



Interconnection Feasibility Study Report

GIP-235-FEAS-R1

System Interconnection Request #235

60 MW Wind Generating Facility

Halifax County (87H)

2011-04-08
Control Centre Operations
Nova Scotia Power Inc.

Executive Summary

The Interconnection Customer submitted an Interconnection Request for Network Resource Interconnection Service (NRIS) to NSPI for a proposed 60 MW wind generation facility at Halifax County. The Point of Interconnection (POI) requested by the customer is the 87H-Musquodoboit Harbour substation via a 17.5 km newly-constructed line from the wind farm which is located at West Jeddore, Halifax County.

As a result of the addition of IR#235, thermal overloads on the following lines would occur under the contingency situation where two transmission lines share a failed common breaker:

- L-6007 and L-5003 are overloaded by 22% and 15% of their summer thermal ratings by loss of L-6040 and L-6003 (91H-640);
- L-6007 and L-5003 are overloaded by 12% and 11% by loss of L-6042 and L-6014 (91H-607);
- L-6003 is overloaded by 17% of its summer rating by loss of L-6007 and L-6009 (108H-600);
- L-6007 is overloaded by 16% of its summer rating by loss of L-6014 and L-6035 (104H-600).

Besides the potential overloads above, loss of either L-6003 or L-6007 could cause the other line to be overloaded by up to 20% of its summer thermal rating, and loss of L-6014 could also result in overloads on L-6007 by 15%.

To provide for sufficient thermal capacity under these contingencies, additional transmission reinforcement will be required. This study recommends extending L-6038 from 103H-Lakeside to 91H-Tuft's Cove by building a new 138 kV line between Tower 4 at Bayer's Lake and 91H-Tuft's Cove (9.2 km) with 795 ACSR Drake conductors designed for the maximum operating temperature of 100°C. The new line terminal will be connected to the 138 kV bus at 91H with an additional circuit breaker. The existing right of way and transmission towers for L-6033, L-6035 and L-6014 between Tower 4 at Bayer's Lake, Bayer's Rd, Seaview Park and the Harbour Crossing can be utilized for this proposed new line. The towers are designed for double circuits use but presently have only one transmission line. The 69 kV line L-5039 is presently sharing 2.3 km of the L-6033 transmission towers, and therefore new 69kV line structures for L-5039 will have to be built to make the room for the extension of L-6038.

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 preliminary non-binding estimated cost of facilities required to interconnect the IR#235 to the 87H- Musquodoboit Harbour substation 138 kV bus is \$11.8 Million including a contingency of 10%. However the cost estimates have not included the network upgrade on building the new line section across the Harbour. The estimate will be further refined in the System Impact Study and the Facility Study.

Table of Contents

	Page
Executive Summary	ii
1 Introduction	1
2 Scope	1
3 Assumptions	2
4 Projects with Higher Queue Positions	3
5 Objective	4
6 Short-Circuit Duty	4
7 Voltage Flicker and Harmonics	5
8 Thermal Limits.....	5
9 Voltage Limits	7
10 System Security / Stability Limits.....	7
11 Expected Facilities Required for Interconnection.....	7
12 NSPI Interconnection Facilities and Network Upgrades Cost Estimate	8
13 Issues to be Addressed in SIS.....	9

1 Introduction

The Interconnection Customer submitted an Interconnection Request (IR) for Network Resource Interconnection Service (NRIS) to NSPI for a proposed 60 MW wind generation facility interconnected to the NSPI transmission system. The Point of Interconnection (POI) requested by the customer is at the 87H- Musquodoboit Harbour substation via a 17.5 km newly-constructed line from the wind farm, which is located at West Jeddore.

The Interconnection Customer signed a Feasibility Study Agreement to study the connection of their proposed Generating Facility to the NSPI transmission system on 2011-02-03, and this report is the result of that Study Agreement. This project is listed as Interconnection Request #235 in the NSPI Interconnection Request Queue, and will be referred to as IR#235 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 high level 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.

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 per section 3.2 of the RGIP.
2. 60 MW wind with 20 x 3.0 MW Vestas V112 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 HV terminals of the IC Substation Step Up transformer. The Generating Facility is assumed to be specified for 60 MW at a rated power factor of 0.9 for both lagging and leading at the generator terminals. Because IR#235 is connected to the grid via a radial transmission line, it is required to have centralized automated control to maintain constant power factor during and following system disturbances as determined in the subsequent System Impact Study.
4. The Interconnection Customer indicated that the generation interconnection point is at the 87H- Musquodoboit Harbour substation. The wind facility is located approximately 17.5 km from the 87H substation.
5. Preliminary data was provided by the Interconnection Customer for the generator step-up and IC substation step-up transformers. Modeling was conducted with a 138kV-34.5kV 40/53/66.6 MVA Interconnection Facility transformer with a positive sequence impedance of 9% and an assumed X/R ratio of 7.5. The Interconnection Customer indicated that this Interconnection Facility step-up transformer has a grounded wye-delta-wye winding configuration with +/-5% off-load tap changer. The generator step-up transformer is indicated with an impedance of 8% on 3.35 MVA with +/-5% off-load tap changer and an assumed X/R ratio of 7.5.

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#151, IR#219, IR#227, IR#225, IR#233 and IR#234 are included in this study.

4 Projects with Higher Queue Positions

All in-service generation is included in the FEAS.

As of 2011-04-02 the following Transmission Service Requests from the Open Access Transmission Tariff are higher queued, and have the status indicated.

- TSR 100 SIS in progress
- TSR 200 SIS in progress

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 #45 Unexecuted GIA filed
- IR #8 GIA Executed
- IR #56 GIA Tendered
- IR #151 FAC in progress
- IR #219 FAC in progress
- IR #227 SIS complete
- IR #225 FAC in progress
- IR #233 SIS in progress
- IR #234 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 #222	IR#232	

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 high-level non-binding cost estimate of interconnecting the 60 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 criteria¹ are applied for the NRIS 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 3500 MVA on 69 kV systems. The short-circuit levels in the area before and after this development are provided below in Table 6-1.

Table 6-1: Short-Circuit Levels. Three-phase MVA ⁽¹⁾		
Location	IR #235 in service	IR #235 not in service
All transmission facilities in service		
87H-Musquodoboit Harbour 138kV (POI)	895	775
113H-Dartmouth East 138 kV	1855	1745
91H-Tuft's Cove 138 kV	3787	3680
91H-Tuft's Cove 69 kV	2216	2197
108H- Burnside 138 kV	3452	3387
Minimum Conditions		
87H-Musquodoboit Harbour 138kV (POI)	688	566

⁽¹⁾ Classical fault study, flat voltage profile

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

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 on the 138kV bus at 87H substation is presently 777 MVA. After installing IR # 235, the short-circuit level will increase to 895 MVA at the POI. Similarly, under summer light load conditions with certain generation units offline, the minimum short-circuit level will be approximately 566 MVA at the POI. This translates into maximum equivalent system impedance at the POI of 0.177 per unit on 100 MVA base.

The interrupting capability of the 138kV circuit breakers at 91H-Tuft's Cove is at least 5000 MVA and all 69 kV circuit breakers at that substation are rated at least 3000 MVA. As such, the interrupting rating will not be exceeded by this development on its own. The breaker rating is 5000 MVA at both 108H-Burnside 138 kV and 113H-Dartmouth East 138 kV; therefore IR#235 will not impact the circuit breakers at these stations.

7 Voltage Flicker and Harmonics

The generator flicker co-efficient data was not available at the time of this study. As a result, the voltage flicker analysis will be conducted during the System Impact Study. However, as the ratio of short-circuit level to generating capacity at POI under system normal condition is 14.9 (based on proposed plant rating of 60 MW), there should be no specific issues regarding voltage control and power quality due to the addition of this facility on its own.

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

This facility will be interconnected to the 87H- Musquodoboit Harbour substation by constructing an approximately 17.5 km of 138kV transmission line with 556 ACSR Dove conductors and maximum operating temperature of 100°C. The proposed new line terminal will be connected onto 87H bus via a dedicated circuit breaker.

Load flow analysis has been conducted with all lines in service and for all single contingencies required by NERC and NPCC. Historical dispatch patterns included all units at Tuft's Cove generating at full load for system load levels above 70% of winter peak load and at 100% of summer peak load. However the Tuft's Cove units have also been operated at full load under system light load conditions in the past few years.

With the addition of 60 MW generation proposed by IR#235 in combination with the full generation at Tuft's Cove plant under summer peak and light load conditions, thermal overload violations have been found under several contingencies. L-6003 shares a common circuit breaker (91H-605) with L-6007 at 91H-Tuft's Cove. Due to the fault on the common breaker or a line fault with the failure of the breaker, simultaneous loss of L-6003 and L-6007 could result in flow across the 138 kV L-6014 and the 69 kV line L-5003 exceeding their thermal limits. This contingency was found to cause the most severe overload violations. Therefore the line terminals of L-6040 and L-6003 at 91H-Tuft's Cove should be swapped to eliminate this contingency so that L-6003 and L-6007 don't share a common breaker. The addition of IR#235 does not initiate the overloads by this contingency, but increase the level of the overloads. Since the overloads exist prior to the addition of IR#235, the cost of mitigation is not assigned to IR# 235.

As a result of the addition of IR#235, thermal overloads on the following lines would occur under the contingency situation where two transmission lines shares a failed common breaker:

- L-6007 and L-5003 are overloaded by 22% and 15% of their summer thermal ratings by loss of L-6040 and L-6003 (91H-640);
- L-6007 and L-5003 are overloaded by 12% and 11% by loss of L-6042 and L-6014 (91H-607);
- L-6003 is overloaded by 17% of its summer rating by loss of L-6007 and L-6009 (108H-600);
- L-6007 is overloaded by 16% of its summer rating by loss of L-6014 and L-6035 (104H-600).

Besides the potential overloads above, loss of either L-6003 or L-6007 could cause the other line to be overloaded by up to 20% of its summer thermal rating, and loss of L-6014 could also result in overloads on L-6007 by 15%.

To provide for sufficient thermal capacity under these contingencies, additional transmission reinforcement will be required. The solution recommended in this study is to extend L-6038 from 103H-Lakeside to 91H-Tuft's Cove by building a new 138 kV line between Tower 4 at Bayer's Lake and 91H-Tuft's Cove (9.2 km) with 795 ACSR Drake conductors designed for the maximum operating temperature of 100°C. The new line terminal will be connected to the 91H-Tuft's Cove 138 kV bus with an additional circuit breaker. The existing right of way and transmission towers for L-6033, L-6035 and L-6014 between Tower 4 at Bayer's Lake, Bayer's Rd, Seaview Park and the Harbour Crossing can be utilized for this new line. These towers are designed for double circuits use but presently have only one transmission line. The 69 kV line L-5039 is sharing 2.3 km of the L-6033 transmission towers, and therefore new 69kV line structures for L-5039 will have to be built to make the room for the extension of L-6038. At the feasibility stage there is insufficient information regarding the cost on the line section across the harbour near Mackey Bridge, therefore further engineering survey will be required for the detailed cost estimates at the SIS stage.

The requirement for restrictions or curtailments of this facility when operating with an element (transmission line, transformer etc) out of service (N-1 operation) will be further assessed in the SIS.

9 Voltage Limits

This project, like all new generating facilities must be capable of providing both lagging and leading power factor of 0.95, measured at the HV terminals of the IC Substation Step Up Transformer, at all production levels up to the full rated load of 60 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 34.5 kV 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 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 to the Standard Generator Interconnection and Operating Agreement (GIA). The SIS will state specific options, controls and additional facilities that are required to achieve this.

10 System Security / Stability Limits

The SIS will determine if any facility changes are required to permit the proposed 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 #235 to the 138 kV bus at 87H substation:

Additions/Changes to POI

1. Addition of approximate 17.5 km of 138kV spur line to connect the wind farm to the POI with 556 Dove ACSR conductors rated 100°C conductor temperature,
2. A dedicated 138 kV circuit breaker and associated switches at 87H for the spur line to the wind farm,
3. Modification on NSPI protection systems,

4. Control and communications between the wind farm and NSPI SCADA system (to be specified).

Requirements for the Generating Facility

1. Facilities to provide 0.95 leading and lagging power factor when delivering rated output (60 MW) at the HV terminals of the IC Substation Step Up Transformer when the voltage at that point is operating between 95 and 105 % of nominal.
2. Centralized controls. These will provide centralized voltage set-point controls known as a Farm Control Unit (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. 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 Appendix G to the Standard Generator Interconnection and Operating Agreement (GIA).
5. Real-time monitoring (including a Remote Terminal Unit) of the interconnection facilities.
6. Facilities for NSPI to execute high speed rejection of generation (transfer trip) if determined in SIS.

12 NSPI Interconnection Facilities and Network Upgrades Cost Estimate

Estimates for NSPI Interconnections Facilities and Network Upgrades for interconnecting 60 MW wind energy onto 138 kV systems are included in Table 12-1.

Control Centre Operations – Interconnection Feasibility Study Report

Table 12-1: Cost Estimates identified from FEAS scope		
	Determined Cost Items	Estimate
NSPI Interconnection Facilities		
i	Build 17.5 km 138kV single circuit line and line termination into the 87H substation	\$ 6,037,500
ii	One 138 kV circuit breaker and associated switches at 87H	\$ 1,000,000
iii	Protection, control, communication	\$ 656,500
Network Upgrades		
iv	New 138kV transmission line as extension of L-6038 (9.2 km)	\$1,385,000
v	New structures for 69kV transmission line L-5039 (2.3 km)	\$ 460,000
vi	New circuit breaker for L-6038 termination at 91H	\$ 1,200,000
Totals		
viii	Contingency (10%)	\$1,073,900
ix	Total of Determined Cost Items	\$11,812,900
To be Determined Costs		
x	Transmission structures for the new line across the harbour	TBD (SIS)
xi	System additions to address potential stability limits	TBD (SIS)

The preliminary non-binding cost estimate for interconnecting IR#235 with 87H-Musquodoboit Harbour substation would be \$11,812,900. The Interconnection Customer is also required to fund the Items iv), v) and vi) costs plus the To Be Determined costs associated with Items x) and xi), but would be eligible for repayment in accordance with the terms of the GIA.

13 Issues to be addressed in SIS

The following provides a preliminary scope of work for the subsequent SIS on IR#235. The SIS will include a more comprehensive assessment of the technical issues and requirements to interconnect generation as requested. In addition, this will include contingency analysis, system stability and ride through and operation following a contingency (N-1 operation). The SIS must determine the facilities required to operate this facility at full capacity, withstand any contingencies (as defined by the criteria appropriate to the location) and identify any restrictions that must be placed on the system following a first contingency loss. 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 SIS will be conducted in accordance with the RGIP with the assumption that all appropriate higher-queued projects will proceed and the facilities associated with those projects are installed.

Control Centre Operations – Interconnection Feasibility Study Report

The following outline provides the minimum scope that must be complete in order to assess the impacts. It is recognized the actual scope may deviate, to achieve the primary objectives.

The assessment will consider but not be limited to the following.

- i. Facilities that the customer must install to meet the requirements of the RGIP
- ii. The minimum transmission additions/upgrades that are necessary to permit operation of this Generating Facility, under all dispatch conditions, catering to the first contingencies listed.
- iii. Guidelines and restrictions applicable to first contingency operation (curtailments etc)
- iv. System loss impacts
- v. Under-frequency load shedding impacts
- vi. The impact of the facility on the Bulk Power System (BPS) status of any existing buses. If IR#235 causes any facilities to become classified as BPS, relevant NPCC criteria will be applied.

To complete this assessment the following first contingencies, as a minimum, will be assessed:

- L-6003
- L-6007
- L-6014
- L-6009
- L-6040
- L-6042
- L-6035
- L-6038
- L-5003
- L-5012
- L-5049
- L-6033
- L-6038
- 91H-604 (taking out 91H-T62, L-6042 and L-6007)
- 91H-606 (taking out 91H-T11, L-6040 and L-6003)
- 91H-605 (taking out L-6007 and L-6040 after terminals' swapping)

Control Centre Operations – Interconnection Feasibility Study Report

- 91H-621 (taking out 91H-T62 and L-6042)
- 91H-523 (taking out 91H-T11 and L-5041)
- 91H-511 (taking out 91H-T62 and L-5049)
- 104H-600 (taking out L-6014 and L-6035)
- 108H-600 (taking out L-6007 and L-6009)

To complete this assessment the dynamics of the following first contingencies, as a minimum, will be assessed:

- 3 phase fault on L-6003
- 3 phase fault on L-6014
- 3 phase fault on L-6007
- 3 phase fault on L-6009
- 3 phase fault on L-6040
- 3 phase fault at 91H-B63
- 3 phase fault at 91H-B64

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 NERC² and NPCC³ 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 #235 which is lost through the transmission system. Preliminary value is calculated to be -3.5% (system losses decreased by net 2.1 MW when IR #235 is operated at 60 MW).

Nova Scotia Power
2011-04-08

² NPCC criteria are set forth in it's Reliability Reference Directory #1 *Design and Operation of the Bulk Power System*

³ NERC transmission criteria are set forth in *NERC Reliability Standards TPL-001, TPL-002, TPL-003*



Interconnection Feasibility Report Addendum

GIP-235-FEAS-R2

System Interconnection Request #235

50 MW Wind Generating Facility

Halifax County (87H)

2011-05-16
Control Centre Operations
Nova Scotia Power Inc.

1 Introduction

The Interconnection Customer (IC) originally submitted an Interconnection Request (IR) for Network Resource Interconnection Service (NRIS) to NSPI for a proposed 60 MW wind generation facility interconnected to the NSPI transmission system. Report GIP-235-FEAS-R1 shows the study results of that Interconnection Request. However the IC re-submitted a request to reduce the nameplate capacity of IR#235 from 60 MW to 50 MW and switched the IR to Energy Resource Interconnection Service (ERIS). This report shows the study results of the 50 MW generating facility based on the Point of Interconnection (POI) at 87H-- Musquodoboit Harbour substation and a 17.5 km newly-constructed line to the wind farm. This report only includes the assessment of the thermal issues and the associated high-level estimated costs which updated Section 8, 11 and 12 in the original report GIP-235-FEAS-R1.

2 Thermal Limits

This facility would be interconnected to 87H-- Musquodoboit Harbour substation by constructing approximately 17.5 km of 138 kV transmission line with 556 ACSR Dove conductors and maximum operating temperature of 100°C. The spur line would be interconnected into the substation through a line terminal, one 138 kV circuit breaker and associated switches.

Load flow analysis has been conducted with all lines in service and for all single contingencies required by NERC and NPCC. Historical dispatch patterns included all units at Tuft's Cove generating at full load for system load levels above 70% of winter peak load and at 100% of summer peak load. However the Tuft's Cove units have also been operated at full load under system light load conditions in the past few years.

With the addition of 50 MW proposed by IR#235 in combination with the full generation at Tuft's Cove plant under summer peak and light system load conditions, certain transmission lines on the local 138 kV systems in the Halifax and Dartmouth areas could become overloaded under several contingencies. L-6003 and L-6007 could be overloaded by up to 20% of their summer ratings. Therefore operating restrictions on the total generation output within this area would have to be established. Either the generation at Tuft's Cove will be displaced by IR#235 or this wind facility has to be operated at a restricted level or even off-line depending on system load conditions. Based on historical generation and load patterns, it is estimated that this wind facility would not be able to operate at full generation output for approximately 100 hours per year, which represents 1% of the time. IR#235 could be restricted from operating at any level due to the potential overloads on L-6003 and L-6007. However the historical transmission performance is not necessarily an indicator of the future performance.

The requirement for restrictions or curtailments of this facility when operating with an element (transmission line, transformer etc) out of service (N-1 operation) will be further assessed in the SIS.

3 Expected Facilities Required for Interconnection

The following facility changes are required to interconnect IR #235 to the 138 kV bus at 87H-Musquodoboit Harbour substation:

Additions/Changes to POI

1. Addition of approximate 17.5 km of 138kV spur line to connect the wind farm to the POI with 556 Dove ACSR conductors rated 100°C conductor temperature,
2. A dedicated 138 kV circuit breaker and associated switches at 87H-Musquodoboit Harbour for the spur line to the wind farm,
3. Modification to NSPI protection systems,
4. Control and communications between the wind farm and NSPI SCADA system (to be specified).

Requirements for the Generating Facility

1. Facilities to provide 0.95 leading and lagging power factor when delivering rated output (50 MW) at the HV terminals of the IC Substation Step Up Transformer when the voltage at that point is operating between 95 and 105 % of nominal.
2. Centralized controls. These are centralized voltage set-point controls known as a Farm Control Unit (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. 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 Appendix G to the Standard Generator Interconnection and Operating Agreement (GIA).
5. Real-time monitoring (including a Remote Terminal Unit) of the interconnection facilities.
6. Facilities for NSPI to execute high speed rejection of generation (transfer trip) if determined in SIS.

4 NSPI Interconnection Facilities and Network Upgrades Cost Estimate

Estimates for NSPI Interconnections Facilities and Network Upgrades for interconnecting 50 MW wind energy onto 138 kV systems are included in Table 4-1.

Table 4-1: Cost Estimates identified from FEAS scope		
	Determined Cost Items	Estimate
NSPI Interconnection Facilities		
i	Build 17.5 km 138kV single circuit line and line termination into the 87H-Musquodoboit Harbour substation	\$ 6,037,500
ii	One 138 kV circuit breaker and associated switches at 87H	\$ 1,000,000
iii	Protection, control, communication	\$ 656,500
Totals		
iv	Contingency (10%)	\$769,400
v	Total of Determined Cost Items	\$8,463,400
To be Determined Costs		
vi	System additions to address potential stability limits	TBD (SIS)

The preliminary non-binding cost estimate for interconnecting IR#235 with 87H-Musquodoboit Harbour substation would be \$8,463,400.

Nova Scotia Power
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