Interconnection Feasibility Study Report

GIP-367-FEAS-R1

System Interconnection Request #367

49.6 MW Wind Generating Facility

Weaver's Mountain (L-7004/L-7003)

2012-02-28
Control Centre Operations
Nova Scotia Power Inc.

Executive Summary

The IC submitted an Interconnection Request (IR#367) for Network Resource Interconnection Service (NRIS) to NSPI for a proposed 49.6 MW wind generation facility interconnected to the NSPI transmission system, and also asked that Energy Resource Interconnection Service (ERIS) be studied concurrently. The commercial operation date will be December 31, 2014.

The Point of Interconnection (POI) requested by the customer is on L-7004 with L-7003 as the alternate POI. In either case, the POI will be approximately 65 km from the 3C-Port Hastings 230 kV substation on L-7004 or L-7003. The Interconnection substation will be directly at the POI without any 230 kV line extension.

The analysis for the feasibility study is done twice, first for the expected system conditions in 2014 and second for 2017 since there are other higher queued Transmission Service Request and Generation Interconnection Requests that will occur in 2017.

The preliminary investigation shows that the POI on the alternate line L-7003 requires fewer system upgrades than the POI on L-7004; hence it is recommended that the POI be on L-7003. This feasibility study centers on the interconnection to L-7003.

The study finds that IR#367 meets the requirement for voltage flicker level based on the wind turbine parameters provided.

The increased short circuit levels do not exceed the ratings of existing breakers in the system, hence there are no existing breakers require upgrading.

The incremental system loss factor for IR#367 is about 9% on 49.6 MW rating under system winter peak.

Based on +/-0.9 power factor for the wind turbines and the supplied data for the transformers and the assumed parameters for the collector circuits, the wind facility does not meet the +0.95 power factor requirement on the 230 kV side of the main generating transformer. The design of the collector circuits, choice of transformers and wind turbine options will need to be reviewed to ensure the power factor requirement will be met or power factor correction option will be required.

The wind facility must meet the Total Harmonics Distortion provisions of IEEE 519. This feasibility study cannot make that determination.

For IR#367 to generate at full output as ERIS with IR#367 displacing Cape Breton generation, the recommended system upgrade includes a three breaker ring bus configuration for the Interconnection substation, uprating L-6511, communication system for protection and control, protection changes at the remote terminals of L-7003 to meet the bulk power criteria[1], and

[1] As defined in Northeast Power Coordinating Council (NPCC) criteria are set forth in the Reliability Reference Directory #1 *Design and Operation of the Bulk Power System (BPS)*

control and communication to SCADA. The preliminary non-binding cost estimate is $11.9 million. Without upgrading L-6511, IR#367 would be curtailed to zero MW under some system conditions.

For IR#368 to generate at full output as NRIS with IR#368 displacing Tufts Cove generation, the recommended system upgrade includes a three breaker ring bus configuration for the Interconnection substation, uprating L-6511, communication system for protection and control, protection changes at the remote terminals of L-7003 to meet the bulk power criteria, control and communication to SCADA. The preliminary non-binding cost estimate is $11.9 million.

L-6511 will require line survey to confirm if uprating the line is possible and within the cost estimate.

The above cost estimates do not account for any system upgrades that the future SIS may determine.

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1 Introduction

The IC submitted an Interconnection Request (IR#367) for Network Resource Interconnection Service (NRIS) to NSPI for a proposed 49.6 MW wind generation facility interconnected to the NSPI transmission system. The request also asks for an Energy Resource Interconnection Service (ERIS) study concurrently. The Point of Interconnection (POI) requested by the customer is on L-7004 with L-7003 as the alternate, approximately 65 km from the 3C-Port Hastings 230 kV substation. It is assumed that the IC substation is at the POI on L-7004 or L-7003 without any 230 kV line extension.

The Interconnection Customer (IC) signed a Feasibility Study Agreement to study the connection of their proposed generating facility to the NSPI transmission system dated November 28, 2011, and this report is the result of that Study Agreement. This project is listed as Interconnection Request #367 in the NSPI Interconnection Request Queue, and will be referred to as IR#367 throughout this report.

2 Scope

This Interconnection Feasibility Study (FEAS) consists of a power flow and short circuit analysis.

Based on this scope, the FEAS report will 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 high level non-binding cost estimate of system upgrades required to interconnect the Generating Facility to the Transmission System to address the identified short circuit and power flow issues.
4. Preliminary non-binding cost estimate of system upgrades required to interconnect IR#367.

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 3.2.1.2 of Standard Generation Interconnection Procedures (GIP), as approved by the UARB on February 10, 2010, 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.

In accordance with Section 3.2.2.2 of the GIP, 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.

The scope of this FEAS does not include the detailed analysis that is normally completed in the System Impact Study (SIS). The SIS will include 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, 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 are 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

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

1. NRIS and ERIS as per the GIP.
2. 49.6 MW wind facility with 31 wind turbines model GE 1.6 MW with power factor of +/- 0.9. The generator terminal voltage is 690 volts.
3. The generation technology used must meet NSPI requirement for reactive power capability of 0.95 capacitive to 0.95 inductive at the HV terminals of the IC Generating Step Up (GSU) transformer. The wind facility must have a high-speed Automatic Voltage Regulation to maintain constant voltage at the generator terminals during and following system disturbances.

4. The IC indicated that the generation interconnection point is on the line L-7004 with L-7003 as the alternate, approximately 65 km from the 3C-Port Hastings 230 kV substation. The IC substation will be at the POI on L-7004 or L-7003 without any 230 kV line extension and will have a three breaker ring bus configuration.
5. The IC indicated that the GSU transformer will be a 230 kV to 34.5 kV 33/44/55 MVA Y-Y-D transformer with a positive sequence impedance of 7.5% on 33 MVA and an X/R ratio of 30. The transformer has a +/- 10% tap range in 1% steps. The tertiary is buried.

   The positive sequence impedances of the wind turbine generator step-up transformers are based on a value of 5.75% and an X/R ratio of 7.5 on 1.75 MVA.
6. The FEAS analysis is based on the assumption that IR's higher in the Generation Interconnection Queue and OATT Transmission Service Queue that have completed a System Impact Study, or that have a System Impact Study in progress will proceed, as listed in Section 4 below.

4 Projects with Higher Queue Positions

All in-service generation is included in the FEAS.
As of 2012-01-19 the following projects are higher queued in the Interconnection Request Queue and OATT Transmission Service Queue, and have the status indicated.

Interconnection Requests -Included in FEAS

- IR #8 GIA Executed
- IR #45 GIA Executed
- IR #56 GIA Executed
- IR #151 GIA Executed
- IR #219 GIA Executed
- IR #227 GIA in Progress
- IR #225 GIA in Progress
- IR #234 FAC in Progress

Interconnection Requests –Not Included in FEAS

- IR #131 SIS Milestones Met
- IR #360 SIS in progress
- IR #362 SIS in progress

OATT Transmission Service Queue– Included in FEAS
- TSR-100 SIS in progress

OATT Transmission Service Queue– Not Included in FEAS
- TSR-400 SIS Agreement Completed

While TSR-100, IR#225 and IR#234 are higher queued, TSR-100 has an in-service date of 2016 and both IR#225 and IR#234 have an in-service date of 2017; whereas IR#367 has an in-service date of December 31, 2014. Therefore the FEAS for this IR will be performed twice, one for 2014 without TSR-100, IR#225 and IR234 in service and again for 2017 onwards with them in-service, along with any related system changes.

The additional Transmission Service Request TSR-400 and Interconnection Requests IR#131, IR#360 and IR#362 are higher queued than IR#367 and SISs are in progress. However, the results of these SISs are not sufficiently defined to be included in the FEAS for IR#367.

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

IR #67	IR #68	IR#117	IR #126	IR #128	IR #149
IR #163	IR #213	IR #222	IR #235	IR #238	IR #241
IR #242	IR #314	IR #356	IR#361	IR#364	IR#365

If any of the higher-queued projects included in this FEAS are subsequently withdrawn from the Queue, the results of this FEAS may require updating or a re-study may be necessary. 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 withdraws the higher queued project.

5 Objective

The objective of this FEAS is to provide a preliminary evaluation of the system impact and the high-level non-binding cost estimate of interconnecting the 49.6 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[2] are applied for both 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).

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

6 Steady State Thermal Analysis

The load flow analysis was completed for a number of generation dispatches under system light load, summer peak load, and winter peak load conditions.

For ERIS, the FEAS uses Cape Breton generation to be displaced by IR#367 generation while complying with the existing ONI limit of 1,025 MW.

For NRIS, the FEAS lets IR#367 generation to increase the ONI and ONS above the existing limits. The pre_IR#367 ONS limit of 850 MW for summer will be used as the starting point pre-IR#367.

Single contingencies on the 345 kV, 230 kV, 138 kV, and 69 kV voltage levels were conducted for the above system conditions for pre-IR#367 and post-IR#367 for both POIs, one on L-7004 and one on L-7003 for 2014 and 2017.

The results of the load flow analysis shows that the base cases for the summer peak system load and generation dispatch conditions produce the highest thermal violations hence the discussion will center on summer peak base cases.

L-7004 POI

The POI of IR#367 on L7004 will divide the line into two sections. In this FEAS, the line section from IR#367 to 91N-Dalhousie Mountain will be referred to as L-7004a and the line section from IR#367 to 3C-Port Hastings will be referred to as L-7004b.

The load flow results for 2017 summer peak pre-IR#367 show all system elements are within 110% of their summer ratings as shown below in the table below:

Case 2017_SP_L7004_P40C Pre-IR#367		
CBX=801 MW, ONI=963 MW, TR=80 MW		
Contingency	**System Element**	**Percent of Rating**
DCT8004_5g6	L7019	105
	L7004a	85
	L6511	110
L7005	L7019	97
	L6511	90
L7014	L7019	96
	L6511	103
DCT7003_7004a_g3	L7019	21
	L6511	99

The legends are:

- CBX: Cape Breton Export.
- ONI: Onslow Import.
- TR: Trenton generation.
- DCT8004_5g6: Double Circuit Tower L-8004 and L-7005 with Group 6 Special Protection Scheme (SPS) to trip two Lingan thermal units with 310 MW net.
- DCT7003a_7004_g3: Double Circuit Tower L-7003a and L-7004 with Group 3 Special Protection Scheme (SPS) to trip one Lingan thermal unit with 155 MW net.

Adding IR#367's 49.6 MW generation to the previous base case shows L-7019 and L-6511 overloaded beyond 110% as shown in the following table:

Case 2017_SP_L7004_P40C Post-IR#367		
CBX=801 MW, ONI=1009 MW, TR=80 MW		
Contingency	**System Element**	**Percent of Rating**
DCT8004_5g6	**L7019**	**118***
	L7004a	98
	L6511	**116**
L7005	L7019	109
	L6511	93
L7014	L7019	108
	L6511	108
DCT7003_7004a_g3	L7019	21
	L6511	108

* This is with Trenton generation at minimum. When Trenton generation is at a higher level, L-7019 will overload to 124% of its summer rating as shown in the table below:

Case 2014_SP_L7004_P61C Post-IR#367		
CBX=810 MW, ONI=1072 MW, TR=260 MW		
Contingency	**System Element**	**Percent of Rating**
DCT8004_5g6	**L7019**	**124**
	L7004a	103
	L6511	102

The above analysis shows that there are two options for system upgrades to mitigate the thermal overload of L-7019 and L-6511, either uprating both L-7019 and L-6511 or separating the lines L-8004 and L-7005 from their common towers.

The cost estimate for uprating L-7019 is $2.96 million and L-6511 is $3.65 million for a subtotal of $6.61 million. The cost estimate for 138 kV line uprating, not 230 kV uprating is used for L-7019 as this line was originally built for 138 kV operation.

The cost estimate for separating L-8004 and L-7005 is approximately $8.1 million. This option will also require the modification to the Group 3 SPS for the double circuit tower line L-7003 and L-7004a contingency at Trenton.

Hence uprating L-7019 and L-6511 is a more economical choice, assuming that the lines can be uprated.

L-7003 POI

The POI of IR367 on L7003 will divide the line into two sections. In this FEAS, the line section from IR367 to 67N-Onslow will be referred to as L-7003a and the line section from IR367 to 3C-Port Hastings will be referred to as L-7003b.

The load flow results for the 2017 summer peak case pre-IR#367 show all system elements are within 110% of their summer ratings as shown in the following table:

Case 2017_SP_L7003_P40C Pre-IR#367		
CBX=805 MW, ONI=967 MW, TR=80 MW		
Contingency	**System Element**	**Percent of Rating**
DCT8004_5g6	L7019	105
	L7003a	89
	L6511	110
L7005	L7019	97
	L6511	89
L7014	L7019	95
	L6511	101
DCT7003_7004_g3	L7019	21
	L6511	99

Adding IR#367's 49.6 MW generation to the above base case shows L-6511 overloaded beyond 110% as shown in the following table below:

Case 2017_SP_L7003_P40C Post-IR#367		
CBX=806 MW, ONI=1014 MW, TR=80 MW		
Contingency	**System Element**	**Percent of Rating**
DCT8004_5g6	L7019	110*
	L7003a	102
	L6511	**116**
L7005	L7019	100
	L6511	93
L7014	L7019	98
	L6511	105
DCT7003a_7004_g3**	L7019	21
	L6511	107
DCT7003a_7004 (no SPS)	**L6511**	**127**

** Require Group 3 SPS modification for the Trenton double circuit tower location.

* This is with Trenton generation at minimum. When Trenton generation is at a higher level, unlike the POI on L-7004 discussed earlier, L-7019 will remain within 110% of its summer rating as shown in the following table:

Case 2014_SP_L7003_P11C Post-IR#367		
CBX=762 MW, ONI=1073 MW, TR=298 MW		
Contingency	**System Element**	**Percent of Rating**
DCT8004_5g6	L7019	108
	L7003a	99
	L6511	94

The overload of L-6511 can be resolved by the separation of L-8004 and L-7005 from their common towers and a modification to Group 3 SPS for L-7003 and L-7004 common towers. The cost estimate for L-8004 and L-7005 separation is $8.1 million. The modification of Group 3 SPS for L-7003 and L-7004 to cater for faults near Trenton is $0.3 million. The total cost estimate for this option is $8.4 million.

The other option is to uprate L-6511 at a cost estimate of $3.65 million; hence it is recommended that L-6511 be uprated.

This demonstrates that the POI on L-7003 requires fewer system upgrades and less costs than the POI on L-7004, hence it is recommended that the POI be on L-7003 and the study will center on the interconnection to L-7003.

In both cases, (POI on L-7004 or on L7003), without these system upgrades, IR#367 would be curtailed to zero MW under some system conditions such as Trenton generation at minimum with high CBX.

Onslow South (ONS) Interface

In the Pre-IR#367 summer peak base case with ONS at 850 MW and ONI at 1025 MW, the system can be dispatched to meet the required dynamic reserve in Metro of 250 MVAR.
For contingencies involving L-8002 either by itself or with L-8003 for 67N-812 contingency or with 67N-T81 for 67N-813 contingency, the overload on L-6001 remains within 110% as can be seen on the table below:

Case 2014_SP_L7003_P81C (Pre-IR#367)		
CBX= 762, ONI=1025 , ONS=850,TR=298: all values in MW		
Contingency	**System Element**	**Percent of Rating**
L8002	None	
L8002+L8003_g6	L6001	102
L8002+T81	None	

The same contingencies with IR#367 added to the previous base case produce similar result with L-6001 being overloaded to 108%, still within 110%, of its summer rating as shown in the following table:

Case 2014_SP_L7003_P81C_IR#367 (Post-IR#367)		
CBX= 762, ONI=1073 , ONS=896,TR=298, NS exp. 164 in MW		
Contingency	**System Element**	**Percent of Rating**
L8002	None	
L8002+L8003_g6	L6001	108
L8002+T81	None	

The above table shows ONI increases to 1073 MW and ONS to 896 MW. The Metro dynamic reserve (DRR) drops from 250 MVAR to 225 MVAR. For ONS at 896 MW, the system requires about 280 MVAR for DRR estimated using NSPI’s dynamic reserve curve. Thus, there is a shortage of 55 MVAR dynamic reserve. This requirement will need to be confirmed by the future SIS.

One option is to add a dynamic var source such as SVC, DVAR, or DSTATCOM. The other option is to run Tufts Cove or Burnside generation, if available, out of merit to provide the dynamic vars. The options will be evaluated in the future SIS.

The above analysis uses the recently revised line ratings for L-7018 with a summer rating of 506 MVA and a winter rating of 675 MVA.

When Point Aconi plant is off-line, the system is re-dispatched to meet criteria pre and post IR#367.

The incremental system loss factor for IR#367 is about 9% on 49.6 MW rating under system winter peak.

7 Short-Circuit Duty

The maximum (design) expected short-circuit level is 10,000 MVA for 230 kV level, 5,000 MVA for 138kV level and 3,500 MVA for 69 kV level. The short-circuit levels with maximum generation in Nova Scotia pre and post IR#367 in 2017 are provided below:

Maximum Short Circuit Level Pre and Post IR#367 versus Circuit Breaker Rating

	Fault Location	3 Phase MVA	L-G MVA	% increase 3 Phase	% increase L-G	Lowest Breaker rating kA	Voltage Level kV	Lowest Breaker rating MVA	Breaker Duty 3Phase	Breaker Duty L-G
Pre IR#367	IR#367 POI 230	1,824	1,730	N/A	N/A	N/A	230	N/A	N/A	N/A
	67N-Onslow 230	4,665	5,137	N/A	N/A	25	230	9,959	47%	52%
	3C-Port Hastings 230	3,219	3,151	N/A	N/A	25	230	9,959	32%	32%
Post IR#367	IR#367 POI 230	1,929	1,791	5.8%	3.5%	N/A	230	N/A	N/A	N/A
	67N-Onslow 230	4,719	5,181	1.2%	0.9%	25	230	9,959	47%	52%
	3C-Port Hastings 230	3,276	3,188	1.8%	1.2%	25	230	9,959	33%	32%

The short circuit levels are calculated using classical faults with flat voltage profile.
The maximum generation in 2017 is used since it produces higher short circuit levels than 2014 as the 345 kV system upgrades in TSR-100 will increase the short circuit levels in 2017.

In determining the maximum short-circuit levels with this generating facility in service IR#367 generators have been modeled as per the machine type specified in the Interconnection Request application. These generators are modelled to provide 2 per unit fault currents for faults on the transmission system as per the description from the manufacturer.

The above short circuit table shows that the existing circuit breakers in the system do not require upgrades due to the installation of IR#367.

8 Voltage Flicker and Harmonics

Based on the voltage flicker coefficient data for the wind turbines specified in the Interconnection Request application, the voltage flicker levels were calculated for the minimum generation in 2014, which would produce lower fault level than 2017, are tabulated in the following table:

2104 Minimum Generation System Short Circuit versus Voltage Flicker at POI L7003			
	System Normal	L7003a out	L7003b out
3 Phase Fault (MVA) at 230kV POI	1,270	838	756
3 Phase Fault (MVA) at 690V Term	204	189	184
Calculated Voltage Flicker Level	0.0360	0.0540	0.0600
Requirement	<0.35	<1	<1

Based on the result of the above table, IR#367 meets the requirement of voltage flicker levels.

The minimum generation in 2014 is used since it produces lower short circuit levels than 2017 as the 345 kV system upgrades in TSR-100 will increase the short circuit levels in 2017.

The generators are required to meet IEEE Standard 519 limiting Total Harmonic Distortion (all frequencies) to a maximum of 5%, with no individual harmonic exceeding 1%. This FEAS cannot make this assessment. It is the responsibility of the generating facility to ensure that this requirement is met.

9 Voltage Limits

IR#367 generating facilities must be capable of providing both lagging and leading power factor of 0.95, measured at the 230 kV terminals of the GSU transformer, at all production levels up to the full rated load of 49.6 MW.

Based on the data provided by the IC for +/-0.9 power factor for the wind turbines, the transformer impedances, and the assumed collector impedances, the load flow analysis shows that IR#367 is able to meet the power factor requirement for absorbing var at the 230 kV side of the GSU transformer, but not for delivering var. When the wind turbines deliver their maximum vars, the power factor at the 230 kV side of the GSU is +0.96, short of meeting +0.95 requirement. Power factor correction to +0.95 at the 230 kV side of the GSU will be required. This will be further investigated in the SIS.

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 34.5 kV bus voltage. 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 the ability to 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 set-point of this facility to coordinate reactive power dispatch requirements.

This facility must also have low voltage ride-through capability as per Appendix G of the Standard Generator Interconnection and Operating Agreement (GIA). The SIS will state specific options, controls and additional facilities that are required to achieve this.

11 Expected Facilities Required for Interconnection

The following facility changes are identified for interconnecting IR #367 onto L-7003 as ERIS:

1. Three 230 kV circuit breakers and associated switches in a ring-bus arrangement and structures to tap L-7003 at the POI into a new Bulk Power System (BPS) substation. This includes the protection for the new substation and line terminals.
2. Uprate 36.5 km of L-6511 from 50^0 C conductor temperature design to 70^0 C.
3. Communication system from the new substation to 3C-Port Hastings substation and 67N-Onslow substation for the protection and control.
4. Protection changes at the remote terminals of L-7003 to BPS.
5. Control and communications between the wind farm and NSPI SCADA system (to be specified).

The following facility changes are identified for interconnecting IR #367 onto L-7003 as NRIS:

1. Three 230 kV circuit breakers and associated switches in a ring-bus arrangement and structures to tap L-7003 at the POI into a new BPS substation. This includes the protection for the new substation and line terminals.
2. Uprate 36.5 km of L-6511 from 50^0 C conductor temperature design to 70^0 C.
3. Communication system from the new substation to 3C-Port Hastings substation and 67N-Onslow substation for the protection and control.
4. Protection changes at the remote terminals of L-7003 to BPS.
5. Control and communications between the wind farm and NSPI SCADA system (to be specified).

Requirements for the Generating Facility

1. 230 kV Interconnection Substation. An RTU to interface with NSPI’s SCADA, with telemetry and controls as required by NSPI.
2. Facilities to provide 0.95 leading and lagging power factor when delivering rated output at the 230 kv terminals of the GSU transformer when the voltage at that point is operating between 95 % and 105 % of nominal.

3. Centralized controls. These will provide centralized voltage set-point controls and are known as Farm Control Units (FCU). The FCU will control the 34.5 kV bus voltage and the reactive output of the machines. 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.
4. 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.
5. Low voltage ride-through capability as per Appendix G to the Standard Generator Interconnection and Operating Agreement (GIA).
6. Real-time monitoring (including a Remote Terminal Unit) of the interconnection facilities.
7. Facilities for NSPI to execute high speed rejection of generation (transfer trip) if determined in SIS.

12 Network Upgrades Cost Estimate

The preliminary and non-binding cost estimate for IR#367 with POI on L-7003 as ERIS is shown in the following table:

System upgrades for POI on L-7003: ERIS Full Output	Estimate
3 breaker ring bus at POI incl. local line terminal protection	$5,895,000
Uprate 36.5 km of L-6511*	$3,650,000
Communication system	$500,000
Protection upgrade to BPS at remote terminals of L-7003**	$460,000
Control & communication to SCADA	$300,000
Subtotal	$10,805,000
10% Contingency	$1,080,500
Total	**$11,885,500**
Other system upgrades to be determined by SIS	**TBD**

The preliminary and non-binding cost estimate for IR#367 with POI on L-7003 as NRIS is shown on the following table:

System upgrades for POI on L-7003: NRIS	Estimate
3 breaker ring bus at POI incl. local line terminal protection	$5,895,000
Uprate 36.5 km of L-6511*	$3,650,000
Communication system	$500,000
Protection upgrade to BPS at remote terminals of L-7003**	$460,000
Control & communication to SCADA	$300,000
Subtotal	$10,805,000
10% Contingency	$1,080,500
Total	**$11,885,500**
Other system upgrades to be determined by SIS	**TBD**

* This estimate will vary depending upon the result of the field survey. A full line rebuild can have cost estimate of $8.9 million for L-6511.

** This estimate for protection upgrade to BPS at the remote terminals of L-7003 is for a full modification of the nodes of L-7003 at 67N-Onslow and 3C-Port Hastings to BPS. However, there is some work being planned to bring some level of the two substations to BPS. If that work proceeds prior to IR#367 being installed, the cost of this item could be much less than indicated.

13 Future SIS

The SIS will include a comprehensive assessment of the technical issues and requirements to interconnect generation as requested. It will include more detailed load flow and system stability analysis for system normal and for single contingencies as defined by NERC[3] and NPCC[4] criteria for expected system conditions. The SIS will also examine the scenarios of the Nova Scotia system being islanded and the operation of the under frequency load shedding and the ability of IR#367 to remain on line during system frequency deviation. 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 for faults in the transmission system. The SIS will be conducted in accordance with the GIP with the assumption that all appropriate higher-queued projects will proceed and the facilities associated with those projects are installed.

In addition, the SIS will determine the dynamic reactive power reserve that may be required for ONI to exceed 1,025 MW and ONS to exceed 850 MW to allow IR#367 to operate as NRIS.

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