated cost of $7,315,000. The second alternative includes the addition of a new 345kV circuit breaker at 67N-Onslow and swapping the connection points of L-8003 and 67N-T82 to eliminate contingency of loss of L-8002 and L-8003 simultaneously. The latter option is estimated to cost $3,720,000, and is the recommended action.

If IR#225 interconnects with L-7003 or L-6503, 100 MVar Switched Capacitors at 120H-Brushy Hill would be required, but a SVC would not be required at 67N.

If the Interconnection Customer selects ERIS type, IR#225 would be restricted such that Onslow Import transfer level would not exceed its limit of 1025MW, while the dynamic reactive reserves at Metro Area would be maintained at the appropriate level.

[3] The SVC size is based on the assumption that 100 Mvar of switched capacitors are added to 120H-Brushy Hill.

In general, the SIS will determine the facility changes that are required to permit higher transmission loadings while maintaining compliance with NERC/NPCC standards and in keeping with good utility practice.

11 Expected Facilities Required for Interconnection

The following facility changes are required to interconnect IR #225 with L-7019, L-7003 and L-6503 respectively:

Additions/Changes to POI on L-7019 :

1. Three 230kV circuit breakers and associated switches in a ring-bus arrangement and structures to turn L-7019 into a new switching station,
2. 10.8 km 230kV spur line to connect the wind farm to the POI,
3. Protection systems designed to NPCC Bulk Power System criteria,
4. Control and communications between the POI switching station and NSPI SCADA system (to be specified)

Note: For Wind Generation POI on L-7019, another alternative is to bring the POI into 91N-Dalhousie Mountain substation. The 230kV bus at 91N substation can be expanded to accommodate an additional circuit breaker and associated switches for the new line terminal. The total cost of the expansion at 91N substation would be $1,000,000 including the modifications on existing protection control and communications. This change will also bring the length of the 230kV spur line from the wind farm down to 9.8 km, and the cost associated with that would be $4,900,000. In addition to these costs, the IR#225 would be required to pay compensation to the existing Interconnection Customer at 91N, based on the pro rata use of the existing interconnection facilities and as agreed by the parties. In addition, cost responsibilities of ongoing cost, including operation and maintenance costs associated with the interconnection facilities, will be allocated between Interconnection facilities and IR#225 based upon the pro rata use of interconnection facilities by Transmission Provider, IR#225 and Interconnection Customer at 91N.

Additions/Changes to POI on L-7003

1. Three 230kV circuit breakers and associated switches in a ring-bus arrangement and structures to turn L-7019 into a new switching station,
2. 10.8 km 230kV spur line to connect the wind farm to the POI,
3. Protection systems designed to NPCC Bulk Power System criteria (nodes of L-7003 at 67N and 3C would be upgraded to BPS protection),
4. Control and communications between the POI switching station and NSPI SCADA system (to be specified).

Additions/Changes to POI on L-6503

1. Three 138kV circuit breakers and associated switches in a ring-bus arrangement and structures to turn L-6503 into a new switching station,
2. 11.7 km 138kV spur line to connect the wind farm to the POI,
3. The structures required for the line tap to cross two 230kV lines and Trans-Canada Highway,
4. Protection systems designed with provision for future upgrade to NPCC Bulk Power System criteria,
5. Control and communications between the POI switching station and NSPI SCADA system (to be specified).

Requirements for the Generating Facility (Preliminary)

1. Facilities to provide 0.95 leading and lagging power factor when delivering rated output (70 MW) at the 230kV or 138kV bus when the voltage at that point is operating between 95 and 105 % of nominal.
2. Centralized controls. These will provide centralized voltage set-point control known as a Farm Control Unit (FCU). The FCU will control the 34.5kV bus voltage. Responsive (fast-acting) controls are required. The controls will also include a curtailment scheme which will limit or reduce total output from the facility, upon receipt of a telemetered signal from NSPI's SCADA system. The controller will also limit the load ramp rate of the facility to within limits set by NSPI and/or telemetered from NSPI's SCADA system.
3. NSPI to have control and monitoring of reactive output of this facility, via the centralized controller. This will permit the NSPI Operator to raise or lower the voltage set-point remotely.
4. Low voltage ride-through capability as per FERC Order 661a[4] .
5. Real-time monitoring (RTU) of the interconnection facilities for NSPI to execute high speed rejection of generation (transfer trip).

12 NSPI Interconnection Facilities and Network Upgrades Cost Estimate

Table 12-1 shows the facility changes and network upgrades that are required for the 70MW wind facility interconnect to the NSPI system via a 230kV or 138kV transmission line for both NRIS and ERIS types.

[4] FERC Order 661A addresses the requirement for wind-powered generation to ride-through faults in a manner similar to traditional synchronous generator.

POI	NRIS		ERIS	
	Winter Peak	Summer Peak	Winter Peak	Summer Peak
L-7019	100 MVar Switched Capacitor, Reconfiguration of 67N Bus	Re-build L-7019	N/A	Gen. curtailed to 50MW Modification to SPS for CBX& ONI
L-7003	100 MVar Switched Capacitor	Re-build L-7003	N/A	Modification to SPS for CBX
L-6503	100 MVar Switched Capacitor, Reconfiguration of 67N Bus	N/A	N/A	N/A

Estimates for NSPI Interconnections Facilities as NRIS with POI on L-7019 are included in Table 12-2.

Table 12-2: Cost Estimates identified from FEAS Scope for POI on L-7019(1)		
	Determined Cost Items	**Estimate**
NSPI Interconnection Facilities		
i	Build 10.8 km 230kV single circuit line	$5,400,000
Network Upgrades		
ii	Three 230kV circuit breakers in a ring-bus arrangement	$5,894,513
iii	Protection, control, communication	$750,000
iv	Re-build L-7019 with 795 ACSR Drake (22 km, Gulfport) (2)	$11,000,000
v	100Mvar Capacitors at Brushy hill	$2,760,000
vi	67N Bus Reconfiguration	$3,720,000
Totals		
vii	Contingency (10%)	$2,952,451
	Total of Determined Cost Items	$32,476,964
	To be Determined Costs	
viii	System additions to address potential stability limits	TBD (SIS)
ix	Compensation to the existing Interconnection Customer for use of Interconnection Facilities at 91N (1)	TBD

(1) For the option to bring POI into 91N-Dalhousie Mountain substation, cost of items ii & iii can be brought down to $1,000,000, and the cost of item i is $4,900,000 for development of 9.8 km 230kV single circuit line instead of 10.9 km. Therefore the total determined cost for this option would be $ 25,718,000 plus the compensation to the existing Interconnection Customer at 91N, based on the pro rata use of the interconnection facilities and as agreed by the parties.
(2) Cost of items iv, v and vi are not applicable to ERIS.

Estimates for NSPI Interconnections Facilities as NRIS with POI on L-7003 are included in Table 12-3.

Table 12-3: Cost Estimates identified from FEAS Scope for POI on L-7003		
	Determined Cost Items	**Estimate**
NSPI Interconnection Facilities		
i	Build 10.8 km 230kV single circuit line	$5,400,000
Network Upgrades		
ii	Three 230kV circuit breakers in a ring-bus arrangement	$5,894,513
iii	Protection, control, communication	$850,000
iv	Re-build L-7003 with 795 ACSR Drake (22 km, Gulfport) (3)	$11,000,000
v	100Mvar Capacitors at Brushy hill	$2,760,000
Totals		
vi	Contingency (10%)	$2,590,451
	Total of Determined Cost Items	$28,494,964
	To be Determined Costs	
vii	System additions to address potential stability limits	TBD (SIS)

(3) Cost of items iv and v are not applicable to ERIS.

Estimates for NSPI Interconnections Facilities as NRIS with POI on L-6503 are included in Table 12-4.

Table 12-4: Cost Estimates identified from FEAS Scope for POI on L-6503		
	Determined Cost Items	**Estimate**
NSPI Interconnection Facilities		
i	Develop 11.7 km 138kV single circuit line	$5,850,000
ii	Structures for line tap across the Trans-Canada Highway	$100,000
Network Upgrades		
iii	Three 138kV circuit breakers in a ring-bus arrangement	$5,894,513
iv	Protection, control, communication	$600,000
v	100Mvar Capacitors at Brushy Hill (4)	$2,760,000
vi	67N Bus Reconfiguration	$3,720,000
Totals		
vii	Contingency (10%)	$1,892,451
	Total of Determined Cost Items	$20,816,964
	To be Determined Costs	
viii	System additions to address potential stability limits	TBD (SIS)

(4) Cost of items v and vi are not applicable to ERIS.

13 Issues to be Addressed in SIS

The SIS must determine the facilities required to operate this facility at full capacity, withstand the contingencies as defined by NPCC/NERC and identify any restrictions that must be placed on the system following a first contingency loss. The SIS will be conducted in accordance with the RGIP with all appropriate higher-queued projects included in the SIS study base cases as well as identified Network Upgrades associated with those higher-queued projects.

The SIS will confirm the options and ancillary equipment that the customer must install to control flicker, voltage and ensure that the facility has the required ride-through capability.

The assessment will consider but not be limited to the following. The facility additions/changes required to increase NSPI east to west transfers under system normal conditions (all transmission in) over the range of NSPI loads and with interruptible loads on or off. Some of the constrained interfaces that will be included in the assessment are as follows.

1. Cape Breton Export
2. Onslow Import
3. Onslow South
4. Metro reactive reserve requirements
5. NS – NB export/import

13.1 Steady-state post-contingency analysis

All elements within acceptable voltage and thermal limits under the following single contingencies, in accordance with NPCC[5] and NERC[6] criteria

i. L-8004
ii. Hopewell transformer 79N-T81
iii. L-8003
iv. L-7019

13.2 System stability for the following faults

Loss of any element without a fault

i. L-8004
ii. Hopewell transformer 79N-T81

[5] NPCC criteria are set forth in it's Reliability Reference Directory #1 *Design and Operation of the Bulk Power System*
[6] NERC transmission criteria are set forth in *NERC Reliability Standards TPL-001, TPL-002, TPL-003*

iii. L-8003
iv. L-7019

Three-phase fault cleared in normal time:

i. L-8003 at Onslow end
ii. L-8003 at Hopewell end
iii. L-8001 at import and export limits
iv. L-7019 at Onslow end
v. 1N-B61 (for 138kV option at export limits)

Single-phase to ground fault cleared in backup time (Breaker Failure)

i. L-8003 at Onslow with failure of 67N-812 (lose L-8002)
ii. L-7019 at Onslow plus L-7001

Single-phase to ground fault on separated circuits of double-circuit tower:

i. L-8004 plus L-7005 at Canso Crossing
ii. L-7003 plus section of L-7004 at Trenton

Any changes to SPS schemes required for operation of this generating facility, in addition to existing generation and facilities that can proceed before this project, will be determined by the SIS as well as any required additional transmission facilities. The determination will be based on NERC and NPCC criteria as well as NSPI guidelines and good utility practice. The SIS will also determine the contingencies for which this facility must be curtailed.

The SIS will calculate the unit loss factor, which is a measure of the percentage of the net output of IR #225 which is lost through the transmission system. Preliminary value is calculated to be 4.4% on 230kV line (system losses increase by 3.1 MW when IR #225 is operated at 70 MW), and 5.3% on 138kV line (system losses increase by 3.7 MW when IR #225 is operated at 70 MW).

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