



IR742 - Goose Harbour Wind II SIS

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IESO Nova Scotia

1791 Barrington Street, Suite 1010
Halifax, Nova Scotia
B3J 3K9

REVISION TABLE

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TABLE OF ABBREVIATIONS

Term	Definition
AAS	Automated Action Schemes
BES	Bulk Electric System
BESS	Battery Energy Storage System
BPS	Bulk Power System
DCT	Double Circuit Tower
ERIS	Energy Resource Interconnection Request
EMT	Electromagnetic Transient
FAC	Facility Study
FEAS	Feasibility Study
FRT	Fault Ride Through
GIA	Generator Interconnection Agreement
GIP	Generator Interconnection Procedure
GSU	Generator Step-up Transformer
HVRT	High Voltage Ride Through
IBR	Inverter Based Resource
IC	Interconnection Customer
ICIF	Interconnection Customer Interconnection Facility
IESO-NS	Nova Scotia Independent System Operator
IR###	Interconnection Request No. ###
LVRT	Low Voltage Ride Through
MQT	Model Quality Test
NERC	North American Electric Reliability Cooperation
NPCC	Northeast Power Coordinating Council
NRIS	Network Resource Interconnection Service
NS	Nova Scotia
NSPI	Nova Scotia Power, Inc.
OLTC	On Load Tap Changer
PCO	Point of Change of Ownership
POI	Point of Interconnection to Transmission Owner facilities
PPC	Power Plant Controller
RMS	Root Mean Square
SIS	System Impact Study
RAS	Remedial Action Scheme
TPIF	Transmission Provider Interconnection Facility
SMIB	Single Machine Infinite Bus
SVC	Static Var Compensator
TSR	Transmission Service Request
TSIR	Transmission System Interconnection Requirements
UFLS	Under Frequency Load Shedding
VSC	Voltage Source Converter
WECS	Wind Energy Conversion System

1 INTRODUCTION

The Interconnection Customer (IC) submitted an Interconnection Request (IR) for the connection of a Wind Energy Conversion System (WECS) facility to the Nova Scotia Power Inc. (NSPI) system as Network Resource Interconnection Service (NRIS). The proposed Commercial Operation Date is 2026-12-15. The facility is proposed as a 35 MW addition to the IR618 site. The total facility (IR618 & IR742) nameplate capacity is proposed to be 168 MW.

The IC signed a System Impact Study (SIS) Agreement, and this report is the result of that Agreement. This project is listed as Interconnection Request #742 in the NSPI Interconnection Request Queue and will be referred to as IR742 throughout this report.

1.1 Scope

The SIS for IR742 has been conducted in both Root Mean Squared (RMS) and Electromagnetic Transient (EMT) domains. The RMS assessment has been conducted in PSS®E, while the EMT assessment has been conducted in PSCAD™. Both assessments are based on the Nova Scotia (NS) Transmission System Interconnection Requirements (TSIR) version 1.3, applicable Northeast Power Coordinating Council (NPCC) planning criteria for Bulk Power System (BPS), and applicable North American Electric Reliability Corporation (NERC) planning criteria for Bulk Electricity System (BES).

The requested POI for IR742 is a tap from the 230 kV line L-7003. The proposed generation site will be interconnected to the POI via a 230kV transmission line from the Point of Change of Ownership (PCO). The one-line diagram showing the location of IR742 and IR618 is shown in Figure 1 below.

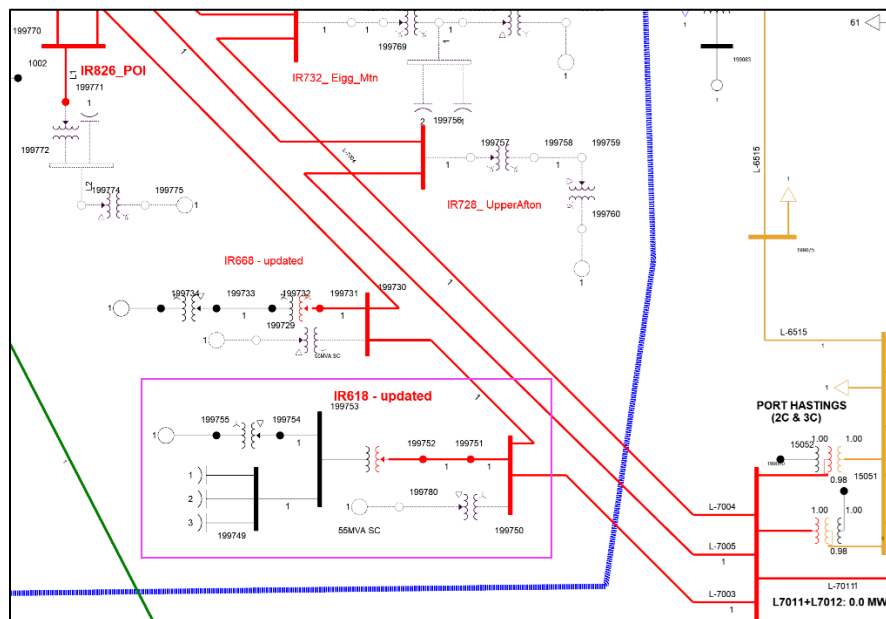


Figure 1: Proposed Interconnection Configuration One-Line Diagram

The scope of this study to assess the impact of the proposed generation facility on the interconnected system includes but is not limited to:

- Steady state analysis:
 - Identification of any thermal overload of transmission elements
 - Identification of any steady state voltage criteria violation
- Stability analysis:
 - Assess NPCC BPS and NERC BES classification criteria for the substation in PSS®E
 - Identification of any requirements necessary for the interconnected power system to maintain stable and well damped performance for normal contingencies in PSCAD™
- EMT analysis, Wide Area Model simulation to assess:
 - Control interactions between the proposed facility and surrounding Inverter Based Resource (IBR) facilities
 - Control interactions with neighbouring devices and/or with synchronous machines
- Active Power and Inertia Review of compliance with the TSIR requirements for Active Power Control and Inertia response
 - Assess the ability of the proposed facility to ride through frequency deviation
- Review compliance with the TSIR requirement for Reactive Power and Voltage Control
 - Assess the ability of the proposed facility to ride through voltage deviations
- Short circuit analysis and its impact on circuit breaker ratings
- Power factor requirement at the high side of the ICIF transformer(s)
- Assessment of voltage flicker and harmonics
- Impact on any existing Remedial Action Schemes (RAS)

This report describes methodology, plant and equipment models, and results of the study work carried out to evaluate the impact of connecting IR742 to the Nova Scotia transmission network.

This report provides a high-level non-binding cost estimate for the connection of the IR742 facility to ensure there will be no adverse impact on the reliability of the NSPI transmission system.

1.2 Background

Nova Scotia is moving towards very high levels of IBR, while maintaining a stable and well damped grid. To achieve high levels of IBR, planning criteria have been developed to ensure that new IBR facilities are able to stay online during all expected operating scenarios and not adversely impact the ability of other facilities to do the same.

The SIS for all new interconnections includes all inertia sources that would be expected to be online for a particular study scenario. Facilities, such as the Maritime Link HVDC, that provide fast

frequency response (not to be confused with inertia) are online and dispatched in study cases to provide performance comparable to that expected under the operating scenario under study. As the Maritime Link, existing IBR facilities and existing motor loads around the province require a minimum Short Circuit MVA for FRT or motor starts, online inertia resources will be maintained comparable to the existing levels when required to ensure no adverse impact to existing facilities as synchronous units are removed from service or dispatched with lesser frequency. Existing synchronous resources such as small generators and large motor loads in the province are dispatched to align with credible dispatches in the operating timeframe.

All new facilities (load, generation and BESS) will be required to stay online under a range of operating conditions with performance meeting all IESO-NS, NPCC and NERC criteria without causing adverse impact to existing facilities.

1.3 Project Queue Position

All in-service generation facilities are included in the SIS, except for Lingan Unit 2, which is assumed to be retired.

Due to ongoing development discussions and engineering studies, the Transmission System Network Upgrades identified as part of Transmission Service Request (TSR) #411 will not be included in the SIS analysis for Generator Interconnection Procedures (GIP) Study Groups #32 to #35. GIP Study Group #32 to #35 analysis will be limited to the 2029 Transmission System configuration plus any material Network Upgrades identified in higher queued projects.

The following Transmission System Network Upgrades are included in this study:

- Reliability Tie (345 kV line from 67N-Onslow to 410N-Memramcook)
- 67N-Onslow substation reconfiguration due to Reliability Tie
- Memramcook and Salisbury substation reconfiguration due to Reliability Tie
- Additional 345-138 kV transformer at Memramcook
- +/- 300 MVAR STATCOM facility connected to Salisbury substation

As of 2026/08/04, the following projects are higher queued in the Advanced Stage Interconnection Request Queue, excluding those already in Commercial Operation:

- IR #516: GIA executed, 2027/12/31 in-service date.
- IR #542: GIA executed, 2027/06/30 in-service date.
- IR #598: GIA executed, 2027/06/30 in-service date.
- IR #597: GIA executed, 2026/09/30 in-service date.
- IR #670: GIA in progress, 2027/08/31 in-service date.
- IR #668: GIA executed, 2026/10/31 in-service date.
- IR #618: GIA executed, 2026/06/30 in-service date.

- IR #675: GIA executed, 2028/05/31 in-service date.
- IR #677: GIA executed, 2026/11/15 in-service date.
- IR #686: FAC complete, 2028/05/31 in-service date.
- IR #739: SIS in progress, 2027/12/31 in-service date.

The higher-queued Interconnections will be modelled and included in IR742 study base cases. If any of these included projects are subsequently withdrawn from the Queue, it may be necessary to update this SIS or perform a re-study.

2 PLANT AND EQUIPMENT MODEL

The study is based on technical information provided by the IC.

2.1 WECS Facility

Table 1: Project Overview	
Attribute	Description
Project name	Goose Harbour Wind II
Project identifier	IR742
Project type	WECS
Project rating	35 MW (168 MW total IR618 + IR742)
Connection point	L-7003
PSSE bus No.	199750
Connection Voltage	138 kV
Operating Mode	Frequency Droop
V/Q control strategy	Voltage Droop (Q(U)), Q direct, PF control
Filter / capacitor banks	3x mechanically switched 16.5 MVAR capacitors on 34.5 kV bus
IBR voltage supporting devices	N/A
OEM	Nordex
OEM reference model	Delta4000 - N163/6.x
Number of units	5 (24 total IR618 + IR742)

The POI and configuration are studied with the following:

- NRIS type with an in-service date of 2026-12-15.
- The 24 turbines were modeled as one equivalent lumped parameter generator. The equivalent models were provided by the IC. The manufacturer's dynamics data is included in Appendix A: Generating facility dynamic data of this report.
- A 3.13 PU fault current is used for short circuit analysis.
- The POI is identified on the 230kV bus node of the new 230kV three-breaker ring substation (125C-Grosvenor) located approximately 11.8 kms from 3C-Port Hastings

substation. This project utilizes a 230 kV transmission spur line of approximately 2.1 km from the POI substation to the IR618+IR742 IC substation (126C-Goose Harbour Lake).

- Generation in a higher queue position are modeled in the base cases. The included projects are listed in Section 1.3.

2.2 Plant Control

The following modes of operation have been studied for IR742 per the latest model submission:

- Frequency droop of 4%
- Voltage droop of 5%

These settings are the recommended values for WECS projects.

2.3 PSS®E and PSCAD™ Models

To facilitate the load flow analysis, the proposed 24 turbines are grouped as one equivalent generator with a terminal voltage of 950 V. The voltage is stepped up to 34.5 kV at the collector substation with a single equivalent step-up transformer. This equivalent model is then stepped up to 230 kV via the interconnection transformer.

The PSS®E model for load flow is shown in Figure 2 below. The equivalent 950 V/34.5 kV generator step-up transformer was modeled to have an impedance of 9% based on 128.0 MVA. The interconnection transformer was modeled to have 9.5% impedance on 111 MVA base. The SIS results must be updated if the actual nameplate data for these transformers materially differs from these impedance values.

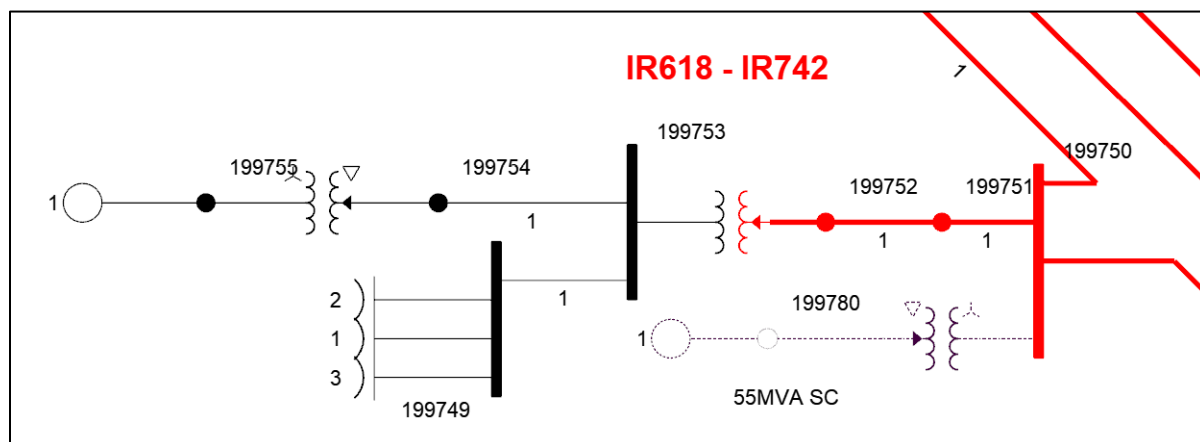


Figure 2: PSS®E Model for IR742

The PSCAD™ model comprises one wind turbine connected to a single 34.5 kV step-up transformer which has its output scaled by a factor of 24 to represent the full size of the plant as shown in Figure 3, below.

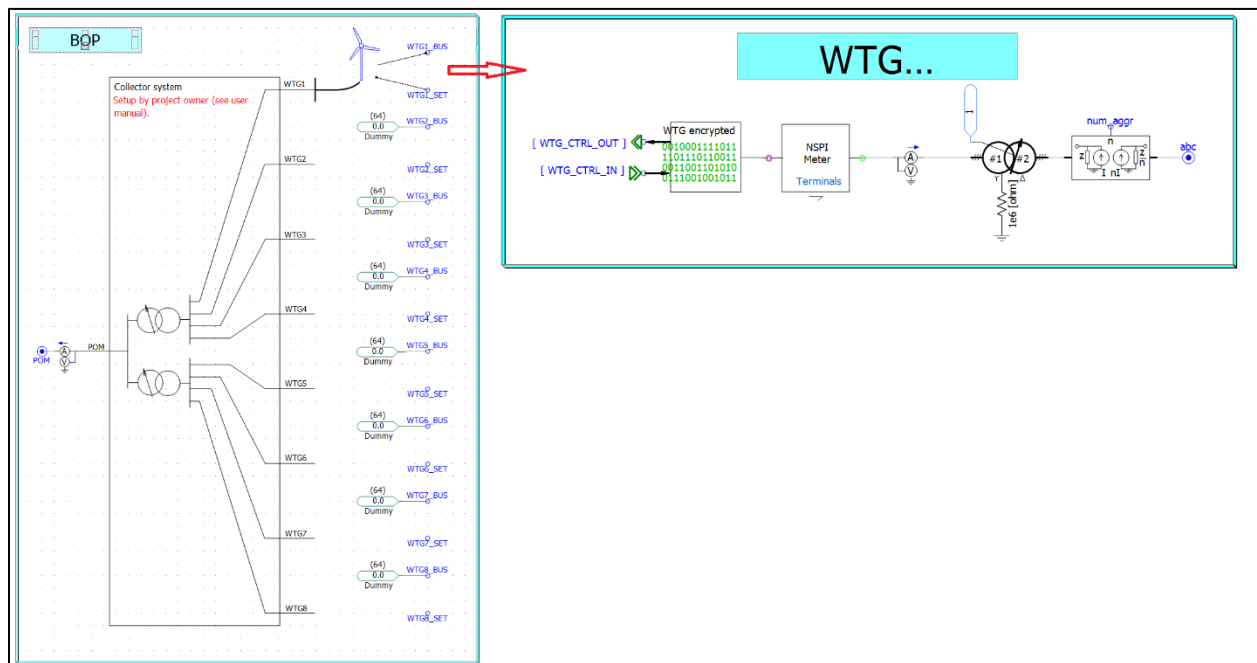


Figure 3: PSCAD™ Model for IR742

Table 2 and Table 3 identify the PSS®E and the PSCAD™ plant models used for this SIS.

Table 2: PSS®E Model Files for IR742		
File Name	File Type	Comments
IR742_GooseHL_NX_WTG_wkspc	.pswx	PSCAD™ workspace
IR742_GooseHL_NX_WTG_case	.pscx	PSCAD™ project
BOP_Lib	.pslx	Collector system library
MC_Lib	.pslx	Wind turbine converter library
MFR_Lib	.pslx	Converter protection library
PPC_Lib	.pslx	Power plant controller library
WF_Lib	.pslx	Wind farm library
WTC_lib	.pslx	Does not appear to be used in the PSCAD™ project
WTG_Lib	.pslx	Wind turbine generator library

Table 3: PSCAD™ Model Files for IR742		
File Name	File Type	Comments
IR742_GHL_Q0_R1_v35	.sav	PSSE .sav base case
IR742_GHL_dyr_R2	.dyr	Dynamic simulation file
NXWFC_V4.188_r35	.dll	Plant controller model
NXWTG_V8.693_r35	.dll	Generator model

2.4 Model Quality Test

To identify potential modelling issues for the plant a Model Quality Test (MQT) report was prepared for both the PSS®E and PSCAD™ models. MQT-006-R4 (dated 2026-07-21) describes the performance of the plant models.

2.4.1 PSCAD™ MQT Results

The following summary is duplicated from Section 8.2 of MQT-006-R4:

The following issues were observed with the plant dispatched at $P = 0$ MW. These issues have been previously reported and are understood to be limitations of the Nordex turbines [...].

- *The plant does not ramp up from $P = 0$ for frequency support.*
- *The plant does not inject sufficient reactive current I_Q during LVRT events at $P = 0$.*
- *The plant does not absorb sufficient reactive current I_Q during HVRT events at $P = 0$.*
- *The plant does not deliver sufficient reactive power at $P = 0$ MW to satisfy the PQ capability requirement.*

These concerns will not impede the project entering Commercial Operation.

It is recommended the IC and OEM should investigate if improvements can be made to resolve the items noted above. It is also recommended that the IC and OEM investigate repackaging the library files into one library for the project for ease of integration with the large system model. While neither of these recommendations are required, they would improve ease of simulation in the large area case in future studies.

2.4.2 PSS®E MQT Results

The following summary is duplicated from Section 8.3 of MQT-006-R4:

For one of the under-frequency tests, plant is unable to provide power boost for 10 seconds due to Plant going into FRT mode after terminal voltage drops below FRT activation voltage Threshold which as a result disables VIC for 60 Seconds as IC explained.

For one of the Three phase faults, Plant has severe oscillations at its terminal Voltage V and active power P which are not acceptable and IC needs to address this issue.

IC has provided acceptable technical explanation for the MQT deficiencies identified in the current model which are marked as Noted. Accordingly, the project may proceed to the SIS using the current model. However, these deficiencies remain outstanding, and IC is responsible for addressing them in the next PSSE model revision.

The issues noted above will not impede the project entering commissioning and system performance testing. The IC and OEM shall address these issues and submit revised models for testing prior to entering Commercial Operation.

The IC must also submit updated PSS®E Standard Library Model. Acceptable benchmarking between PSS®E UDM and SLM models is required prior to entering Commercial Operation.

3 SYSTEM TECHNICAL MODELS

To assess the performance of the plant models, wide-area system models in PSS®E and PSCAD™ are used. These models consist of transmission elements, generating facilities, load, and network support devices as outlined below.

3.1 System Data

The “2025 10-Year System Outlook,” dated July 14, 2025, produced by NSPI, and filed with the Nova Scotia Energy Board (NSEB) was used to allocate the loads in NS. This study uses a Net System Peak Demand of 2,458 MW for the year 2029 as shown in Table 4. Please note that the load forecast includes the power system losses but excludes the station service loads at power generating stations.

Table 4: Load Forecast for Study Period					
Forecast Year	System Peak	Interruptible contribution to peak	Firm Contribution	Demand Response	Growth %
2025	2,403	132	2,267	4	15.1
2026	2,408	133	2,263	12	0.2
2027	2,423	131	2,268	24	0.6
2028	2,443	133	2,274	36	0.8
2029	2,458	134	2,285	39	0.6
2030	2,474	132	2,303	39	0.7
2031	2,503	132	2,332	39	1.2
2032	2,535	133	2,364	38	1.3
2033	2,573	133	2,402	38	1.5
2034	2,618	132	2,449	37	1.8
2035	2,672	132	2,503	37	2.0

The rating of transmission facilities in the vicinity of IR742 are shown in Table 5 and Table 6.

Table 5: Rating of Transformers

Transformer	Normal Rating / 15-Minute Emergency Rating	
	Summer (MVA)	Winter (MVA)
67N-T81/T82	392.0/478.0	392.0/478.0
67N-T71	224.0/268.8	224.0/292.0
3C-T71/T72	224.0/235.2	224.0/235.2

Table 6: Rating of Transmission Lines

Line	Conductor	Design Temp. (C)	Limiting Element	Hot Rating (30C) Normal/Emerg. (MVA)	Cool Rating (5C) Normal/Emerg. (MVA)
L-8003	ACSR 2x1113 Beaumont	120	Metering	747.9/789.5	747.9/789.5
L-8004	Type 41 SDC / ACSR 2x1113 Beaumont	50	Metering	498.6/526.3	498.6/526.3
L-7003 / L-7024 / L-7026	ACSR 556.5 Dove	60*	Conductor	241.0/265.1	318.0/349.8
L-7004	ACSR 556.5 Dove	60	Conductor	241.0/265.1	318.0/349.8
L-7019	ACSR 556.5 Dove	70	Conductor	285.0/313.5	345.0/379.5
L-7005 / L-7027	ACSR 1113 Beaumont	70	Metering Conductor**	346.5/365.8 429.0/471.9	346.5/365.8 523.0/575.3
L-6515	ACSR 556.5 Dove	60	Switch Conductor**	128.7/135.9 145.0/159.5	128.7/135.9 191.0/210.1
*The existing L-7003 is limited to 60C but is expected to be upgraded to 70C by NSPI (as part of TSR400 upgrades). See L-7019 for 70C rating.					
**The conductor rating is provided as indication of the line rating with other limiting equipment ignored					

3.2 Steady State

Analysis was performed in PSS®E version 35.6.4 using Python scripts to simulate a wide range of single contingencies, with the output reports summarizing bus voltages and branch flows that exceeded established limits.

System modifications and additions up to 2029 were modelled to develop base cases to best test system reliability in accordance with NS Power and NPCC design criteria:

- Summer peak load (based on ~60% of winter peak forecast),
- Winter peak load.

3.2.1 Steady State Base Cases

The base cases used for power flow analysis are listed in Appendix A: Base Cases .

One-line diagram comparisons of a subset of base cases are presented in Appendix C: PSCAD™ Contingencies.

For these cases:

- Transmission connected wind generation facilities were dispatched between 17% and 100% of their rated capacity.
- Transmission connected wind is used to displace thermal generation in the province. No minimum thermal unit requirement is enforced.
- IR742 (and IR618) is dispatched at 100% rated capacity.
- No restrictions were placed on BESS charging/discharging during peak load conditions.
- TSR411 550MW import is not considered. Refer to Section 1.3.
- All existing interface limits were respected for base case scenarios.

For each of the load levels studied, the following variables were adjusted to create a wide range of base cases:

- Nova Scotia <> New Brunswick transfer
- Nova Scotia <> Newfoundland transfer
- Port Hawkesbury Paper load (max load / min load)
- BESS charge/discharge status
- Wind levels (high / low)

Transmission connected wind was curtailed as necessary to balance the system, with preference given to wind sites that are electrically close to IR742 (e.g. electrically remote wind was curtailed first). All cases were studied with IR742 online at maximum output. Where violations were identified, the case was compared without the project online to determine if the violations were pre-existing.

3.2.2 Steady State Contingencies

The steady state power flow analysis was performed using the contingencies listed in Appendix B: Steady State Contingencies.

3.3 Stability

Stability analysis was performed in PSS®E, version 35.6.4. The base cases used in PSS®E stability analysis were derived from the steady-state cases listed in Appendix A Table 11. These cases were used for the NPCC BPS testing described in Section 3.2.1 of this report.

Additional stability analyses were performed in PSCAD™. Details on the contingencies studied are provided in Section 3.4.6. These scenarios represent a critical subset of the contingencies studied in PSS®E.

3.4 Electromagnetic Transient

To supplement the analysis performed in RMS, EMT simulations in PSCAD™ are performed to assess model performance and stability in the microsecond timescale.

3.4.1 Study Scenarios

A base scenario with minimum synchronous inertia and maximum IBR dispatch was used as the main scenario for the IR742 SIS. This scenario has low inertia coupled with low damping (low load) and is more likely to expose control interactions and/or ride through issues after the addition of the new WECS.

Table 13 in Appendix A: Base Cases provides a description of the scenarios used to evaluate IR742 in the system.

3.4.2 PSCAD™ Model Version

Table 7 identifies the PSCAD™ wide area network model version used in this SIS.

Table 7: PSCAD™ Wide Area Network Model Files for IR742		
File Name	File Type	Comments
2026-16	Case Folder	Overall collection of files for the transmission system
NSPI_2026_01_16.py	Python Script	Script for configuring and running contingency simulations
PSCAD_Contingencies_IR742.xlsx	Excel Workbook	Contingency list as described in Section 3.4.6

3.4.3 Model Overview

The Maritimes Area is included in the PSCAD™ model. Nova Scotia was divided in six major regions: Valley, Western, Northern, Halifax, Canso, and Sydney. Each of these regions is contained in a PSCAD™ project 'network'. Neighbouring regions are also included in six project networks: Central, East, North, South and West for New Brunswick, and PEI for Prince Edward Island (connected through New Brunswick). Note that all synchronous machines within represented networks are included using PSCAD™'s synchronous machine model for NS and NB networks. Synchronous machines in the PEI network are represented using voltage source components in series with a pre-calculated source impedance.

The PSCAD™ model includes all existing dynamic devices, including synchronous machines, wind farms, and static var compensators (SVC), as well as the voltage source converter (VSC) high-voltage direct current (HVDC) Maritime Link. All the investigations presented here are based on EMT simulations using PSCAD™ software version 5.0.2.

3.4.4 Model Boundaries

Network equivalent voltage sources are used at the wide area model boundaries to represent the remainder of the Eastern North America power system. The network equivalent voltages, angles and impedances are precalculated such that power flows and short circuit levels are preserved according to the solved PSS®E load flow used to setup the scenario initial conditions. Table 8 enumerates the locations where the network equivalents are located.

Table 8: PSCAD™ Wide Area Network Model Boundaries		
Region	Area	Bus Number
Central	NB	190230
North	NB	190493 and 190494, Eel River HVDC link
South	NB	190237
West	NB	190619, 190001, and 190028

3.4.5 Dynamic Plants

All synchronous machines in NS and all IBR facilities are represented using their latest available PSCAD™ models. It should be noted that different scenarios or dispatches may not have all synchronous machines and IBRs in service.

3.4.6 PSCAD™ Contingencies

This portion of the SIS used a selected set of representative contingencies to study the impact of adding IR742 to the network. These contingencies are a subset of those tested in PSS®E and are listed in Appendix C: PSCAD™ Contingencies.

4 TECHNICAL ASSESSMENT

The models described in Sections 2 and 3 were used to simulate the system with the inclusion of IR742. The results of these studies are described below.

4.1 Steady State

The steady state power flow analysis in PSS®E was conducted without IR742 in service and with IR742 in service.

The addition of IR742 generation has the capability to offset thermal generation east of Onslow. This results in decreased flows on the Cape Breton Export corridor (lines L-8004, L-7024, L-7004,

L-7027, and L-6515) and increased relative flows on the Onslow Import corridor (lines L-8003, L-7003, L-7019, L-7005, L-6503).

Due to the electrical location of the IR618+IR742 projects, there is a change to the Onslow Import and Cape Breton Export corridor definitions which results in a functional modification to a Type 1 RAS: Group 5/6 345 kV and a Limited Impact RAS: Group 3 L7003/4/5 Faults. With the addition of IR742 and any associated Network Upgrades, these RAS will require a full restudy and expected changes to logic, parameters settings, and/or arming levels.

The power flow analysis did not identify any transmission system contingencies inside Nova Scotia that violate thermal loading or voltage criteria for system normal (N-0), attributed to the project. Full results of the steady state analysis are presented in Appendix D: Steady State Results .

4.2 Stability

4.2.1 NPCC-BPS / NERC-BES

Compliance with NERC reliability standards is mandatory to maintain reliability of NSPI transmission system and its interconnection to the wider North American transmission system. Based on NERC BES brightline criteria, IR742+IR618 is BES classified due to its gross plant/facility aggregate nameplate rating being greater than 75 MVA in BES Inclusion I2a.

NSPI is a member of NPCC and adheres to NPCC's requirements, including the requirements for BPS. The methodology for determining if a substation is BPS is defined in NPCC's criteria document A-10 titled "Classification of Bulk Power System Elements". The methodology in the latest A-10 document, dated March 27, 2020, is used to determine if IR742 will be categorized BPS or not.

The 230 kV buses at the 67N-Onslow substation and the 3C-Port Hastings substation as well as line L-7003 are part of the Nova Scotia Bulk Power System (BPS). As such, all protection systems associated with the POI substation 125C-Grosvenor and IC substation 126C-Goose Harbour Lake must comply with NPCC Directory 4 System Protection Criteria.

Appendix E: BPS Stability Test Results has the complete results to demonstrate IR742 does not have adverse impacts outside the local area.

4.2.2 System Stability

System stability analysis was conducted in PSS®E for a subset of load flow cases. Stability analysis results for IR742 rely on results from a stability analysis conducted for a later queued group of IRs. These results provide a reasonable and conservative representation of the impact of IR742. Results of the analysis are presented in Table 9.

Table 9: Summary of Stability Analysis		
Case	Contingency Violations	Notes
2029SUM_s_ML_1	N/A	IR742+IR618 trips offline for the following: - c_IR618_701** - c_IR618_HV_3PH_Fault**
2029WIN_s_ML_2	N/A	IR742+IR618 trips offline for the following: - c_67N_811_G0* - c_79N_601* - c_79N_803_G0* - c_79N_810_G0* - c_79N_T81_G0* - c_IR618_701** - c_IR618_HV_3PH_Fault**
*RAS is expected to be armed in this case, plant trip is not unexpected		
**Plant is isolated due to the contingency		

4.3 Electromagnetic Transient Assessment

To expand on the Steady State and Stability Assessments described above, additional contingency simulations were performed to evaluate the plant against applicable performance requirements and its impact on system stability. These contingency simulations were also used to validate the performance of the PSCAD™ model against applicable planning requirements.

4.3.1 Active Power Requirement and Frequency Response

Frequency response for grid disturbance assesses performance during over and under frequency events including Nova Scotia islanding from the Eastern Interconnection with load shedding in the wide area model as well MQT assessment in a SMIB model.

4.3.1.1 Off-Nominal Frequency Operations

Under all normal operating scenarios, IR742 must be capable of operating reliably for frequency variations in accordance with NERC Standards PRC-024-2 and PRC-006-NPCC-2. It is required to ride through a rate of change of frequency (RoCoF) of 4Hz/s, sampled over 500ms. The WECS performed well in these tests, reaching the expected droop output in accordance with the frequency droop settings described in Section 4.3.1.

4.3.1.2 TSIR Section 7.6.5 Active Power Control - WECS and Solar

The TSIR requirement states:

- Asynchronous Generators connected to the Transmission System must be capable of controlling active power in response to frequency deviations and control signals from the NS System Operator to the extent enabled by the technology utilized.

- While the Asynchronous Generating Facility is curtailed, it shall offer over-frequency and under-frequency control with a deadband of ± 0.2 Hz and a droop characteristic of 4% or as otherwise directed by NS Power. The active power controls shall also react to continuous control signals from the NS Power Automatic Generation Control (AGC) system to control tie-line fluctuations when required.

This requirement was validated in Section B.3 “Robustness of the Control System” and Section B.4 “Dynamic Response” of the MQT report for the PSCAD™ model. While the tests demonstrate compliance with criteria it was noted that when operating at 0 MW (STATCOM Mode) the plant does not ramp its output up in response to a decrease in frequency.

4.3.1.3 TSIR Section 7.6.11 Inertia Equivalent Response - Grid following IBR

There is a minimum inertia equivalent response required for this facility. For facilities in weak areas of the grid, adjacent to existing IBR facilities that do not have inertial support or in a high-density IBR cluster, higher levels of inertial support will be required.

For the combined Goose Harbour Lake facility (IR618 & 742) the SIR scaling factor is 0.52 for interconnection at POI voltage level of 230 kV. The facility will require a synchronous support (or equivalent) located at or near the POI with a rating of at least 87 MVA, specified for low inertia, high SCMVA. A combination of generic synchronous condensers was used to enable this facility to meet all applicable criteria in this study. Generic synchronous condensers were modelled in both PSS®E and PSCAD™ study cases to provide stable performance of the plant under expected operating scenarios.

4.3.2 Reactive Power Requirements and Voltage Control

4.3.2.1 Power Factor Requirements

For IR742 power factor evaluation, at all production levels up to the full rated load, the facility must be capable of operating between 0.95 PU lagging to 0.95 PU leading net power factor at the high side of the ICIF transformer over the range as shown in Figure 4. The power factor is measured at the high side of the ICIF transformer for this requirement.

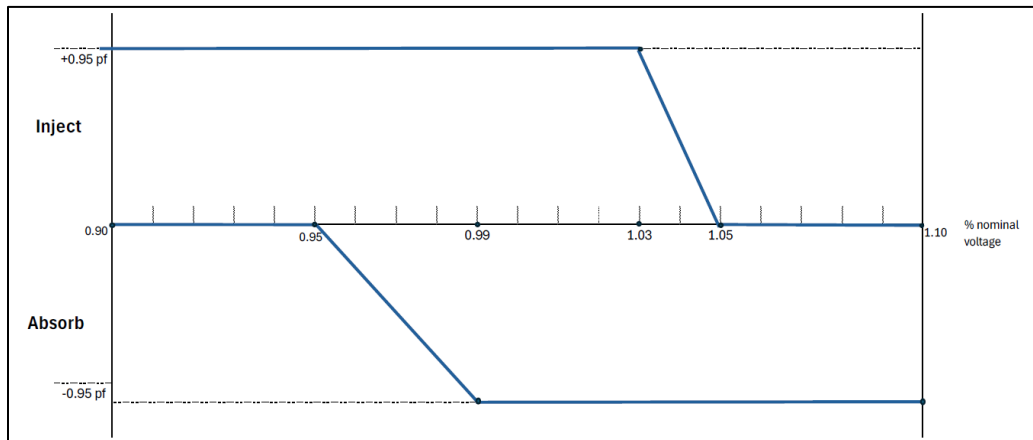


Figure 4: Reactive Power Requirement

From the model provided by the IC, the 138/34.5 kV substation transformer has a on-load tap changer with $\pm 10\%$ taps and 33 equal steps.

This requirement was validated in MQT-006-R4. It was observed that the plant does not deliver sufficient reactive power at $P = 0$ MW to satisfy the PQ capability requirement, this is a known limitation of the STATCOM mode of the turbines.

4.3.2.2 TSIR Section 7.6.3 Reactive Power and Voltage Control

This TSIR requirement states that:

- Rated reactive power shall be available through the full range of active power output of the Generating Facility, from zero to full power.
- Unless otherwise determined by the System Impact Study SIS, continuously acting voltage regulation shall have a voltage response time of no greater than 100 milliseconds.

This requirement was validated in MQT-006-R4. It was observed that the plant does not deliver sufficient reactive power at $P = 0$ MW to satisfy the PQ capability requirement.

4.3.2.3 TSIR Section 7.6.4 Voltage Ride-through

IR742 must remain operational under the following voltage conditions:

- Under normal operating conditions: 0.95 PU to 1.05 PU
- Under stressed (contingency) conditions: 0.90 PU to 1.10 PU
- Under the voltage ride-through requirements in NERC Standard PRC-024-2

The MQT report MQT-006-R4 confirmed that the WCS plant remains online and operational across the normal operating and stressed voltage conditions. The contingency simulations shown in Appendix F: EMT Analysis Results demonstrate that the plant meets the voltage ride-through

requirements specified by PRC-024-2. An example of the plant's ride-through ability for a nearby three-phase-to-ground fault is shown in Figure 5.

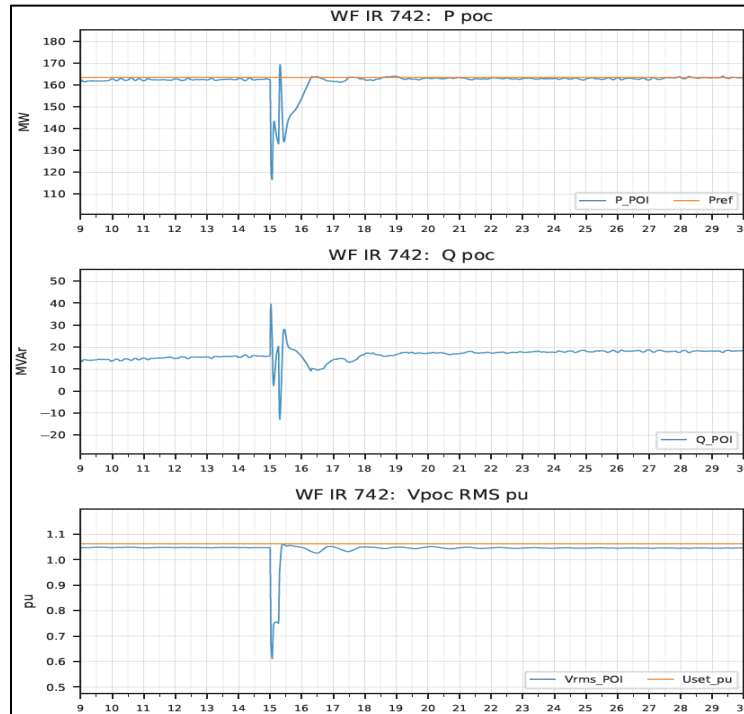


Figure 5: IR742 Response to 3-phase fault at Dalhousie Mtn with BBU action

4.3.3 Control Interactions

EMT simulations were performed to evaluate control interactions between the WECS and nearby facilities. This has two primary forms, the first being interactions between the proposed facility and nearby IBR facilities while the second is concerned with the interactions between IR742 and synchronous machines.

These assessments did not reveal that the presence of IR742 resulted in unacceptable impacts on nearby IBR or synchronous machines.

4.4 Remedial Action and Load Shedding Schemes

IR742 is connected in the Cape Breton Export corridor on the Central part of the province which has several Remedial Action Schemes. Due to the electrical location of the IR618+IR742 projects, there is a change to the Onslow Import and Cape Breton Export corridor definitions which results in a functional modification to the following RAS:

- Type 1 RAS: Group 5/6 345 kV
- Limited Impact RAS: Group 3 L7003/4/5 Faults

With the addition of IR742 and any associated Network Upgrades, these RAS will require a full restudy and expected changes to logic, parameters settings, and/or arming levels. Wide-area studies will be performed to review current RAS settings.

4.5 Short Circuit Duty / Short Circuit Ratio

PSS®E 35.6, classical fault study, flat voltage profile at 1 PU voltage, and 3LG fault was used to assess before and after short circuit conditions. The 2029 system configuration with IR742+IR618 in service and out of service was studied, with comparison between the two. The short circuit levels in the area before and after this development are provided in Table 10.

Site specific data contained in IR742 PSSE .sav file was used in machine modelling by the IC. The transient reactance of 0.319 was used in the short circuit calculation for IR742 generator. The associated synchronous condenser was online for the maximum generation case and offline for the minimum generation case.

IR742 does not impact the neighbouring breaker's interrupting capability based on this study's short circuit analysis. The interrupting capability of the 138 kV and 230 kV levels is as follows:

- 138 kV breakers at 2C-Port Hastings are at least 5,000 MVA.
- 230 kV breakers at 3C-Port Hastings and 67N-Onslow are at least 10,000 MVA.

The NS Power design criteria for maximum system fault capability (3-phase, symmetrical) is 5,000 MVA at the 138 kV voltage level and 10,000 MVA at the 230 kV voltage level.

Table 10: Short Circuit Analysis					
Location	IR742+IR618 Facilities not in- service	IR742+IR618 Facilities in-service	Post MVA increase	Post % Increase	Short Circuit Ratio (SCR) Without Facilities
Max generation, all facilities in service (MVA)					
3C-Hastings (230 kV)	4190.4	4332.8	142.5	3.4%	#N/A
2C-Hastings (138 kV)	3496.0	3572.2	76.2	2.2%	#N/A
67N-Onslow (230 kV)	5384.8	5420.8	36.0	0.7%	#N/A
IR742/IR618 POI (230 kV)	3416.6	3593.8	177.2	5.2%	20.3
IR742/IR618 HV (230 kV)	3320.1	3499.0	178.9	5.4%	19.8
IR742/IR618 MV (34.5 kV)	863.4	1075.1	211.7	24.5%	5.1
Min generation, all facilities in service (Maritime Link, Point Tupper, Tufts Cove 3 online) (MVA)					
3C-Hastings (230 kV)	1555.3	1722.3	167.1	10.7%	#N/A
2C-Hastings (138 kV)	1442.6	1599.7	157.1	10.9%	#N/A
67N-Onslow (230 kV)	1903.2	2018.0	114.8	6.0%	#N/A
IR742/IR618 POI (230 kV)	1399.4	1578.2	178.8	12.8%	8.3

Table 10: Short Circuit Analysis

Location	IR742+IR618 Facilities not in- service	IR742+IR618 Facilities in-service	Post MVA increase	Post % Increase	Short Circuit Ratio (SCR) Without Facilities
IR742/IR618 HV (230 kV)	1378.6	1557.7	179.2	13.0%	8.2
IR742/IR618 MV (34.5 kV)	631.9	843.6	211.7	33.5%	3.8
Min generation, L-7024 (IR742 Goose Harbour Lake to 3C-Port Hastings) Out of Service (MVA)					
3C-Hastings (230 kV)	1466.0	1515.4	49.4	3.4%	#N/A
2C-Hastings (138 kV)	1389.2	1438.5	49.3	3.5%	#N/A
67N-Onslow (230 kV)	1874.1	2017.3	143.3	7.6%	#N/A
IR742/IR618 POI (230 kV)	519.2	697.2	178.1	34.3%	3.1
IR742/IR618 HV (230 kV)	516.3	694.7	178.4	34.6%	3.1
IR742/IR618 MV (34.5 kV)	358.6	570.1	211.5	59.0%	2.1

The minimum short circuit level for IR742 is expected when L-7024 (IR742 Goose Harbour Lake to 3C-Port Hastings) is out of service, and generation in at minimum. Under these conditions, the SCR, a measure of system strength relative to the size of the facility, is calculated to be 2.1 at IR742's 34.5 kV bus. The SCR would be further reduced at the high side of the generator step-up transformers due to the collector circuit impedance.

Please note that Nova Scotia TSIR, Section 7.4.14, states that "System short circuit level may decline over time due to changes to transmission configuration and generation mix. The Generating or BESS Facility shall be tunable to accommodate these changes to SCR as low as 1.4".

4.6 Voltage Flicker

Per the TSIR Section 7.6.9: "the wind turbines shall not exceed the flicker emission limits established by the IEC 61000-3-7 standard."

The submitted technical documentation for the Nordex N163 turbine shows that the flicker coefficients are not exceeded.

If, for any reason the actual installation of IR742 causes issues with voltage flickers, then IR742 will be responsible for mitigating the issues.

4.7 Harmonics

IR742 is required to meet IEEE-519 Harmonics standard limiting voltage Total Harmonic Distortion (all frequencies) to a maximum of 1.5%, with no individual harmonic exceeding 1.0% for 230 kV.

The specifications provided for the Nordex N163 turbine show individual current harmonics which approach or exceed IEEE-519 limits. Since IEEE-519 applies at the point of common coupling (in

this case the high side of the interconnection transformer), it is possible that these individual harmonic components will not result in violations in the field.

If, for some reason, in the actual installation, IR742 causes issues with voltage flickers or harmonics, then IR742 will be responsible for mitigating the issues.

5 OPERABILITY

It is required that plant output be stable and well damped in response to contingencies. An updated model meeting all MQT requirements and with any outstanding issues mitigated is required at least six months prior to the start of performance commissioning tests to allow for operating studies and commissioning studies to be performed.

When final models are available, operating studies will be completed, determining operating constraints for grid elements maintenance outages or other restrictive operating scenarios

6 REQUIREMENTS AND COST ESTIMATE

The following facility changes will be required to connect IR742 to the Nova Scotia transmission system with IR618 via the POI at L-7003:

Required Transmission Provider's Interconnection Facilities (TPIF):

1. IR742 is an expansion of IR618 and no major additions to TPIF are required. The FAC will identify any additional requirements to support the expansion to the combined Goose Harbour Lake Facility.

Required Interconnection Customer's Interconnection Facilities (ICIF):

1. Facilities to provide 0.95 leading and lagging power factor when delivering rated output 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. Rated reactive power shall be available through the full range of real power output, from zero to full power.
2. Centralized controls for voltage setpoint control for the high side of the ICIF transformer. Fast acting control is required and will include a curtailment scheme, which will limit/reduce total output from the facility, upon receipt of a telemetered signal from the System Operator's SCADA system.

3. NSPI to have supervisory and control of this facility (IR742 and IR618), via the centralized controller. This will permit the System Operator to raise/lower the voltage setpoint, change the status of reactive power controls, change the real/reactive power remotely.
4. When curtailed, the facility shall offer over-frequency and under-frequency control with ± 0.2 Hz deadband and 4% droop characteristic. The active power controls shall also react to continuous control signals from the System Operator's SCADA system's Automatic Generation Control (AGC) system to control tie-line fluctuations as required.
5. Voltage ride-through capability as described in the NS Power TSIR.
6. Frequency ride-through capability in accordance with the NS Power TSIR.
7. Facilities for the System Operator to execute high speed generation rejection (transfer trip). The plant may be incorporated in AAS or RAS runback, or load rejection schemes as the system changes.
8. Operation at ambient temperatures as low as -30°C . The IC shall also provide icing models and conduct icing studies for their facility.
9. The facility must meet NSPI's TSIR as published on the NSPI OASIS site.

7 CONCLUSIONS

It is concluded that the interconnection of the proposed IR742 facility into the NS transmission system at the specified location has no adverse impacts on the reliability of the Nova Scotia grid, provided the items below are addressed.

7.1 Summary of Technical Points to be Addressed

7.1.1 Outstanding Modelling Issues

As discussed in Section 2.4, there are outstanding modelling issues which require resolution prior to Commercial Operation.

- The IC and OEM shall address the oscillations observed in the PSS®E User Defined Model fault response to 3-phase faults.
- The IC shall submit an updated PSS®E Standard Library Model.

PSCAD™ models are used to validate performance during the System Performance Testing. However, PSS®E simulation is required in the operational time frame and model deficiencies are to be resolved prior to moving to Commercial Operation.

It is recommended for the IC to work with the OEM to:

- investigate if reactive current injection can be improved in STATCOM mode.

- investigate if the PSCAD™ libraries can be repackaged to improve usability in the wide-area system model.

While neither of these recommendations are required, they would improve ease of simulation in the large area case in future studies.

7.1.2 Low Short Circuit Level

The minimum short circuit level for IR742 is expected when L-7024 (IR742 Goose Harbour Lake to 3C-Port Hastings) is out of service and generation in at minimum. Under these conditions, the SCR, a measure of system strength relative to the size of the facility, is calculated to be 2.1 at IR742's 34.5 kV bus. The SCR would be further reduced at the high side of the generator step-up transformers due to the collector circuit impedance. Please note that Nova Scotia TSIR, Section 7.4.14, states that "System short circuit level may decline over time due to changes to transmission configuration and generation mix. The Generating or BESS Facility shall be tunable to accommodate these changes to SCR as low as 1.4".

7.1.3 Thermal Overloads

The power flow analysis did not identify any transmission system contingencies inside Nova Scotia that violate thermal loading or voltage criteria for system normal (N-0), attributed to the project.

7.1.4 NPCC BPS / NERC BES

Based on NERC BES brightline criteria, IR742 and IR618 are BES classified due to its gross plant/facility aggregate nameplate rating being greater than 75 MVA in BES Inclusion I2a.

The 230 kV buses at the 67N-Onslow substation and the 3C-Port Hastings substation as well as line L-7003 are part of the Nova Scotia Bulk Power System (BPS). As such, all protection systems associated with the POI substation 125C-Grosvenor and IC substation 126C-Goose Harbour Lake must comply with NPCC Directory 4 System Protection Criteria.

7.1.5 System Stability

No contingency violations were observed for IR742.

7.1.6 Harmonics

The specifications provided for the Nordex N163 turbine show individual current harmonics which approach or exceed IEEE-519 limits. Since IEEE-519 applies at the point of common coupling (in this case the high side of the interconnection transformer), it is possible that these individual harmonic components will not result in violations in the field. If, for some reason, in the actual

installation, IR742 causes issues with voltage flickers or harmonics, then IR742 will be responsible for mitigating the issues.

7.2 Facility Specification

During operational study, updated control system parameters may be provided to the IC and must be reflected in the installed plant. If there are control parameter changes made to the installed plant by the IC, IESO-NS must be informed to ensure that simulation models are accurate representations of the facility.

7.3 Commissioning Tests and Tuning

Change in plant design, such as transformer specification, will require updated models to be submitted to the IESO-NS for review of impact on plant performance.

Any updates to the plant design and plant models must be delivered to IESO-NS with sufficient time to assess and run in simulation prior to the expected review and approval of commissioning tests.

Once updated models have been accepted for use, PSCAD™ studies will be performed for use in benchmarking against commissioning results. Any discrepancy must be remedied prior to the facility receiving permission for commercial operation.

In the operational time frame, parameter changes may be required to accommodate rapidly evolving technology and regulatory requirements for the large-scale integration of inverter-based energy sources.

Appendix A: Base Cases

Table 11: Power Flow Base Cases

Monitored Type	Monitored Element(s)	2029SUM_base	2029SUM_s ML 1	2029SUM_s NB 1	2029SUM_s PHP 1	2029SUM_s PHP 2	2029WIN_s ML 1	2029WIN_s ML 2	2029WIN_s NB 1	2029WIN_s PHP 1	2029WIN_s PHP 2
Load	NS Basic	1275	1275	1275	1275	1275	2305	2305	2305	2305	2305
Load	Station Service	6	6	6	6	6	33	33	23	33	33
Load	Transmission Losses	59	61	54	64	71	109	126	94	96	111
Load	Port Hawkesbury Paper	9	9	9	208	208	9	9	209	209	209
Load	Forecast Equivalent	1470	1472	1465	1474	1482	2479	2496	2465	2467	2481
Intertie	NS to NB	171	166	1	167	328	170	329	-100	0	169
Intertie	NS to NL	-330	-475	-330	-330	-475	-330	-475	-170	-170	-330
Intertie	NB to PEI	290	290	290	290	290	297	297	297	297	297
Corridor	Cape Breton Export	235	356	202	50	158	554	769	265	265	426
Corridor	Onslow Import	556	674	525	376	483	922	1125	496	645	801
Corridor	Onslow South	567	620	633	467	430	878	897	722	772	805
Generation	Total Thermal	72	69	76	90	79	711	702	586	747	739
Generation	Total Combustion Turbine	0	0	0	30	0	30	30	30	30	60
Generation	Wreck Cove Hydro	0	0	0	0	0	170	209	209	209	211
Generation	Total Small Hydro	50	43	54	55	44	148	148	148	148	148
Generation	Total Transmission Wind	1162	1047	1012	1322	1402	1317	1267	1317	1317	1417
Generation	Total BESS	-150	-150	-150	-150	-150	-150	-99	0	-49	-150

Note 1: All values are in MW.

Note 2: CBX (Cape Breton Export) and ONI (Onslow Import) are Interconnection Reliability defined interfaces.

Note 3: Wind refers to transmission connected wind only.

Note 4: Negative MW in the All BESS column indicate charging.

Table 12: PSCAD™ Base Cases

Monitored Type	Monitored Element(s)	2029SUM_base	2029SUM_s ML 1	2029SUM_s NB 1	2029SUM_s PHP 1	2029SUM_s PHP 2	2029WIN_s ML 1	2029WIN_s ML 2	2029WIN_s NB 1	2029WIN_s PHP 1	2029WIN_s PHP 2
Load	NS Basic	1270	1270	1270	1270	1270	2327	2327	2327	2327	2327
Load	Station Service	6	6	6	6	6	33	33	23	33	33
Load	Transmission Losses	59	61	54	64	71	109	126	94	96	111
Load	Port Hawkesbury Paper	9	9	9	208	208	9	9	209	209	209
Intertie	NS to NB	172	168	0	171	331	173	329	-96	-4	167
Intertie	NS to NL	-330	-475	-330	-330	-475	-330	-475	-170	-170	-330
Intertie	NB to PEI	290	290	290	290	290	297	297	297	297	297
Corridor	Cape Breton Export	232	355	217	29	154	535	750	246	246	405
Corridor	Onslow Import	557	677	543	356	478	960	1162	535	684	837
Corridor	Onslow South	565	688	724	544	505	942	989	786	842	824
Generation	Total Thermal	120	69	76	90	78	726	706	597	751	770
Generation	Total Combustion Turbine	0	0	0	0	0	30	30	30	30	60
Generation	Wreck Cove Hydro	0	0	0	0	0	170	209	209	209	209
Generation	Total Small Hydro	51	51	51	51	51	175	175	175	175	175
Generation	Total Transmission Wind	1079	872	1220	1179	1234	1150	1105	1154	1154	1263
Generation	Total BESS	-150	-150	-150	-150	-150	-150	-99	0	-49	-150

Note 1: All values are in MW.

Note 2: CBX (Cape Breton Export) and ONI (Onslow Import) are Interconnection Reliability defined interfaces.

Note 3: Wind refers to transmission connected wind only.

Note 4: Negative MW in the All BESS column indicate charging.

Appendix B: Steady State Contingencies

Table 13: Steady State Contingencies

ID	Element	Type	Location	ID	Element	Type	Location
p001	2C-B61	Bus fault	2C-Hastings	p146	L-7015	Line fault	101S-Woodbine
p002	2C-B62	Bus fault	2C-Hastings	p147	L-7021	Line fault	88S-Lingan
p003	3C-712	Breaker fail	3C-Hastings	p148	L-7022	Line fault	88S-Lingan
p004	3C-715	Breaker fail	3C-Hastings	p149	L-8004	Line fault	101S-Woodbine
p005	L-6515	Line fault	2C-Hastings	p150	L-5016 + L-6012	Double ckt tower	St Croix
p006	L-6516	Line fault	2C-Hastings	p151	L-6011 + L-6010	Double ckt tower	Sackville
p007	L-6517	Line fault	2C-Hastings	p152	L-6507 + L-6508	Double ckt tower	Trenton
p008	L-6518	Line fault	2C-Hastings	p153	L-6534 + L-7021	Double ckt tower	Lingan / VJ
p009	L-6537	Line fault	2C-Hastings	p154	L-7003 + L-7004	Double ckt tower	Canso Causeway
p010	L-6543	Line fault	2C-Hastings	p155	L-7008 + L-7009	Double ckt tower	Bridgewater
p011	L-7004	Line fault	3C-Hastings	p156	L-7009 + L-8002	Double ckt tower	Sackville
p012	103H-B61	Bus fault	103H-Lakeside	p157	50N-607	Breaker fail	50N-Trenton
p013	103H-B62	Bus fault	103H-Lakeside	p158	50N-614	Breaker fail	50N-Trenton
p014	103H-T63	Transformer fault	103H-Lakeside	p159	50N-B62	Bus fault	50N-Trenton
p015	104H-600	Breaker fail	104H-Kempt Rd	p160	13V-B51	Bus fault	13V-Gulch
p016	113H-601	Breaker fail	113H-Dartmouth East	p161	15V-B51	Bus fault	15V-Sissiboo
p017	120H-621	Breaker fail	120H-Brushy	p162	17V-B1	Bus fault	17V-St Croix
p018	120H-622	Breaker fail	120H-Brushy	p163	17V-B2	Bus fault	17V-St Croix
p019	120H-623	Breaker fail	120H-Brushy	p164	1V-442	Breaker fail	1V-Avon 1
p020	120H-624	Breaker fail	120H-Brushy	p165	20V-B51	Bus fault	20V-Five Points
p021	120H-625	Breaker fail	120H-Brushy	p166	3V-551	Breaker fail	3V-Hell's Gate
p022	120H-626	Breaker fail	120H-Brushy	p167	43V-B51	Bus fault	43V-Canaan Rd
p023	120H-627	Breaker fail	120H-Brushy	p168	43V-B61	Bus fault	43V-Canaan Rd
p024	120H-628	Breaker fail	120H-Brushy	p169	43V-B62	Bus fault	43V-Canaan Rd
p025	120H-629	Breaker fail	120H-Brushy	p170	43V-T61	Transformer fault	43V-Canaan Rd
p026	120H-710	Breaker fail	120H-Brushy	p171	43V-T62	Transformer fault	43V-Canaan Rd
p027	120H-711	Breaker fail	120H-Brushy	p172	51V-601	Breaker fail	51V-Tremont
p028	120H-712	Breaker fail	120H-Brushy	p173	51V-B51	Bus fault	51V-Tremont
p029	120H-713	Breaker fail	120H-Brushy	p174	51V-T61	Transformer fault	51V-Tremont
p030	120H-714	Breaker fail	120H-Brushy	p175	51V-T62	Transformer fault	51V-Tremont
p031	120H-715	Breaker fail	120H-Brushy	p176	6V-GT1	Transformer fault	6V-Hollow Bridge
p032	120H-716	Breaker fail	120H-Brushy	p177	82V-600	Breaker fail	82V-Elmsdale
p033	120H-720	Breaker fail	120H-Brushy	p178	92V-B51	Bus fault	92V-Michelin Waterville
p034	132H-602	Breaker fail	132H-Spider Lake	p179	L4045	Line fault	17V-St Croix
p035	132H-603	Breaker fail	132H-Spider Lake	p180	L4046	Line fault	17V-St Croix
p036	132H-605	Breaker fail	132H-Spider Lake	p181	L4047	Line fault	17V-St Croix
p037	132H-606	Breaker fail	132H-Spider Lake	p182	L4048W	Line fault	39V-Fundy Gypsum
p038	1H-603	Breaker fail	1H-Water St	p183	L4049	Line fault	3V-Hell's Gate
p039	90H-601	Breaker fail	90H-Sackville	p184	L-5014	Line fault	17V-St Croix
p040	90H-602	Breaker fail	90H-Sackville	p185	L-5015	Line fault	17V-St Croix
p041	90H-603	Breaker fail	90H-Sackville	p186	L-5016	Line fault	17V-St Croix
p042	90H-605	Breaker fail	90H-Sackville	p187	L-5017	Line fault	43V-Canaan Rd
p043	90H-606	Breaker fail	90H-Sackville	p188	L-5021	Line fault	43V-Canaan Rd
p044	90H-608	Breaker fail	90H-Sackville	p189	L-5022	Line fault	43V-Canaan Rd
p045	90H-609	Breaker fail	90H-Sackville	p190	L-5025	Line fault	11V-Paradise
p046	90H-611	Breaker fail	90H-Sackville	p191	L-5026	Line fault	11V-Paradise
p047	90H-612	Breaker fail	90H-Sackville	p192	L-5033	Line fault	43V-Canaan Rd

Table 13: Steady State Contingencies

ID	Element	Type	Location	ID	Element	Type	Location
p048	90H-613	Breaker fail	91H-Tufts Cove	p193	L-5035	Line fault	3V-Hell's Gate
p049	90H-621	Breaker fail	91H-Tufts Cove	p194	L-5050	Line fault	15V-Sissiboo
p050	91H-603	Breaker fail	91H-Tufts Cove	p195	L-5053	Line fault	92V-Michelin Waterville
p051	91H-604	Breaker fail	91H-Tufts Cove	p196	L-5060	Line fault	17V-St Croix
p052	91H-605	Breaker fail	91H-Tufts Cove	p197	L-5531	Line fault	13V-Gulch
p053	91H-606	Breaker fail	91H-Tufts Cove	p198	L-5532	Line fault	13V-Gulch
p054	91H-607	Breaker fail	91H-Tufts Cove	p199	L-5533	Line fault	13V-Gulch
p055	91H-608	Breaker fail	91H-Tufts Cove	p200	L-5535	Line fault	15V-Sissiboo
p056	91H-609	Breaker fail	91H-Tufts Cove	p201	L-5538	Line fault	15V-Sissiboo
p057	91H-611	Breaker fail	91H-Tufts Cove	p202	L-6001N	Line fault	82V-Elmsdale
p058	L-6044	Line fault	132H-Spider Lake	p203	L-6001S	Line fault	82V-Elmsdale
p059	L-6002E	Line fault	90H-Sackville	p206	L-6012	Line fault	43V-Canaan Rd
p060	L-6003	Line fault	90H-Sackville	p207	L-6013	Line fault	43V-Canaan Rd
p061	L-6004	Line fault	90H-Sackville	p209	L-6015	Line fault	43V-Canaan Rd
p062	L-6005	Line fault	120H-Brushy	p210	L-6051	Line fault	17V-St Croix
p063	L-6007	Line fault	91H-Tufts Cove	p211	L-6052	Line fault	43V-Canaan Rd
p064	L-6008	Line fault	103H-Lakeside	p212	L-6054	Line fault	43V-Canaan Rd
p065	L-6009	Line fault	90H-Sackville	p213	30W-B51	Bus fault	30W-Souriquois
p066	L-6010	Line fault	120H-Brushy	p214	30W-B61	Bus fault	30W-Souriquois
p067	L-6011	Line fault	120H-Brushy	p215	3W-B53	Bus fault	3W-Big Falls
p068	L-6014	Line fault	91H-Tufts Cove	p216	50W-B2	Bus fault	50W-Milton
p069	L-6016	Line fault	120H-Brushy	p217	50W-B3	Bus fault	50W-Milton
p070	L-6033	Line fault	103H-Lakeside	p218	50W-B4	Bus fault	50W-Milton
p071	L-6035	Line fault	1H-Water St	p219	50W-T53	Transformer fault	50W-Milton
p072	L-6038	Line fault	103H-Lakeside	p220	99W-B51	Bus fault	99W-Bridgewater
p073	L-6040	Line fault	91H-Tufts Cove	p221	99W-B61	Bus fault	99W-Bridgewater
p074	L-6042	Line fault	91H-Tufts Cove	p222	99W-B62	Bus fault	99W-Bridgewater
p075	L-6043	Line fault	113H-Dartmouth East	p223	99W-B71	Bus fault	99W-Bridgewater
p076	L-6044	Line fault	113H-Dartmouth East	p224	99W-B72	Bus fault	99W-Bridgewater
p077	L-6051	Line fault	120H-Brushy	p225	99W-T61	Transformer fault	99W-Bridgewater
p078	L-6055	Line fault	132H-Spider Lake	p226	99W-T62	Transformer fault	99W-Bridgewater
p079	L-7018	Line fault	120H-Brushy	p227	99W-T71	Transformer fault	99W-Bridgewater
p080	90H-T1	Transformer fault	90H-Sackville	p228	99W-T72	Transformer fault	99W-Bridgewater
p081	1N-B61	Bus fault	1N-Onslow	p229	9W-B52	Bus fault	9W-Tusket
p082	1N-B62	Bus fault	1N-Onslow	p230	9W-B53	Bus fault	9W-Tusket
p083	50N-604	Breaker fail	50N-Trenton	p231	L-5530	Line fault	50W-Milton
p084	67N-701	Breaker fail	67N-Onslow	p232	L-5540	Line fault	50W-Milton
p085	67N-702	Breaker fail	67N-Onslow	p233	L-5541	Line fault	3W-Big Falls
p086	67N-703	Breaker fail	67N-Onslow	p234	L-5545	Line fault	99W-Bridgewater
p087	67N-704	Breaker fail	67N-Onslow	p235	L-5546	Line fault	99W-Bridgewater
p088	67N-705	Breaker fail	67N-Onslow	p236	L-6006	Line fault	99W-Bridgewater
p089	67N-706	Breaker fail	67N-Onslow	p237	L-6020	Line fault	50W-Milton
p090	67N-710	Breaker fail	67N-Onslow	p238	L-6024-1	Line fault	50W-Milton
p091	67N-711	Breaker fail	67N-Onslow	p239	L-6025	Line fault	99W-Bridgewater
p092	67N-712	Breaker fail	67N-Onslow	p240	L-6048	Line fault	50W-Milton
p093	67N-713	Breaker fail	67N-Onslow	p241	L-6531	Line fault	99W-Bridgewater
p094	67N-811	Breaker fail	67N-Onslow	p242	L-7008	Line fault	99W-Bridgewater

Table 13: Steady State Contingencies

ID	Element	Type	Location	ID	Element	Type	Location
p095	67N-812	Breaker fail	67N-Onslow	p243	L-7009	Line fault	99W-Bridgewater
p096	67N-813	Breaker fail	67N-Onslow	p244	17V-611	Breaker fail	17V- St. Croix
p097	67N-814	Breaker fail	67N-Onslow	p245	17V-512	Breaker fail	17V- St. Croix
p098	74N-600	Breaker fail	74N-Springhill	p246	17V-563	Breaker fail	17V- St. Croix
p099	79N-B61	Bus fault	79N-Hopewell	p247	17V-T63	Transformer fault	17V- St. Croix
p100	79N-B81	Bus fault	79N-Hopewell	p248	1V-B51	Bus fault	1V-Avon 1
p101	L-5029	Line fault	74N-Springhill	p249	43V-604	Breaker fail	43V-Canaan Rd
p102	L-5058	Line fault	74N-Springhill	P250	43V-613	Breaker fail	43V-Canaan Rd
p103	L-6001	Line fault	1N-Onslow	p250	43V-501	Breaker fail	43V-Canaan Rd
p104	L-6057	Line fault	50N-Trenton	p251	43V-502	Breaker fail	43V-Canaan Rd
p105	L-6503	Line fault	50N-Trenton	p252	43V-503	Breaker fail	43V-Canaan Rd
p106	L-6507	Line fault	79N-Hopewell	p253	43V-504	Breaker fail	43V-Canaan Rd
p107	L-6508	Line fault	50N-Trenton	p254	43V-505	Breaker fail	43V-Canaan Rd
p108	L-6511	Line fault	50N-Trenton	p255	43V-506	Breaker fail	43V-Canaan Rd
p109	L-6514	Line fault	74N-Springhill	p256	43V-562	Breaker fail	43V-Canaan Rd
p110	L-6527	Line fault	1N-Onslow	p257	51V-500	Breaker fail	51V-Tremont
p111	L-6536	Line fault	74N-Springhill	p258	51V-521	Breaker fail	51V-Tremont
p112	L-6613	Line fault	74N-Springhill	p259	51V-562	Breaker fail	51V-Tremont
p113	L-7001	Line fault	67N-Onslow	p260	51V-602	Breaker fail	51V-Tremont
p114	L-7002	Line fault	67N-Onslow	p261	51V-603	Breaker fail	51V-Tremont
p115	L-7003	Line fault	67N-Onslow	p262	51V-604	Breaker fail	51V-Tremont
p116	L-7005	Line fault	67N-Onslow	p263	51V-B52	Bus fault	51V-Tremont
p117	L-7019	Line fault	67N-Onslow	p264	82V-B61	Bus fault	82V-Elmsdale
p118	L-8001	Line fault	67N-Onslow	p265	101V-602	Breaker fail	101V-MacDonald Pond
p119	L-8002	Line fault	67N-Onslow	p266	101V-603	Breaker fail	101V-MacDonald Pond
p120	L-8003	Line fault	67N-Onslow	p267	101V-604	Breaker fail	101V-MacDonald Pond
p121	L-8003	Line fault	79N-Hopewell	p268	101V-605	Breaker fail	101V-MacDonald Pond
p122	L-8004	Line fault	79N-Hopewell	p269	101V-606	Breaker fail	101V-MacDonald Pond
p123	101S-701	Breaker fail	101S-Woodbine	p270	101V-607	Breaker fail	101V-MacDonald Pond
p124	101S-702	Breaker fail	101S-Woodbine	p271	50W-501	Breaker fail	50W-Milton
p125	101S-703	Breaker fail	101S-Woodbine	p272	50W-514	Breaker fail	50W-Milton
p126	101S-704	Breaker fail	101S-Woodbine	p273	50W-517	Breaker fail	50W-Milton
p127	101S-705	Breaker fail	101S-Woodbine	p274	50W-600	Breaker fail	50W-Milton
p128	101S-706	Breaker fail	101S-Woodbine	p275	50W-615	Breaker fail	50W-Milton
p129	101S-711	Breaker fail	101S-Woodbine	p276	99W-501	Breaker fail	99W-Bridgewater
p130	101S-712	Breaker fail	101S-Woodbine	p277	99W-562	Breaker fail	99W-Bridgewater
p131	101S-713	Breaker fail	101S-Woodbine	p278	99W-600	Breaker fail	99W-Bridgewater
p132	101S-811	Breaker fail	101S-Woodbine	p279	99W-601	Breaker fail	99W-Bridgewater
p133	101S-812	Breaker fail	101S-Woodbine	p280	99W-602	Breaker fail	99W-Bridgewater
p134	101S-813	Breaker fail	101S-Woodbine	p281	9W-500	Breaker fail	9W-Tusket
p135	101S-814	Breaker fail	101S-Woodbine	p282	L-6024-2	Line fault	9W-Tusket
p136	101S-816	Breaker fail	101S-Woodbine	p283	IR742-Breaker	Breaker fail	IR742
p137	88S-710	Breaker fail	88S-Lingan	p284	101S_MLPOLE1	Line fault	101S-Woodbine
p138	88S-712	Breaker fail	88S-Lingan	p285	101S_MLPOLE2	Line fault	101S-Woodbine

Table 13: Steady State Contingencies

ID	Element	Type	Location	ID	Element	Type	Location
p139	88S-713	Breaker fail	88S-Lingan	p286	101S_MLBIPOLE	Line fault	101S-Woodbine
p140	88S-720	Breaker fail	88S-Lingan	p287	89S-G1	Generator loss	89S-Point Aconi
p141	88S-721	Breaker fail	88S-Lingan	p288	50N-G5	Generator loss	50N-Trenton
p142	88S-722	Breaker fail	88S-Lingan	p289	50N-G6	Generator loss	50N-Trenton
p143	88S-723	Breaker fail	88S-Lingan	p290	91H-G3	Generator loss	91H-Tufts Cove
p144	L-7011	Line fault	101S-Woodbine	p291	1C-G2	Generator loss	1C-Point Tupper
p145	L-7014	Line fault	88S-Lingan				

Appendix C: PSCAD™ Contingencies

Table 14: PSCAD™ Subset of Critical Contingencies for IR742

PSCAD™ Contingency No.	Contingency Description	PSCAD™ Contingency No.	Contingency Description
25	101S MLBIPOLE 3P Fault	105	120H BBU 120H-715
29	3C BBU 3C-710	113	DCT 6507][6508 79N
30	3C T71 3PH Fault	115	DCT 7003][7004
31	3C BBU 3C-712	116	DCT 7008][7009
32	3C BBU 3C-713	117	DCT 7009][8002
33	3C BBU 3C-714	118	DCT 7009][8002 A
34	3C BBU 3C-716	161	104N BBU 104N-801
35	3C BBU 3C-711	162	104N BBU 104N-802
36	3C BBU 3C-715	163	104N BBU 104N-803
57	67N BBU 67N-711	164	104N BBU 104N-804
58	67N BBU 67N-712	165	104N BBU 104N-805
59	67N BBU 67N-713	166	104N BBU 104N-806
65	67N BBU 67N-701	167	67N BBU 67N-820
66	67N BBU 67N-702	168	67N BBU 67N-817
67	67N BBU 67N-703	406	100N 601 BBU
68	67N BBU 67N-704	439	132H BBU 132H-601 IR662
69	67N BBU 67N-705	440	99W BBU 99W-633 IR 664
70	67N BBU 67N-706	1402	67N BBU 67N-814_NSI
71	67N BBU 67N-710	1403	104N BBU 104N-801_NSI
72	67N BBU 67N-811	1404	104N BBU 104N-802_NSI
73	67N BBU 67N-811 T82	1405	IR668 BBU
74	67N BBU 67N-813	1406	c_3C_SEG_IR618_3C
75	67N BBU 67N-814	1407	IR618 BBU
82	79N BBU 79N-803	1415	Dal BBU

Appendix D: Steady State Results



*Compiled outside report

Appendix E: BPS Stability Test Results



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Appendix F: EMT Analysis Results



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