# Facilities Study Report

## IR-669

**100.3 MW Higgins Mountain Wind**
**Colchester County, NS**

Prepared by
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# Facilities Study Report

IR-669 – Higgins Mountain Wind

## EXECUTIVE SUMMARY

This project (IR#669 – Higgins Mountain Wind) provides for the establishment of a 138 kV system interconnection to Nova Scotia Power Inc (NSPI) transmission line L-6613 for a 100.3MW Wind Generation Facility in Colchester County, Nova Scotia.

The Point of Interconnection (POI) is at the 138kV bus node of a new 138kV three-breaker ring substation (100N-Higgins Mountain) located approximately 24 kms from 1N-Onslow substation (between existing line structures L6613-123 and L6613-125). A new, approximately 4 km, 138kV transmission line L-6556 will be constructed from the POI on L-6613 to the Interconnection Customer substation 101N. The Point of Change of Ownership (PCO) is at the new 138kV line (L-6556) terminal structure at the Higgins Mountain Wind Interconnection Facility substation 101N. The POI and PCO are further clarified in the Interconnection Overview Drawing provided in Appendix B.

The new 138kV system interconnection substation has been assigned NSPI system number 100N – Higgins Mountain. The interconnection substation at Higgins Mountain Wind facility has been assigned system number 101N – Higgins Mountain Wind, and the new 4 km transmission line between the interconnection substation 100N and Higgins Mountain Wind substation 101N has been assigned system number L-6556. The section of L-6613 from 100N-Higgins Mountain to 74N-Springhill will be renamed L-6555.

The scope of work associated with this interconnection will consist of a line tap arrangement to NSPI transmission line L-6613, a 138kV three-breaker ring interconnection substation at 100N-Higgins Mountain, a new 4 km 138kV transmission line (L-6556) from the interconnection substation 100N to the Higgins Mountain Wind facility (101N), modifications to existing remote protection and remedial action schemes (RAS).

All interconnection facilities must meet NSPI's Transmission System Interconnection Requirements (TSIR), version 1.1 dated February 25, 2021, as published on the NSPI OASIS site.

The interconnection substation (100N) shall be designed to be easily upgraded to full protection, control, and communications separation and redundancy, fully compliant to the Northeast Power Coordination Council's (NPCC) Directory 4 design criteria. The Interconnection Customer's Facility substation (101N) meets the NERC Bulk Electric System (BES) criteria but not the Bulk Power System criteria and shall be designed and constructed to meet BES criteria.

The following scope of work has been identified as meeting the defined criteria for 'Stand Alone' upgrades as per section 2.10:

- The interconnection substation (100N-Higgins Mountain) including land acquisition, site preparation, access road, foundations, site grounding, primary equipment, control building, protection and control panels, and all associated devices except for the telecommunications equipment and the microwave radio tower.
- The transmission line L-6556 from 100N-Higgins Mountain to 101N-Higgins Mountain Wind substation including easement acquisition, access routes, all structures, conductors, shield wires, insulators, and foundations, the optical fibre shield wire, line terminations at both substations, and all potential railway, highway, and water crossings.
- All elements of the Higgins Mountain Wind Interconnection Facility substation 101N except for provision of the revenue meter, the required L-6556 protection and control equipment, the remote terminal unit (RTU), and the telecommunications equipment required at 101N-Higgins Mountain Wind substation.

Non-stand-alone upgrades include all other elements of the scope of work not identified as stand-alone upgrades including:

- The 138kV transmission line tap from 100N-Higgins Mountain to L-6613
- The addition of shield wire on L-6613 for 1km each side of 100N substation
- The remote protection modifications at 1N-Onslow and 74N-Springhill
- The modifications to existing Remedial Actions Schemes (RAS).
- Telecommunications equipment supply and installation at 100N-Higgins Mountain Substation.
- The revenue meter, L-6556 protection and control equipment, remote terminal unit (RTU), and telecommunications equipment required at 101N-Higgins Mountain Wind substation.

L-6613 forms part of the Nova Scotia system interconnection with New Brunswick. Outages to this line can impose limitations on the inter-provincial tie flows. These constraints will require NSPI System Operator actions to minimize risks and maintain system stability. All system outages required to complete the interconnection work shall require advanced planning and coordination with the NS System Operator.

The Revenue Class 138kV voltage and current transformers required for revenue metering will be supplied and installed by the Interconnection Customer as per NSPI specification.

NSPI will require space and unrestricted access in the Interconnection Customer's substation (101N) control building for the L-6556 line protection equipment, the Remote Terminal Unit (RTU) and the communications equipment.

The total estimated cost to construct the required Network Upgrades and Transmission Provider's Interconnection Facilities is **$13,215,074.** Of this amount, the estimated cost to construct the Stand-Alone Network Upgrades and Transmission Provider's Interconnection Facilities is **$9,429,918**. The estimated cost to construct the Non-Stand-Alone Network Upgrades and Transmission Provider's Interconnection Facilities is **$3,785,156**. The detailed cost estimates are provided in Appendix F. All cost estimates exclude allowance for funds used during construction (AFUDC) or any escalations due to timing of project execution. The customer will be responsible for paying NSPI for the actual costs associated with this project, be they higher or lower than the estimate provided herein, unless otherwise specified in the Generation Interconnection Agreement (GIA).

The Interconnection Customer's targeted commercial operation date is September 1, 2025, with first-power available on August 1, 2025. Based on the current supply chain issues and quoted delivery timelines for high voltage primary equipment, the Interconnection Customer's targeted in-service date is not able to be met. An estimated in-service date of Q2, 2026 has been provided based on an executed GIA in Q4, 2023. An overall preliminary project schedule is provided in Appendix G.

Part 2 of the SIS is still in progress and if any additional requirements are identified in the Part 2 Study, the FAC will be updated to reflect those additions as required.

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# Facilities Study Report

IR-669 – Higgins Mountain Wind

## 1.0 INTRODUCTION

This Facilities Study Report is based on the System Impact Study Report (SIS) as identified below:

System Impact Study Report (Part 1)
Report GIP-IR669-SIS-R1
Dated June 30, 2023
Prepared by: Bryce Clothier

The SIS describes the facilities and modifications required to the Nova Scotia transmission system to add a 100.3 MW Wind Generating Facility at Higgins Mountain interconnected to NSPI's 138kV transmission line L-6613. It also addresses short circuit, steady state, stability, power flow, and motor start analysis. It provides an overview of the scope of work to be completed and directions to this Facilities Study (FAC).

Part 2 of the SIS is still in progress and if any additional requirements are identified in the Part 2 Study, the FAC will be updated to reflect those additions as required.

The scope of work identified in the Facilities Study outlines the anticipated work requirements for a conceptual level of engineering and design. Detailed design may identify additional requirements or modifications that were not anticipated or captured during the preliminary design phase.

### 1.1 Project Ownership and Responsibilities

Ownership, maintenance, and other commercial operation arrangements will be covered separately in a Generation Interconnection Agreement (GIA) between NSPI and the Interconnection Customer.

Following NSPI system naming standards, the new interconnection substation will be labeled 100N-Higgins Mountain and Interconnection Customer's facility substation will be labeled 101N-Higgins Mountain Wind. The new 138kV transmission line from 100N-Higgins Mountain to 101N-Higgins Mountain Wind will be labeled L-6556. The section of L-6613 from 100N-Higgins Mountain to 74N-Springhill will be renamed L-6555.

Ownership of the infrastructure associated with 101N-Higgins Mountain Wind substation is based on the Point of Change of Ownership at L-6556 line dead-end structure at 101N-Higgins Mountain Wind substation (refer to the Interconnection Overview Diagram in Appendix B). NSPI, as the transmission provider, will own the new interconnection substation (100N-Higgins Mountain) and the new 138 kV line L-6556 from the 100N-Higgins Mountain substation to the dead-end structure located within customer's substation 101N.

All communication systems infrastructure between NSPI's 100N-Higgins Mountain substation and the new Higgins Mountain Wind facility required for control and monitoring will be owned by NSPI. This includes the fibre communications equipment, protection equipment, and the Supervisory Control and Data Acquisition (SCADA) Remote Terminal Unit (RTU) located at Higgins Mountain Wind substation 101N.

NSPI will also own the revenue metering equipment located in the interconnection substation 101N-Higgins Mountain Wind.

All interconnection facilities must meet NSPI's Transmission System Interconnection Requirements (TSIR), version 1.1 dated February 25, 2021, as published on the NSPI OASIS site.

## 1.2 Estimated Cost

The total estimated cost to construct the required Network Upgrades and Transmission Provider's Interconnection Facilities is **$13,215,074.** Of this amount, the estimated cost to construct the Stand-Alone Network Upgrades and Transmission Provider's Interconnection Facilities is **$9,429,918.** The estimated cost to construct the Non-Stand-Alone Network Upgrades and Transmission Provider's Interconnection Facilities is **$3,785,156**. The detailed cost estimates are provided in Appendix F. *All cost estimates exclude allowance for funds used during construction (AFUDC) or any escalations due to timing of project execution*.

The cost estimates are based on the scope of work outlined in Section 2.0 of this Facilities Study Report. The cost estimate provided in Appendix F are estimates only based on 2023 budgetary dollars. The customer will be responsible for paying NSPI for the actual costs associated with this project, be they higher or lower than the estimate provided herein, unless otherwise specified in the Generation Interconnection Agreement (GIA).

The cost estimate in this report is valid for one hundred eighty (180) days.

The project cannot commence until the customer delivers to NSPI the balance of the cost estimate for the project in a form acceptable to NSPI, or as per the terms of the GIA. As per Item 11.4 of the GIA, Network Upgrade costs are refundable to the Interconnection Customer pending Nova Scotia Utility and Review Board (NSUARB) approval.

## 1.3 Project Schedule

The estimated project duration includes all scope of work required for the transmission interconnection as outlined in Section 2.0.

The Interconnection Customer's targeted commercial operation date is September 1, 2025, with first-power available on August 1, 2025.

An outline of major project milestones is provided in Section 5.0 and a preliminary project schedule outlining the major components of this project is provided in Appendix F.

Based on the current supply chain issues and quoted delivery timelines for high voltage primary equipment, the Interconnection Customer's targeted in-service date is not able to be met. An estimated earliest in-service date of Q2, 2026 has been provided based on an executed GIA in Q4, 2023.

# 2.0 SCOPE OF WORK

## 2.1 Interconnection Overview

An interconnection overview diagram of the 100.3MW Higgins Mountain Wind interconnection is provided in Appendix B. The Point of Interconnection (POI) is at the 138kV bus node of the new 138kV three-breaker ring substation (100N-Higgins Mountain) located approximately 24 kms from 1N-Onslow substation (between existing line structures L6613-123 and L6613-125). The Point of Change of Ownership (PCO) is at the new 138kV line (L-6556) terminal structure at the Higgins Mountain Wind Interconnection Facility substation 101N.

## 2.2 Substation Interconnection to Transmission Line L-6613

A conceptual design plan for the line tap to L-6613 has been provided in Appendix E. Modifications may be required as detailed design is finalized. The overall design concept entails replacing structure 123 with a three-pole dead-end structure, installing a new dead-end structure 124A, replacing existing structure 124 with a double dead-end structure with open taps and extending line taps under line L-6613 into substation 100N-Higgins Mountain. Two spans of the out-of-service line L-6513, from structure 104 to structure 106, will be removed.

The section of transmission line from 100N to 74N-Springhill will be renamed L-6555. Shield wire will be added to L-6613 and L-6555 for 1 km on each side of the line tap. The shield wire will also be extended into the 100N-Higgins Mountain substation.

An outage will be required on L-6613 to facilitate installation of the line taps to the 100N Substation. Outages to L-6613 will need to be approved by the System Operator and coordinated with any planned outages to minimize any system impacts.

Estimated costs associated with the line tap on L-6613 including termination at the 100N Substation are included in the Non-Stand-Alone Network Upgrade cost estimate.

## 2.3 Transmission Interconnection Substation: 100N-Higgins Mountain

The developmental one line for 100N-Higgins Mountain substation is provided in Appendix C. The developmental plan view for 100N-Higgins Mountain substation is provided in Appendix D. In summary, the transmission scope of work includes a 138kV three-breaker ring bus substation with three 138kV line terminals including all associated protection and control, tele-communications, and site development. The Interconnection Customer shall provide NSPI with deeded ownership, and developed access to, the land associated with the substation site.

The interconnection substation shall be designed to be easily upgraded to full protection, control, and communications separation and redundancy, fully compliant to the Northeast Power Coordination Council's (NPCC) Directory 4 design criteria.

### 2.3.1 Substation Site Development / Civil Works / Structures / Site Access

#### 2.3.1.1 General Requirements

The following are the general requirements for NSPI substation civil design and construction:

- Topological survey is to be performed prior to design.
- Geotechnical investigation and soil resistivity testing is to be performed prior to design.
- Site Access
  - Access driveways must be designed with adequate width such that all equipment, deliveries, and general maintenance vehicles are able to access substation site.
  - Ditching along access roads are to be provided to ensure access is dry and stable.
  - Culverts are to be used where any drainage cuts across access route.
- Erosion/Sediment Control
  - Check dams/silt fences shall be installed to intercept runoff from any ditches and dewatering activities.
  - Substation finished grade shall be chosen such that surface water drains away from the site.
  - All exposed banks and/or erodible soil shall be temporarily stabilized by suitable means (hydroseed, straw, hay, or sodding).
- Environmental
  - A 30m wide buffer zone shall bracket all watercourses (if applicable).
  - Work inside this zone requires approval through the Dept. of Environment.
- Clearing/Stripping
  - Seasonal clearing must ensure nesting season is avoided and no habitat is destroyed.
  - Stripping shall consist of the removal and disposal of all surface vegetation, chipped or mulched brush, topsoil, trees, brush, tree stumps, roots, and any deleterious other material.
  - All greenfield sites are to be stripped at a minimum depth of 300mm.
- Excavation
  - All excavation practices must adhere to NSPI specification SS –10.7 - Earthworks.
  - Slopes resulting from rock cuts shall normally be 1 horizontal to 1 vertical. Slopes shall be cleaned and trimmed of all disturbed and loose material and left in a neat condition.
  - Following excavation on the site, the ground surface shall be graded and compacted to 95% Standard Proctor Density where it is 900 mm or more from subgrade and to the 100% Standard Proctor Density within the top 900 mm from subgrade.
- Backfill
  - All backfill practices must adhere to NSPI spec SS –10.7 - Earthworks
  - No native material shall be used as fill unless specified by design engineer.
  - Standard Type 1, and 2 gravels used for backfill shall conform to the Nova Scotia Department of Transportation and Public Works Standard Specification.
- Foundations
  - Bearing capacity design shall use maximum allowable bearing pressure of 75 kPa for support structures and 120 kPa for dead end structures.
  - Foundation design shall assume unsubmerged conditions.
  - Concrete must adhere to NSPI concrete spec SS –10.7 - Concrete Cast-in-Place with minimum 28-day compressive strength of 30 MPa.
- Fencing
  - Chain link fencing must adhere to NSPI concrete spec SS –10 - Chain-link Fencing – Supply and Install.

- Structural Steel – Design, Fabrication and Welding
  - Steel design and fabrication shall follow SE-12 Steel Substation Structures – Fabricate & Supply.
  - Materials shall be new and of high commercial quality conforming to the requirements of CSA G40.20 and G40.21, unless noted otherwise.
- Land and access allocated for the interconnection substation shall have deeded ownership provided to NSPI.

#### 2.3.1.2 100N-Higgins Mountain Site Specific

All station control cable shall be installed in cable trench or conduits. Cable trenches shall accommodate full cable separation of A and B protection schemes.

Concrete foundations and steel support structures will be installed for:

- 3 – 138kV A-Frame dead-ends
- 4 – 138kV high rigid bus supports
- 6 – 138kV low rigid bus supports
- 7 – 138kV disconnect supports
- 3 – 138V three-phase potential transformer supports
- 2 – 138kV-120/240V single phase station service voltage transformer support
- 3 – 138kV three-phase surge arrester supports
- 2 – single-phase 138kV fuse supports

Concrete foundations only will be installed for:

- 3 – 138kV dead tank circuit breakers
- 1 – control building foundation
- 1 – self-supporting microwave radio tower foundation for 23m tower

### 2.3.2 Substation Grounding

A grounding grid system shall be installed for a design 3-phase fault level of 5000MVA and meet NSPI's substation grounding specification SD-2. A ground grid design to any fault level lower than 5000MVA shall require NSPI approval.

The minimum acceptable size of conductor shall be 2/0 stranded copper. An equivalent copper-weld conductor should be used for above ground applications.

All structures, fencing, and equipment shall be grounded as per NSPI standards.

### 2.3.3 Primary Equipment and Layout

A developmental substation layout for 100N is provided in Appendix D. All equipment shall conform with Nova Scotia Power standard equipment specifications.

#### 2.3.3.1 Circuit Breakers 100N-601, 100N-602, and 100N-603

- 138kV, 2000A, 650kV BIL, 3 cycle, 25kA mom., SF6 dead-tank circuit breaker.

- Complete with two sets (each side) of 2000/16/8/6-5A multi-ratio bushing current transformers.
- As per NSPI Standard Circuit Breaker Specification SE-14.

2.3.3.2 138kV Disconnects (100N-601A, 601B, 602A, 602B, 603A, 604B, and 656)

- 138kV, 2000A, 650kV BIL, 40kA mom., complete with 125Vdc motor operator.
- Line disconnects 100N-602B, 100N-603A and 100N-656 will also include an integral key interlocked ground switch.
- As per NSPI Standard Specification SE-8 (Outdoor Air Switches) and SE-10 (Air Switch Motor Operators).

2.3.3.3 138kV Voltage Transformers (P6613, P6555, and PB61)

- 700/1200:1:1 with two 115/67V secondaries, 3000VA, 0.3 WXYZ, 650kV BIL
- As per NSPI Standard Specification SE-4

2.3.3.4 138kV Station Service Voltage Transformers (ST61 and ST613)

- 80kV – 120/240V single phase voltage transformer with KVA rating sized for full AC station service load.
- Primary power fuses Type SMD-2B will be used to protect each voltage transformer (100N-661 and 100N-613)
- Two high voltage station service voltage transformers (SSVT) were assumed for the purpose of the FAC to provide primary and backup station service supply. If an alternate station service supply can be provided from the distribution network then only one SSVT will be required.

2.3.3.5 138kV Line Terminal Surge Arresters (3 sets)

- Station Type, Metal Oxide, 120kV rated, 98kV MCOV.
- As per NSPI Standard Specification SE-20.

2.3.3.6 138kV Single Phase Power Fuse (100N-613 and 100N-661)

- SMD-2B Power Fuse sized during detailed design.

### 2.3.4 Protection and Control

At 100N, line protection on all three terminals will consist of redundant "A" and "B" protection schemes, with physical separation of panels and cabling between protection schemes, per Northeast Power Coordinating Council's (NPCC) Directory 4 criteria.

#### 2.3.4.1 Line Protection

- The A scheme line protection relays shall be SEL-411L, using the 87L line current differential element for high-speed tripping and step distance elements for backup tripping.
- The B scheme line protection relays shall be GE L90, using the 87L line current differential element for high-speed tripping and step distance elements for backup tripping.

#### 2.3.4.2 Breaker Failure

- Redundant A and B breaker failure protection shall be provided.

- The A scheme breaker failure protection shall be provided by an SEL-451 bay control relay for each breaker, which shall also provide reclosing and synchronizing for the breaker.
- The B scheme breaker failure protection may be provided by the GE L90 line relays.
- Breaker Failure Initiate (BFI) must not be latched in the design. Breaker failure timer shall only run for (Trip active) AND (Breaker current above minimum pickup). The trip input to the BFI logic shall not be subject to a minimum trip duration.
- Transfer tripping via high-speed tele-protection channels to the remote ends of all three lines shall be required for associated line breaker failures.
- Note: Breaker Failure protection is referred to as Breaker Backup (BBU) in NSPI documentation. A Re-trip is referred to as "Early Trip."

2.3.4.3 Reclosing and Synchronizing

- Reclosing shall be initiated in the SEL-451 relays by both the A and B protection schemes.
- Automatic synchronizing/sync check shall be provided by the SEL-451 bay control relays.
- Manual synchronizing shall also be provided.

2.3.4.4 DC Supply for Protection

One 125V DC battery bank along with battery charger shall supply the DC protection and control systems. However, the station design shall provide space for a redundant B battery and charger installation so that NPCC Directory 4 design criteria may be met in the future. The battery and charger will be sized as part of the detailed design to fully accommodate all DC loads under simultaneous operation.

- The 125 Vdc battery shall have the capacity to supply the entire substation. The battery will be designated 100N-D41 for the A battery and disconnect switch, and the future B battery and disconnect switch will be designated 100N-D42.
- The two batteries shall be physically separated, preferably in separate battery rooms.
- DC distribution panels for the A and B systems shall not be located beside each other.

2.3.4.5 Station Control and Communications

- Station control, Remote Terminal Unit (RTU), Fault Recording (FR) and Sequence of Events Recording (SER) functions to be provided by a non-redundant SEL Axion system, including SEL-RTAC and SEL-3350 HMI computer, keyboard/trackpad tray and touch screen. These functions are collectively referred to as the Substation Automation System (SAS).
- Communication to the Supervisory Control and Data Acquisition (SCADA) master will use DNP3 protocol over a serial channel.
- Network connections between different panels shall be via fiber optic cable. Network connections within a panel may be copper cabling (Cat 5e or Cat 6).
- Sequence of Events Recording (SER) and Fault Recording (FR) shall meet the requirements of NERC Reliability standard PRC-002 and NPCC Directory 11.
- A non-redundant SEL-2488 satellite clock shall be provided.
- A time signal shall be distributed to each measuring relay using either PTP (IEEE 1588-2008 or later) or IRIG-B time code over 50 ohm coaxial cable, taking care to maintain galvanic isolation between A and B side equipment.
- Each protective relay shall assert an alarm to the SAS in the event of a loss of satellite clock signal.

- Ethernet switches shall be capable of supporting PTP with the C37.238-2017 power system profile.
- Local substation operation, including tagging functions, shall normally be from the HMI computer/Substation Automation System (SAS).
- In the event of a failure of the SAS, local manual operation of the breakers shall be available from inside the control building.
- Redundant communications paths shall be provided for 74N tele-protection channels.
- Redundant communication paths shall be provided for 1N tele-protection channels.
- Remote engineering access shall be provided via an NSPI-supplied firewall to be installed in either an NSPI telecom panel or the SAS panel.

2.3.4.6 Station Alarms

The following substation alarms will be provided to the local Sequence of Events Recorder (SER) and SCADA (unless otherwise noted):

1. Urgent (SCADA) time delayed & initiated by following SER points:
   - Station Service Failed
   - Battery(s) Volts Low
   - Battery Charger(s) Failed
   - Protection and Control Relay/DC Failed
   - Protection AC Potential Failed
   - Line L-6555 A Tele-protection Channels Failed
   - Line L-6555 B Tele-protection Channels Failed
   - Line L-6556 A Tele-protection Channels Failed
   - Line L-6556 B Tele-protection Channels Failed
   - Line L-6613 A Tele-protection Channels Failed
   - Line L-6613 B Tele-protection Channels Failed
   - Fire Alarm Operated
   - Building High Temperature
   - Building Low Temperature
1. Non-Urgent (Scada) time delayed & initiated by following SER points:
   - Alternate Station Service Failed
   - Station Service Auto Transfer Operated
   - DC Supply(s) Grounded
   - Breaker 601 Monitor Trouble
   - Breaker 602 Monitor Trouble
   - Breaker 603 Monitor Trouble
   - Relay Time Sync Failed
3. A Transfer Trip Received (Scada) initiated by following SER points:
   - Line L-6555 #1 Transfer Trip From 74N Received
   - Line L-6556 #1 Transfer Trip From 101N Received
   - Line L-6613 #1 Transfer Trip From 1N Received
4. B Transfer Trip Received (Scada) initiated by following SER points:
   - Line L-6555 #2 Transfer Trip From 74N Received
   - Line L-6556 #2 Transfer Trip From 101N Received
   - Line L-6613 #2 Transfer Trip From 1N Received
5. Line L-6555 A Protection Operated (SER only)
6. Line L-6555 B Protection Operated (SER only)
7. Line L-6556 A Protection Operated (SER only)
8. Line L-6556 B Protection Operated (SER only)

9. Line L-6613 A Protection Operated (SER only)
10. Line L-6613 B Protection Operated (SER only)
11. Sync Freq Limit Exceeded (Scada) initiated by following SER point:
    - Synchronizing Frequency Limit Exceeded
12. Sync Volt Limit Exceeded (Scada) initiated by following SER point:
    - Synchronizing Voltage Limit Exceeded
13. Sync Phase Angle Limit Exceeded (Scada) initiated by following SER point:
    - Synchronizing Phase Angle Limit Exceeded
14. Local Control (Scada) initiated by following SER point:
    - Station Control Local
15. Breaker 601 Closed
16. Breaker 602 Closed
17. Breaker 603 Closed
18. Breaker 601 Urgent (Scada) initiated by following SER points:
    - Breaker 601 SF6 Density Low
    - Breaker 601 Motor Overload*
    - Breaker 601 Trip Circuit #1 Failed
    - Breaker 601 Trip Circuit #2 Failed
19. Breaker 602 Urgent (Scada) initiated by following SER points:
    - Breaker 602 SF6 Density Low
    - Breaker 602 Motor Overload*
    - Breaker 602 Trip Circuit #1 Failed
    - Breaker 602 Trip Circuit #2 Failed
20. Breaker 603 Urgent (Scada) initiated by following SER points:
    - Breaker 603 SF6 Density Low
    - Breaker 603 Motor Overload*
    - Breaker 603 Trip Circuit #1 Failed
    - Breaker 603 Trip Circuit #2 Failed
21. Breaker 601 Control Lockout (Scada) initiated by following SER point:
    - Breaker 601 SF6 Control Blocked
22. Breaker 602 Control Lockout (Scada) initiated by following SER point:
    - Breaker 602 SF6 Control Blocked
23. Breaker 603 Control Lockout (Scada) initiated by following SER point:
    - Breaker 603 SF6 Control Blocked
24. Breaker 601 Auto-reclose Off (Scada) initiated by following SER point:
    - Breaker 601 Auto-reclose Off
25. Breaker 602 Auto-reclose Off (Scada) initiated by following SER point:
    - Breaker 602 Auto-reclose Off
26. Breaker 603 Auto-reclose Off (Scada) initiated by following SER point:
    - Breaker 603 Auto-reclose Off
27. Breaker Backup Lockout (Scada) initiated by following SER points:
    - Breaker 601 BBU Lockout Operated
    - Breaker 602 BBU Lockout Operated
    - Breaker 603 BBU Lockout Operated
28. Breaker 601 BBU Initiated & Early Trip Operated (SER) only
29. Breaker 602 BBU Initiated & Early Trip Operated (SER) only
30. Breaker 603 BBU Initiated & Early Trip Operated (SER) only
31. Substation Entry

*Note: These alarms may differ depending on the manufacturer of the breakers purchased.

#### 2.3.4.7 General

- Specific part numbers for IEDs and equipment remain to be determined.
- A single line protection panel may include two relays for two lines, or a line relay and a bay control relay if this makes economic use of panel space.
- If IEC 61850 is used for protection functions, the network design shall meet NPCC Directory 4 criteria.
- If serial connections are used for communication between relays and/or the SAS, serial fiber shall be used between A and B systems. Ie. If the SAS is supplied from the A battery, serial connection to B IEDs shall be over fiber.
- The control building panel layout shall provide space for a minimum of two additional protection and control panels to accommodate any future potential additional relaying.

### 2.3.5 Control Building

A control building to house the redundant and physically separated protection and control panels, physically separated dual path tele-communications equipment, battery and charger, and primary and back-up station service supplies is required. The final size of the control building shall be determined during detailed design. Marshalling boxes shall be provided in the control building to interface all control cabling from external equipment.

The full extent of Remedial Action Scheme (RAS) modifications will not be determined until detailed design. Additional space shall be available in the control building at 100N-Higgins Mountain to accommodate a single non-redundant RAS panel in case one is determined to be required.

## 2.4 New 138kV Transmission L-6556

### 2.4.1 Basis of Design

The 138kV transmission line (L-6556) from the interconnection substation 100N-Higgins Mountain to 101N-Higgins Mountain substation shall be 138kV wood pole H-Frame construction as per NSPI standard design. The total length of line is approximately 4 kms. The primary conductor shall be 556 ACSR Dove with a thermal rating of 100 deg C. Two overhead shield wires will be installed, one with embedded fibres for telecommunications. The proposed routing for L-6556 has been provided in Appendix K.

NSPI's base line requirements for site specific wind, ice and temperature weather data shall be compared with CSA Standards and the critical value will be used in the design.

The Interconnection Customer is required to provide NSPI with easement and access rights for the transmission line right of way and is responsible for obtaining all necessary construction permits.

### 2.4.2 Environmental

All land restrictions, environmental conditions, and construction activities shall comply with NSPI procedures, all existing laws and regulations, and any environmental assessment requirements.

## 2.5 Customer Terminal Station: 101N-Higgins Mountain Wind

The Higgins Mountain Wind terminal substation does not meet the NPCC Bulk Power System criteria so redundant and physically separated protection, control, and communications are not required at this site. However, the substation shall be designed and constructed to meet NERC BES criteria.

### 2.5.1 Terminal Station One-Line

A Basic One Line diagram of the Interconnection Customer's substation 101N-Higgins Mountain Wind substation, as provided by the Interconnection Customer, is included in Appendix I. The Interconnection Customer's substation is configured with dual 138kV-34.5kV transformers each equipped with a 138kV high side breaker. Four 34.5kV collector circuits will be utilized to connect the 100.3MW Wind Farm.

### 2.5.2 Layout, Civil Work, and Structures

The substation layout shall be designed by the Interconnection Customer and configured as per the one line provided in Appendix I. The new 138kV transmission line L-6556 will terminate on the substation dead-end structure provided by the IC at 101N-Higgins Mountain Wind substation.

All design, procurement, and construction activities on the IC's side of the PCO shall be the responsibility of the IC including the 138kV-34.5 kV transformers and 34.5kV collector system except for the NSPI protection, communications, and control equipment required at this site.

### 2.5.3 Protection and Control Assets at 101N–Higgins Mtn Wind

At 101N, 138 kV protection will consist of redundant primary and secondary protection schemes.

The Interconnection Customer shall provide space and unrestricted access in the Interconnection Customer's substation control building for NSPI's protection, communications, and control equipment.

NSPI will require space and access for an RTU, communication panel, and a line current differential protection panel. NSPI will own, supply, and install this protection and control equipment.

Estimated costs associated with these protection, control, and communication assets are included in the Non-Stand-Alone Network Upgrade cost estimate.

#### 2.5.3.1 138 kV Line Protection

- The primary scheme line protection relay shall be SEL-411L, using the 87L line current differential element for high-speed tripping and step distance elements for backup tripping.
- Primary protection shall trip the 138 kV breaker via Trip Coil #1.
- The secondary scheme line protection relay shall be GE L90, using the 87L line current differential element for high-speed tripping and step distance elements for backup tripping.
- Secondary protection shall trip the 138 kV breaker via Trip Coil #2.
- AC potentials for the primary and secondary protection schemes shall be supplied from separate secondary windings in the line Potential Transformers (PTs).
- AC currents for the primary and secondary protection schemes shall be supplied from separate Current Transformer (CT) cores.

#### 2.5.3.2 Breaker Failure

- Breaker failure protection shall be provided for the 138 kV circuit breakers.
- Breaker Failure Initiate (BFI) must not be latched in the design. Breaker failure timer shall only run for (Trip active) AND (Breaker current above minimum pickup). The trip input to the BFI logic shall not be subject to a minimum trip duration.
- Transfer tripping via NSPI-supplied high speed tele-protection channels to the remote end of line L-6556 shall be required for breaker failure.

#### 2.5.3.3 Reclosing and Synchronizing

- If included in the design, automatic reclosing of the 138 kV breakers shall be initiated by both the primary and secondary 138 kV line protection schemes.
- The reclosing function shall have a single OFF/ON control for each breaker.
- Automatic reclosing, if enabled, shall only occur with a live line/dead bus condition with the additional requirement of an open breaker or switch between the 138 kV line breaker and the collector circuits.

2.5.3.4 DC Supply for Protection

The Interconnection Customer shall provide dedicated 125 Vdc circuits and conduits (if required) from the Interconnection Customer's substation DC distribution panel to supply the NSPI owned protection and control equipment panels.

Primary and secondary protection schemes shall be supplied by separate DC breakers from the DC distribution panel.

2.5.3.5 Station Control and Communications

- Communication to Supervisory Control and Data Acquisition (SCADA) master will use DNP3 protocol over a serial channel.
- Communication between the substation RTU and the wind farm control system will be via DNP3 protocol over a serial channel.
- Communication between the substation RTU and the Substation Automation System (SAS) will be via DNP3 protocol over a serial channel.
- Sequence of Events Recording (SER) and Fault Recording (FR) functions shall be included in the station design to assist operational investigations.
- SER and FR functions shall meet the requirements of NERC Reliability standard PRC-002.
- A non-redundant satellite clock shall be provided.
- A time signal shall be distributed to each measuring relay using either Precision Time Protocol (PTP) (IEEE 1588-2008 or later) or IRIG-B time code over 50 ohm coaxial cable.
- Each protective relay shall assert an alarm to the SER in the event of a loss of satellite clock signal.
- If PTP is used, then Ethernet switches shall be capable of supporting PTP with the C37.238-2017 power system profile.
- If the Interconnection Customer's design at 101N includes a non-redundant Substation Automation System (SAS), then this may also act as the substation RTU, reducing the NSPI panel space requirement.
- In the event of a failure of the Substation Automation System (SAS), local manual operation of the breakers shall be available from inside the control building.

2.5.3.6 Station Alarms (101N)

The following substation alarms will be provided to the local Sequence of Events Recorder (SER) and SCADA (unless otherwise noted):

1. Urgent (SCADA) time delayed & initiated by following SER points:
   - Station Service Failed
   - Battery(s) Volts Low
   - Battery Charger(s) Failed
   - Protection and Control Relay/DC Failed
   - Protection AC Potential Failed
   - Line L-6556 A Tele-protection Channels Failed
   - Line L-6556 B Tele-protection Channels Failed
   - Fire Alarm Operated
   - Building High Temperature
   - Building Low Temperature
2. Non-Urgent (Scada) time delayed & initiated by following SER points:

- Alternate Station Service Failed
- Station Service Auto Transfer Operated
- DC Supply(s) Grounded
- Relay Time Sync Failed

3. Transfer Trip Received (Scada) initiated by following SER points:
   - Line L-6556 #1 Transfer Trip From 100N Received
   - Line L-6556 #2 Transfer Trip From 100N Received
4. Line L-6556 Primary Protection Operated (SER only)
5. Line L-6556 Secondary Protection Operated (SER only)
6. Local Control (Scada) initiated by following SER point:
   - Breaker 601 Control Local
7. Breaker 601 Closed
8. Breaker 601 Urgent (Scada) initiated by following SER points:
   - Breaker 601 SF6 Density Low
   - Breaker 601 Motor Overload*
   - Breaker 601 Trip Circuit #1 Failed
   - Breaker 601 Trip Circuit #2 Failed
9. Breaker 601 Control Lockout (Scada) initiated by following SER point:
   - Breaker 601 SF6 Control Blocked
10. Breaker 601 Auto-reclose Off (Scada) initiated by following SER point:
    - Breaker 601 Auto-reclose Off
11. Breaker Backup Lockout (Scada) initiated by following SER points:
    - Breaker 601 BBU Lockout Operated
12. Breaker 601 BBU Initiated & Early Trip Operated (SER) only
13. Substation Entry

*Note: These alarms may differ depending on the manufacturer of the breakers purchased.

### 2.5.4 Station Service

The Interconnection Customer shall provide dedicated 120V AC and 125V DC circuits from Interconnection Customer's substation building AC distribution and DC distribution panels to supply the NSPI owned protection and control panels.

### 2.5.5 Supervisory Control and Data Acquisition / Remote Terminal Unit

The anticipated Supervisory Control and Data Acquisition (SCADA) points required at 101N are listed in Appendix J. Please note that the final list of SCADA points will be confirmed during detailed design.

At 101N-Higgins Mountain Wind substation, the Remote Terminal Unit (RTU) will be installed in a common panel with the communications equipment as described in section 2.5.3. The RTU will come with a 48V backup battery and charger. NSPI will own, supply, and install the RTU. A dedicated 120V AC station service supply will be required to be supplied by the Interconnection Customer to supply the battery charger.

### 2.5.6 Tele-Communications

An Optical Ground Wire (OPGW) shall be installed as part of the new transmission line L-6556 from 100N-Higgins Mountain to 101N-Higgins Mountain Wind to provide a communications path for telecontrol and protection. The communications equipment will be in a common panel with the RTU as described in section 2.5.3.

NSPI will own, supply, and install the fibre optic terminations and associated communications equipment.

### 2.5.7 Revenue Metering

Revenue metering shall be installed at 101N as detailed in section 2.8. The Interconnection Customer will supply the 138kV revenue class current and voltage transformers, supporting structures, test switch, and meter base. The supply and installation of revenue metering equipment is considered part of the Interconnection Customers' Terminal Station and is not included in the cost estimates in this Facilities Study.

### 2.5.8 Canadian Electrical Code

The customer owned substation 101N-Higgins Mountain Wind shall be designed and constructed to comply with Canadian Electrical Code requirements.

## 2.6 Remedial Action Scheme (RAS) Modifications

NSPI utilize special protection schemes or Remedial Action Schemes (RAS) to manage system power flow conditions.

- Modifications will be required to the NS Import Monitor RAS logic at the 67N-Onslow 345 kV substation (to be determined during detailed design).
- At a minimum, transfer trip signals from 67N-Onslow 345 kV will be sent via high-speed tele-protection channels to 100N-Higgins Mountain, to trip breakers there.
- The full extent of Remedial Action Scheme (RAS) modifications will not be determined until detailed design.

Estimated costs associated with the RAS modifications are included in the Non-Stand-Alone Network Upgrade cost estimate.

## 2.7 Remote Terminal Protection Modifications

The A and B line protection relays for L-6613 at 1N-Onslow and for L-6555 at 74N-Springhill will be replaced to match the relays to be installed at 100N-Higgins Mountain. Estimated costs associated with these protection modifications are included in the Non-Stand-Alone Network Upgrade cost estimate.

## 2.8 Revenue Metering

A 138kV revenue metering system, owned by NSPI, shall be installed at the Interconnection Customer's substation (101N).

138kV revenue class current and voltage transformers will be supplied and installed by the Customer complete with supporting structures, test switch, and meter base as per Nova Scotia Power metering standard STD 5.12 (attached as Appendix H: Revenue Metering).

The revenue metering class potential and current transformers shall not be embedded in any other piece of equipment and shall be certified by Measurement Canada for three element metering. Nova Scotia Power shall provide the technical specifications for the required current and voltage transformers to the Interconnection Customer.

Nova Scotia Power will install the revenue meter at the Interconnection Customer's substation once the commissioning is complete and the system is ready for energization.

## 2.9 Tele-Communications

The 100N-Higgins Mountain substation is designed to accommodate bulk power criteria with fully redundant communication paths.

The 101N-Higgins Mountain Wind is not classified as bulk power and a single communications path is sufficient.

The telecommunications paths for both the 100N-Higgins Mountain substation and the 101N-Higgins Mountain substation will be installed as per the following:

Dual Communications Paths to 100N-Higgins Mountain
Path A: Microwave radio: Higgins Mountain to NSPI Onslow Radio
Path B: Microwave radio: Higgins Mountain to NSPI Noel Lake Radio

Communications Path from 100N-Higgins Mountain to 101N-Higgins Mountain Wind
Path A: Optical Fibre (L-6556): Higgins Mountain to Higgins Mountain Wind

A 40m self-supporting tower will be required at 100N-Higgins Mountain Substation. This tower will accommodate the microwave radio antennae for the Path A system from Higgins Mountain to Onslow and the Path B system from Higgins Mountain to Noel Lake. The radio tower at 100N-Higgins Mountain will be enclosed in its own fenced area near the 100N substation control building.

The new transmission line L-6556 from 100N to 101N will be constructed with an Optical Ground Wire (OPGW) in one of the two shield wires. This will provide the communications path from 100N to 101N.

The costs to install the OPGW in the new L-6556 transmission line are included in the transmission line estimate. All other costs associated with these telecommunication assets are included in the Non-Stand-Alone Upgrade cost estimate.

## 2.10 Stand Alone Upgrades Categorization

In the event NSPI cannot meet the Interconnection Customer's schedule expectation or as agreed in the terms of the Generation Interconnection Agreement (GIA), the Interconnection Customer may take responsibility for design, procurement, and construction activities associated with NSPI owned assets.

These design, procurement, and construction activities are limited to upgrades deemed to be 'Transmission Providers Interconnection Facilities (TPIF)' or 'Stand Alone Network Upgrades' defined as:

> *Transmission Provider's Interconnection Facilities shall mean all facilities and equipment owned, controlled, or operated by the Transmission Provider from the Point of Change of Ownership to the Point of Interconnection as identified in Appendix A to the Standard Generator Interconnection and Operating Agreement, including any modifications, additions or upgrades to such facilities and equipment.*
>
> *Stand Alone Network Upgrades shall be defined as Network Upgrades that the Interconnection Customer may construct without affecting day-to-day operations of the Transmission System during their construction.*

The Higgins Mountain Wind transmission interconnection includes both Network Upgrades and Transmission Provider Interconnection Facilities. Should the Interconnection Customer decide to exercise their 'Option to Build', NSPI have defined the upgrades in terms of what would be considered stand-alone facilities and may be constructed without affecting day-to-day operations of the Transmission System. If the Interconnection Customer exercises their option to build, all facilities must be designed to NSPI Standards and are subject to NSPI review and approval.

### 2.10.1 'Stand-Alone' Network Upgrades and 'Stand-Alone' TPIF

The following scope of work meets the defined criteria for 'Stand Alone' Network Upgrades or Stand-Alone TPIF:

- Stand-Alone Network Upgrade:
  - The interconnection substation (100N-Higgins Mountain) including land acquisition, site preparation, access road, foundations, site grounding, primary equipment, control building, protection and control panels, and all associated devices except for the telecommunications equipment and the microwave radio tower. Note: the land acquisition and access road costs are the responsibility of the IC and not included in the cost estimates.
- Stand-Alone TPIF
  - The transmission line L-6556 from 100N-Higgins Mountain to 101N-Higgins Mountain Wind substation including easement acquisition, access routes, all structures, conductors, shield wires, insulators, and foundations, the optical fibre shield wire, line terminations at both substations, and all potential railway, highway, and water crossings. Note: the easement acquisition and access route costs are the responsibility of the IC and not included in the cost estimates.

The cost estimates for the 'Stand-Alone' Network Upgrades and Transmission Provider Interconnection Facilities have been broken out as separate cost estimates (see Appendix F).

### 2.10.2 Non-Stand-Alone Network Upgrades and Non-Stand-Alone TPIF

Non-stand-alone network upgrades include all other elements of the scope of work not identified as stand-alone upgrades:

- Non-Stand-Alone Network Upgrades
  - The 138kV transmission line tap to existing L-6613 at 100N-Higgins Mountain Substation
  - The remote protection modifications at 1N-Onslow and 74N-Springhill.
  - The modifications to existing Remedial Actions Schemes (RAS).
  - Telecommunications equipment supply and installation at 100N-Higgins Mountain Substation.

- Non-Stand-Alone TPIF
  - The revenue meter, NSPI's L-6556 protection and control equipment, remote terminal unit (RTU), and telecommunications equipment required at 101N-Higgins Mountain Wind substation.

Interfaces and commissioning activities requiring joint collaboration shall be identified during the detailed design phase and prior to construction.

The cost estimates for the 'Non-Stand-Alone' Network Upgrades and TPIF have been broken out as separate cost estimates (see Appendix F).

## 3.0 PERMITS, APPROVALS, AND STANDARDS

The Interconnection Customer is responsible to obtain all permits and approvals required to construct the interconnection substation at 100N-Higgins Mountain and the new transmission line L-6556 from 100N-Higgins Mountain substation to 101N-Higgins Mountain Wind substation.

The Nova Scotia Electrical Inspection Act requires that electrical work be performed under permit. Contractors must take out permits for work at voltage levels below and above 750V – including work on customer owned substations. Plans must be submitted for review and all equipment must be approved by a recognized certification authority (CSA, ULC, etc.).

The customer facilities are subject to the minimum requirements of the latest edition of the Canadian Electrical Code, CSA C22.1, and other applicable CSA standards, for the purpose of electrical inspection. The cost associated with acquiring wiring permits and the associated electrical inspections are the responsibility of the customer. No equipment will be connected or energized without authorization of the electrical inspector.

Where applicable, all NPCC bulk power standards shall be met.

The interconnection substation installation will be subject to the review and approval by Nova Scotia Power to ensure coordination of the Nova Scotia Power and Interconnection Customer's scopes of work.

## 4.0 DESIGN AND CONSTRUCTION

NSPI will be responsible for the design and engineering drawing production for all aspects of the scope of work from the Point of Interconnection to the Point of Change of Ownership unless otherwise specified and agreed in the Generation Interconnection Agreement (GIA). NSPI will also be responsible for the design of any other associated network upgrades or modifications identified in the Study Impact Study.

NSPI will be responsible for the procurement and construction of all aspects of the scope of work from the Point of Interconnection to the Point of Change of Ownership and any associated network upgrades unless otherwise specified in the Generation Interconnection Agreement (GIA).

The Interconnection Customer shall be responsible for the design, procurement, and construction of all facilities on the Interconnection Customer side of the Point of Change of Ownership.

The construction work associated with this interconnection will require planned outages to existing system components. Planned system outages must be coordinated with NSPI System Operations and will be restricted to opportunities when system reliability risks are acceptable.

## 5.0 SCHEDULE MILESTONES

The Interconnection Customer's targeted commercial operation date is September 1, 2025.

A preliminary project schedule outlining major components is provided in Appendix G.

A series of milestone target dates (listed below) were assumed based on optimistic timelines for the purpose of drafting a preliminary schedule for this Facilities Study. Currently, deliveries on some high voltage primary equipment are being quoted by vendors at 24 months. Based on achieving the milestones listed below and the equipment delivery timelines quoted, **the targeted in-service date requested by the Interconnection Customer of Sept. 1, 2025, is not able to be met**. The in-service dates provided in this schedule are based on achieving the progression milestones noted below. Missing any of these milestones increases the risk of not meeting the proposed commercial operation date.

| | |
|---|---|
| Facilities Study Complete | Q4, 2023 |
| Generation Interconnection Agreement Executed | Q4, 2023 |
| Detailed Design Start – Substation 100N (Higgins Mountain) | Q4, 2023 |
| Procurement of Long Lead Items Start | Q4, 2023 |
| Line L-6556 Route Survey Information Provided to NSPI by Interconnection Customer | Q2, 2024 |
| Detailed Design Start – L-6613 Line Tap | Q2, 2024 |
| Detailed Design Start – L-6556 | Q2, 2024 |
| 100N Site Prep Complete, Access Road Complete | Q3, 2024 |
| L-6556 Right of Way Tree Clearing Complete | Q2, 2025 |
| L-6556 Line Construction Start | Q2. 2025 |
| 100N Substation Construction Start | Q2, 2025 |
| Receipt of Long Lead Substation Primary Equipment | **Q4, 2025** |
| 100N Substation Complete | Q2,2026 |
| L-6613 Line Tap Complete<br>(Actual timing to coordinate with earliest line outage available opportunity) | Q2, 2026 |
| Remote Terminal Protection and RAS Modifications Complete | Q2, 2026 |
| Targeted First Power Available (per Interconnection Customer) | Aug. 1, 2025 |
| Estimated Earliest First Power Available (per NSPI) | **Q2, 2026** |
| Targeted Commercial Operation (per Interconnection Customer) | Sept.1, 2025 |
| Estimated Earliest Commercial Operation Date (per NSPI) | **Q2, 2026** |

## 6.0 COST ESTIMATE

The cost estimates have been produced using 2023 budgetary rates. They do not include allowance for funds during construction (AFUDC) or any escalations due to timing of project execution.

The cost estimates are based on the conceptual design outlined in this report and should be considered as a class 3 accuracy level (-20% / +30%).

The cost estimates include project overheads based on NSPI's typical internal capital administration overhead allocation process. A contingency of 10% has been included in the estimates to account for unforeseen scope changes or supply chain issues.

As per Item 11.4 of the GIA, Network Upgrade costs are refundable to the Interconnection Customer pending Nova Scotia Utility and Review Board (NSUARB) approval.

For this Facilities Study the cost estimates have been broken out into four blocks:

1. Network Upgrade: Stand-Alone Interconnection Substation 100N-Higgins Mountain
2. Network Upgrades – Non-Stand-Alone
3. TPIF: Stand-Alone: Transmission Line L-6556
4. TPIF – Non-Stand-Alone

| Upgrade Component | Cost Estimate |
|---|---|
| **Network Upgrades – Stand Alone** | |
| Three Breaker Ring 138kV Interconnection Substation – 100N Higgins Mountain | **$6,585,617** |
| **Network Upgrades – Non-Stand-Alone** | |
| - The 138kV transmission line tap to existing L-6613 at 100N-Higgins Mountain Substation and 2km shield wire addition to L-6613<br>- The remote protection modifications at 1N-Onslow and 74N-Springhill<br>- The modifications to existing Remedial Actions Schemes (RAS)<br>- Telecommunications equipment supply and installation at 100N-Higgins Mountain Substation | **$2,910,557** |
| **Network Upgrades Sub-Total** | **$9,496,174** |
| | |
| **TPIF - Stand-Alone** | |
| 138kV Transmission Line L-6556 (4 kms) | **$2,844,301** |
| **TPIF - Non-Stand-Alone** | |
| - The revenue meter at 101N<br>- NSPI's L-6556 protection and control equipment, remote terminal unit (RTU), and telecommunications equipment required at 101N-Higgins Mountain Wind substation. | **$874,599** |
| **TPIF Sub-Total** | **$3,718,900** |
| | |
| **Total** | **$13,215,074** |
| | |
| Sub-Total (Stand-Alone) | $9,429,918 |
| Sub-Total (Non-Stand-Alone) | $3,785,156 |

A more detailed breakdown of each cost estimate is provided in Appendix F.

## 7.0 COMMISSIONING / OPERATIONS

NS Power reserves the right to inspect all Interconnection Facilities identified in this study prior to connection to the NS Power Transmission System to ensure the facility design and construction will not adversely affect the reliability of the Transmission System. All Interconnection Facilities are subject to NS Power's review and acceptance of all testing and commissioning requirements and results. Construction, switching, testing, and commissioning schedules that affect the reliable and stable operation of the Transmission System shall be coordinated with the Nova Scotia Power System Operator.

L-6613 forms part of the Nova Scotia system interconnection with New Brunswick. Outages to this line can impose limitations on the inter-provincial tie flows. These constraints will require NSPI System Operator actions to minimize risks and maintain system stability. All system outages required to complete the interconnection work shall require advanced planning and coordination with the NS System Operator.

All interconnection facilities must meet NSPI's Transmission System Interconnection Requirements (TSIR), version 1.1 dated February 25, 2021, as published on the NSPI OASIS site.

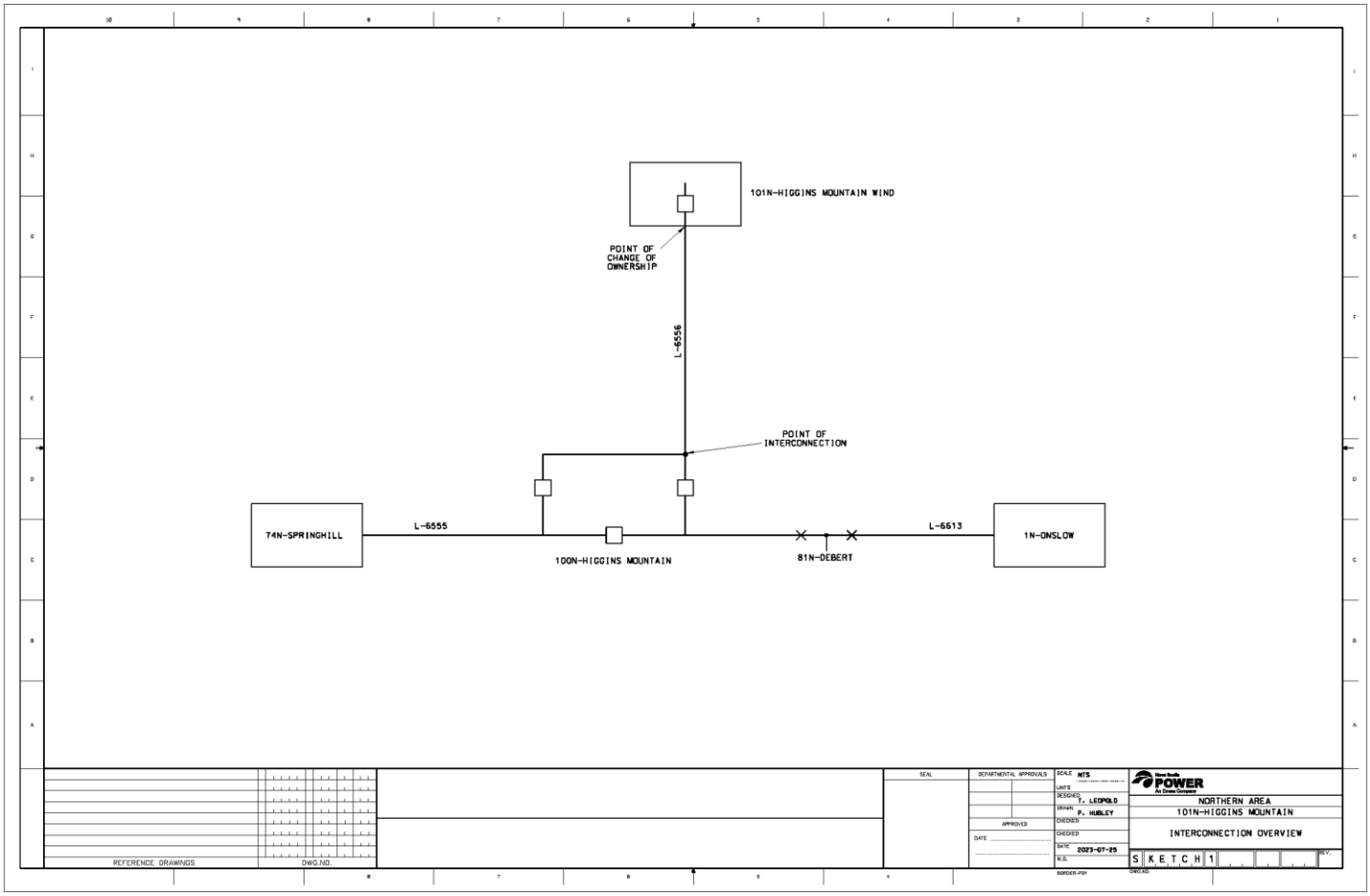
## Appendices

**APPENDIX A – INTERCONNECTION FACILITIES STUDY AGREEMENT**
**APPENDIX B – INTERCONNECTION OVERVIEW**
**APPENDIX C – INTERCONNECTION SUBSTATION DEVELOPMENTAL ONE LINE**
**APPENDIX D – INTERCONNECTION SUBSTATION DEVELOPMENTAL PLAN VIEW**
**APPENDIX E – INTERCONNECTION SUBSTATION LINE TAP CONFIGURATION**
**APPENDIX F – COST ESTIMATE DETAILS**
**APPENDIX G – PRELIMINARY PROJECT SCHEDULE**
**APPENDIX H – REVENUE METERING**
**APPENDIX I – 101N-HIGGINS MOUNTAIN WIND TERMINAL STATION ONE LINE**
**APPENDIX J – 101N-HIGGINS MOUNTAIN WIND SCADA POINTS LIST**
**APPENDIX K – PROPOSED TRANSMISSION LINE ROUTING FOR L-6556**
**APPENDIX L – MINUTES OF FACILITIES STUDY REVIEW MEETING**

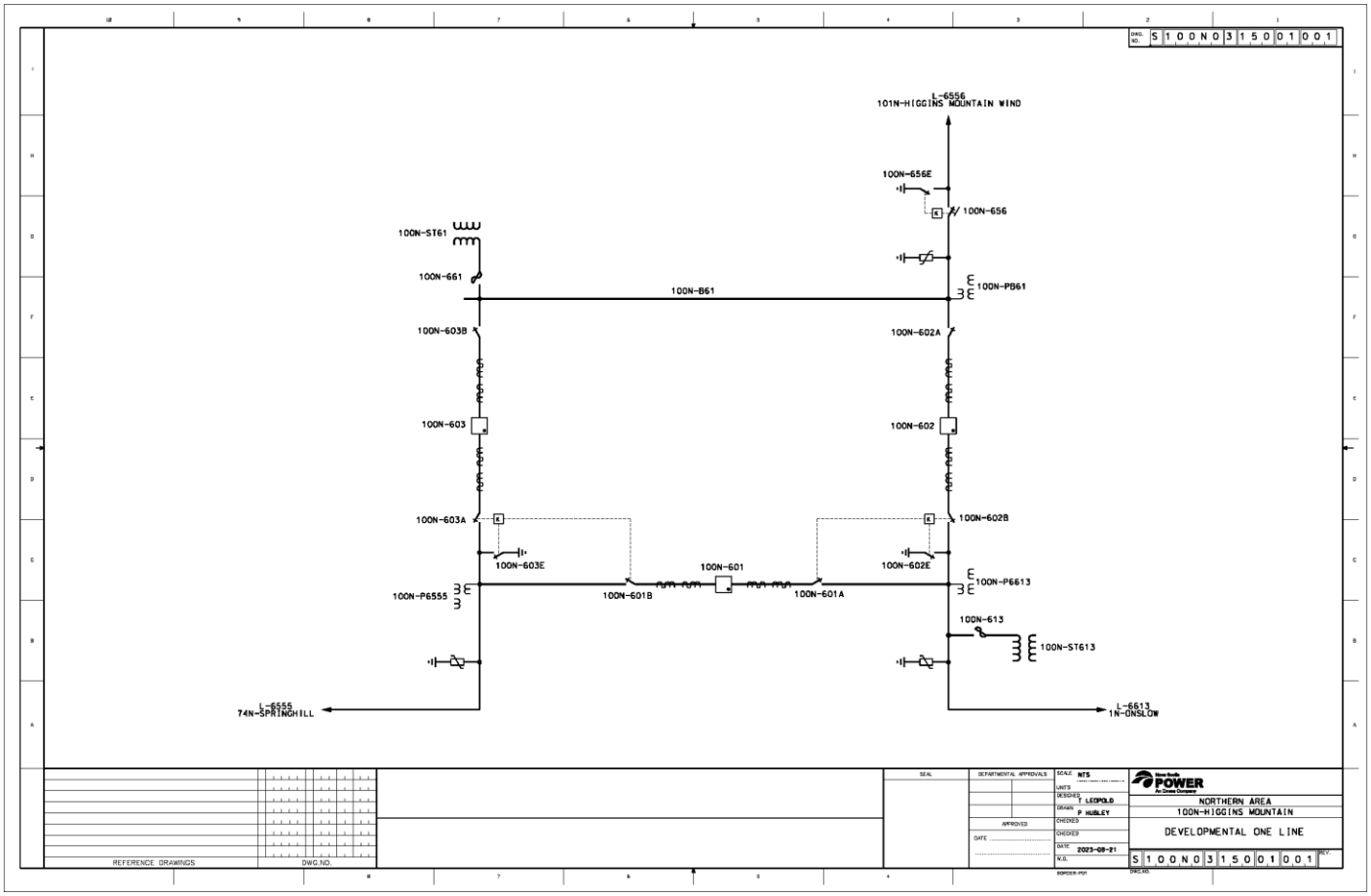
**Appendix A – Interconnection Facilities Study Agreement**

(Attachment 1)

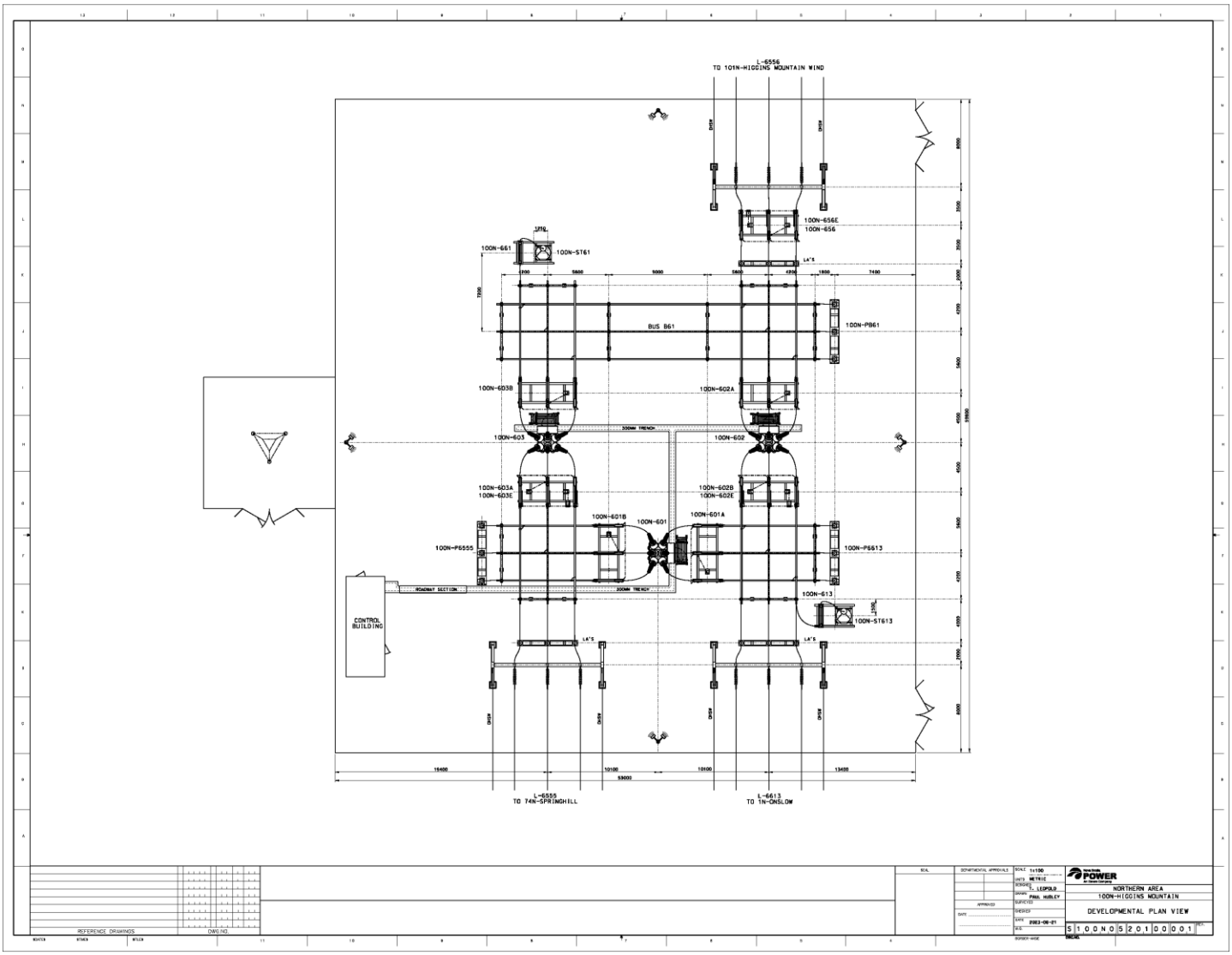
## Appendix B – Interconnection Overview



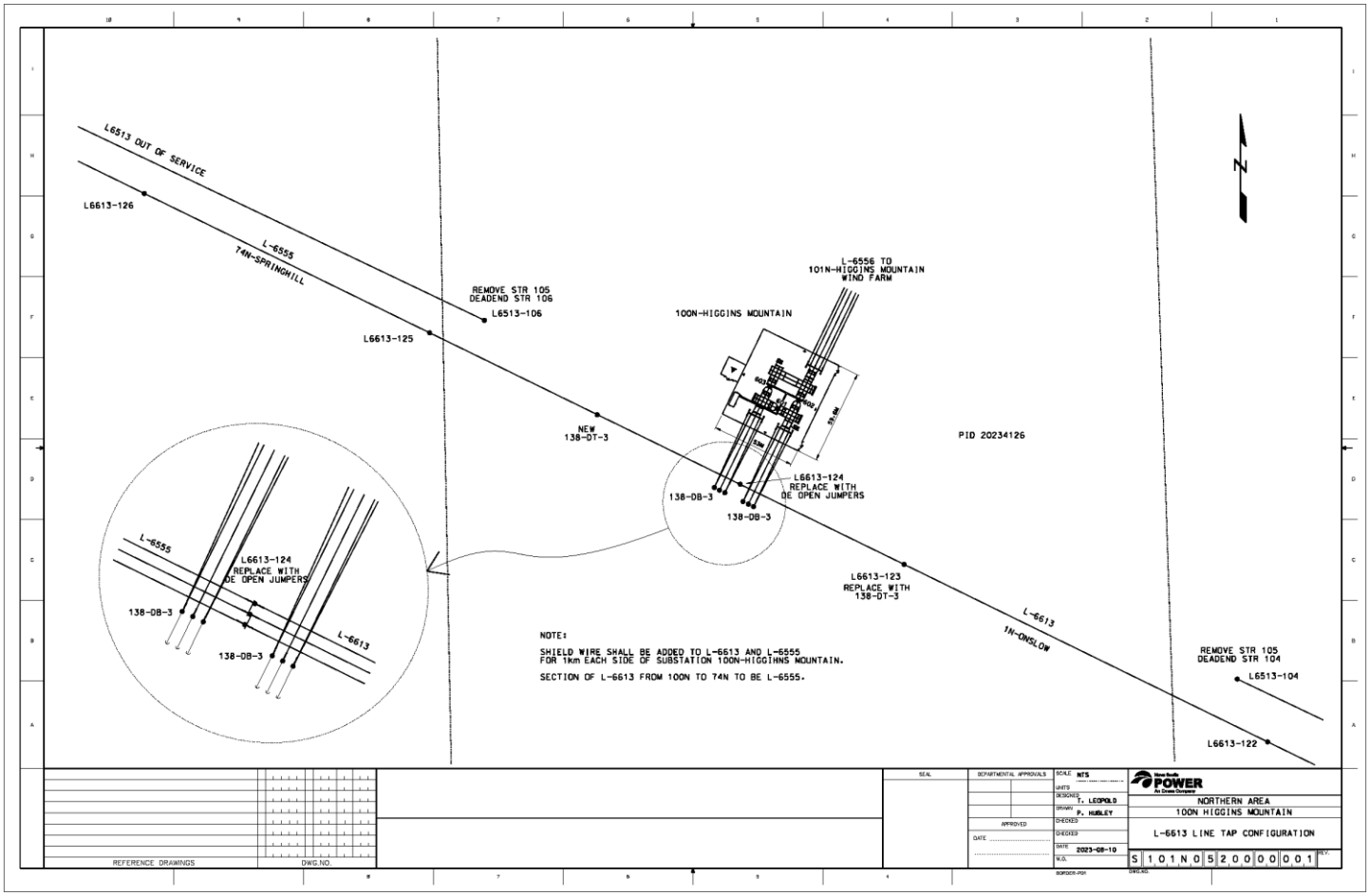
## Appendix C – Interconnection Substation Developmental One Line – 100N Higgins Mountain



## Appendix D – Interconnection Substation Developmental Plan View



## APPENDIX E – INTERCONNECTION SUBSTATION LINE TAP CONFIGURATION



## Appendix F – Cost Estimate Details

### Network Upgrades:

Stand-Alone Network Upgrades: Three Breaker Ring 138kV Interconnection Substation – 100N Higgins Mountain

| IR 669 Higgin's Mountain Interconnection Substation - 100N | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Project Number: | | | | | | | | |
| | | Cost Centre: | | 900 | | | | | | |
| | | Labour | | Material | Expenses | | | Contracts | Consulting | Totals |
| Activity | Accounts --> | 535050 | 535200 | 531400 | 530950 | 533410 | 533400 | 531550 | 532500 | |
| 003 | Buildings, Structures and Grounds | 0 | 0 | 335,000 | 0 | 0 | 0 | 1,684,850 | | 2,019,850 |
| 022 | Electrical Control Equipment | 61,880 | 0 | 1,017,200 | 0 | 0 | 2,500 | 120,000 | | 1,201,580 |
| 043 | Substation Devices | 141,807 | 0 | 1,035,960 | 0 | 0 | 5,000 | 38,000 | | 1,220,767 |
| 085 | Design (i.e. Engineering) | 212,084 | | 10,000 | 2,220 | | 2,500 | 0 | 108,000 | 334,804 |
| 086 | Commissioning | 83,331 | 10,313 | 0 | 0 | 1,500 | 0 | 0 | | 95,144 |
| 087 | Field Supervision and Operations | 10,927 | 0 | 0 | 29,850 | | 5,000 | 150,000 | | 195,777 |
| | **Sub-Total** | **510,028** | **10,313** | **2,398,160** | **32,070** | **1,500** | **15,000** | **1,992,850** | **108,000** | **5,067,922** |
| 085 | Contingency | 51,003 | 1,031 | 239,816 | 3,207 | 150 | 1,500 | 199,285 | 10,800 | 506,792 |
| | **Sub-Total** | **561,031** | **11,345** | **2,637,976** | **35,277** | **1,650** | **16,500** | **2,192,135** | **118,800** | **5,574,714** |
| 005 | Vehicle Allocation (Labour & Eng'g) | | | | 211,174 | | | | | 211,174 |
| 005 | Construction Overhead (Labour) | | | | | | | 419,845 | | 419,845 |
| 005 | Construction Overhead (Contracts) | | | | | | | 379,884 | | 379,884 |
| | **Sub-Total** | | | | **211,174** | | | **799,729** | | 1,010,903 |
| | **Totals** | **561,031** | **11,345** | **2,637,976** | **246,451** | **1,650** | **16,500** | **2,991,864** | **118,800** | **6,585,617** |

Non-Stand-Alone Network Upgrades

- The 138kV transmission line tap to existing L-6613 at 100N-Higgins Mountain Substation and 2km shield wire addition to L-6613
- The remote protection modifications at 1N-Onslow and 74N-Springhill
- The modifications to existing Remedial Actions Schemes (RAS)
- Telecommunications equipment supply and installation at 100N-Higgins Mountain Substation

| IR 669 Higgin's Mtn Facilities Study<br>- Non-Stand-Alone Network Upgrades:<br>L-6613 Line Tap, RAS Mods.,Telecomm, Remote Prot. Mods. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Project Number: | | | | | | | | |
| | | Cost Centre: | | 900 | | | | | | |
| | | Labour | | Material | Expenses | | | Contracts | Consulting | Totals |
| Activity | Accounts --> | 535050 | 535200 | 531400 | 530950 | 533410 | 533400 | 531550 | 532500 | |
| 022 | Electrical Control Equipment | 18,048 | 5,157 | 80,000 | 0 | 0 | 1,250 | 0 | | 104,455 |
| 035 | Wood Poles | 5,018 | 0 | 350,000 | 0 | 0 | 0 | 750,000 | | 1,105,018 |
| 061 | Telephone Equipment ( / Comm Equip.) | 30,940 | 20,627 | 376,500 | 0 | 0 | 0 | 210,000 | | 638,066 |
| 085 | Design (i.e. Engineering) | 179,607 | | 5,000 | 1,850 | | 1,000 | 0 | 20,000 | 207,457 |
| 086 | Commissioning | 15,470 | 3,094 | 0 | 3,000 | 0 | 0 | 0 | | 21,564 |
| 087 | Field Supervision and Operations | 13,658 | 0 | 0 | 2,220 | | 1,500 | 80,000 | | 97,378 |
| | **Sub-Total** | **262,741** | **28,877** | **811,500** | **4,850** | **0** | **2,250** | **1,040,000** | **20,000** | **2,170,218** |
| 085 | Contingency | 26,274 | 2,888 | 81,150 | 485 | 0 | 225 | 104,000 | 2,000 | 217,022 |
| | **Sub-Total** | **289,015** | **31,765** | **892,650** | **5,335** | **0** | **2,475** | **1,144,000** | **22,000** | **2,387,240** |
| 005 | Vehicle Allocation (Labour & Eng'g) | | | | 108,786 | | | | | 108,786 |
| 005 | Construction Overhead (Labour) | | | | | | | 216,283 | | 216,283 |
| 005 | Construction Overhead (Contracts) | | | | | | | 198,248 | | 198,248 |
| | **Sub-Total** | | | | **108,786** | | | **414,531** | | **523,317** |
| | **Grand Total** | **289,015** | **31,765** | **892,650** | **114,121** | **0** | **2,475** | **1,558,531** | **22,000** | **2,910,557** |

## Transmission Provider Interconnection Facilities:

Stand Alone Transmission Provider Interconnection Facilities: 4km 138kV Tap Line L-6556

| IR 669 Higgin's Mtn Facilities Study - Stand-Alone TPIF: Transmission Line L-6556 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Project Number: | | | | | | | | |
| | | Cost Centre: | | 900 | | | | | | |
| | | Labour | | Material | Expenses | | | Contracts | Consulting | Totals |
| Activity | Accounts --> | 535050 | 535200 | 531400 | 530950 | 533410 | 533400 | 531550 | 532500 | |
| 035 | Wood Poles | 5,018 | 0 | 900,000 | 0 | 0 | 0 | 1,100,000 | | 2,005,018 |
| 085 | Design (i.e. Engineering) | 29,454 | | 5,000 | 1,850 | | 1,000 | 0 | 150,000 | 187,304 |
| 087 | Field Supervision and Operations | 10,927 | 0 | 0 | 2,960 | | 2,500 | 60,000 | | 76,387 |
| 088 | Survey and Mapping | 0 | | 0 | 0 | | 0 | 60,000 | 0 | 60,000 |
| | **Sub-Total** | **45,398** | **0** | **905,000** | **1,850** | **0** | **1,000** | **1,220,000** | **150,000** | **2,323,248** |
| 085 | Contingency | 4,540 | 0 | 90,500 | 185 | 0 | 100 | 122,000 | 15,000 | 232,325 |
| | **Sub-Total** | **49,938** | **0** | **995,500** | **2,035** | **0** | **1,100** | **1,342,000** | **165,000** | **2,555,573** |
| 005 | Vehicle Allocation (Labour & Eng'g) | | | | 18,797 | | | | | 18,797 |
| 005 | Construction Overhead (Labour) | | | | | | | 37,371 | | 37,371 |
| 005 | Construction Overhead (Contracts) | | | | | | | 232,560 | | 232,560 |
| | **Sub-Total** | | | | **18,797** | | | **269,931** | | **288,728** |
| | **Grand Total** | **49,938** | **0** | **995,500** | **20,832** | **0** | **1,100** | **1,611,931** | **165,000** | **2,844,301** |

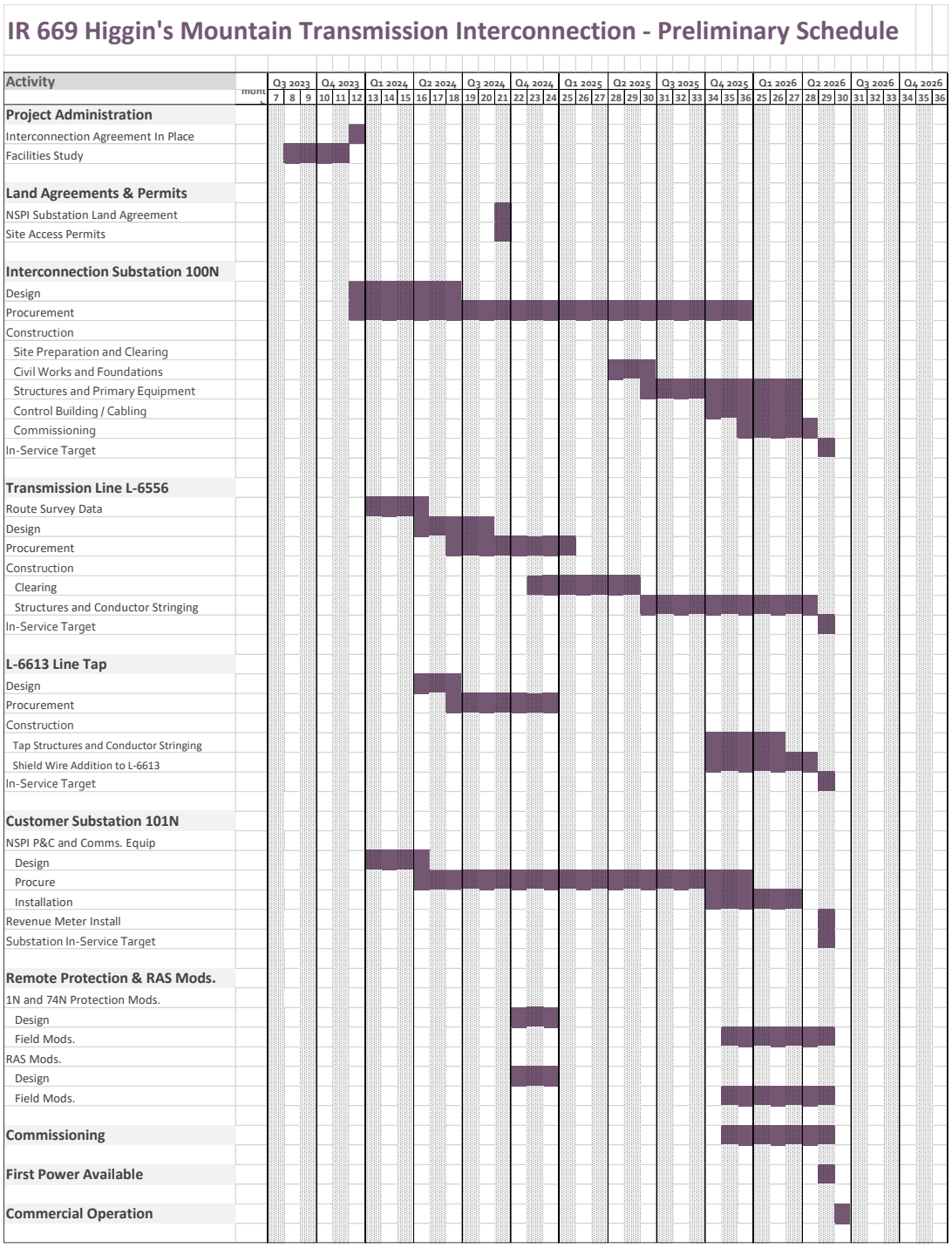
Non-Stand-Alone Transmission Provider Interconnection Facilities

- The revenue meter at 101N
- NSPI's L-6556 protection and control equipment, remote terminal unit (RTU), and telecommunications equipment required at 101N-Higgins Mountain Wind substation.

| IR-669 Higgins Mountain Non Stand Alone - TPIF | | CI Number: | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Project Number: | | | | | | | | |
| | | Cost Centre: | | 900 | | | | | | |
| | | Labour | | Material | Expenses | | | Contracts | Consulting | Totals |
| Activity | Accounts --> | 535050 | 535200 | 531400 | 530950 | 533410 | 533400 | 531550 | 532500 | |
| 022 | Electrical Control Equipment | 15,470 | 0 | 109,000 | 0 | 0 | 0 | 20,000 | | 144,470 |
| 061 | Telephone Equipment ( / Comm Equip.) | 15,470 | 2,063 | 213,000 | 450 | 0 | 500 | 100,000 | | 331,483 |
| 085 | Design (i.e. Engineering) | 82,783 | | 0 | 555 | | 0 | 0 | 12,000 | 95,338 |
| 086 | Commissioning | 10,313 | 0 | 0 | 1,500 | 0 | 0 | 0 | | 11,813 |
| 087 | Field Supervision and Operations | 10,927 | 0 | 0 | 0 | | 0 | 20,000 | | 30,927 |
| 088 | Survey and Mapping | 0 | | 0 | 0 | | 0 | 0 | 5,000 | 5,000 |
| | **Sub-Total** | **134,962** | **2,063** | **322,000** | **2,505** | **0** | **500** | **140,000** | **17,000** | **619,030** |
| 085 | Contingency | 13,496 | 206 | 32,200 | 251 | 0 | 50 | 14,000 | 1,700 | 61,903 |
| | **Sub-Total** | **148,459** | **2,269** | **354,200** | **2,756** | **0** | **550** | **154,000** | **18,700** | **680,933** |
| 005 | Vehicle Allocation (Labour & Eng'g) | | | | 55,880 | | | | | 55,880 |
| 005 | Construction Overhead (Labour) | | | | | | | 111,098 | | 111,098 |
| 005 | Construction Overhead (Contracts) | | | | | | | 26,687 | | 26,687 |
| | **Totals** | **148,459** | **2,269** | **354,200** | **58,636** | **0** | **550** | **291,786** | **18,700** | **874,599** |

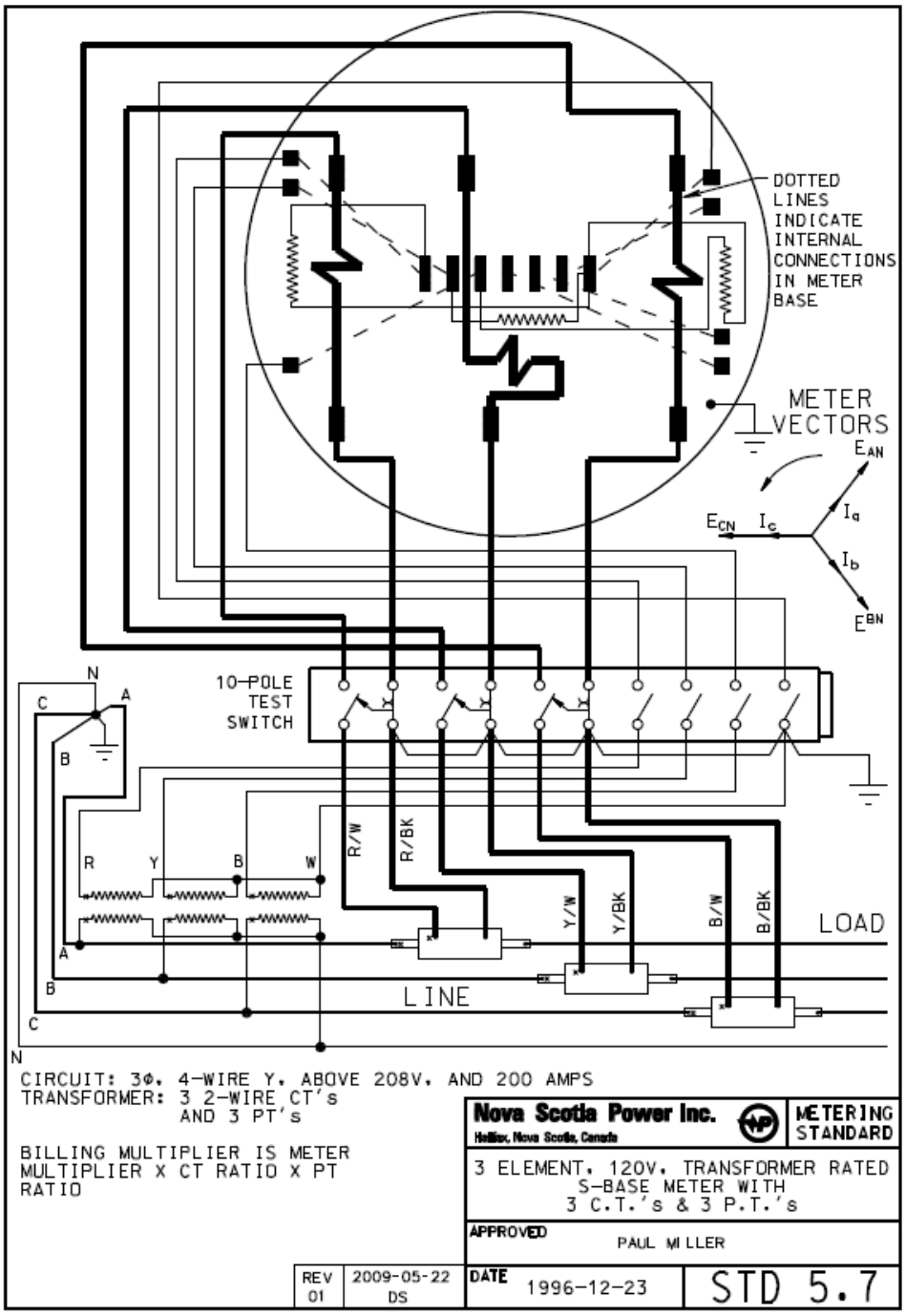
## APPENDIX G – PRELIMINARY PROJECT SCHEDULE

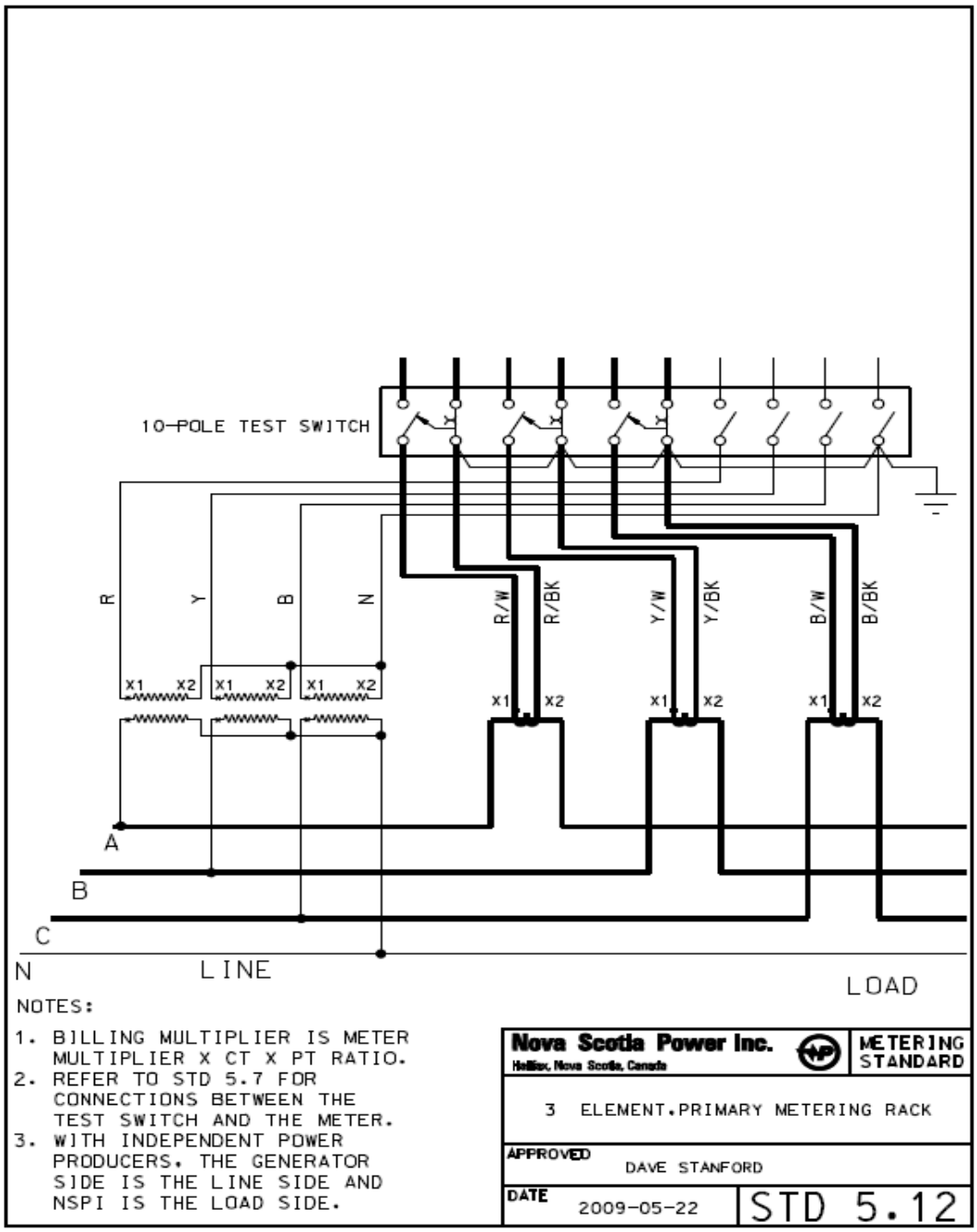
*Note: Primary Equipment supply chain volatility may introduce significant and unpredictable procurement timelines to the overall project schedule.*



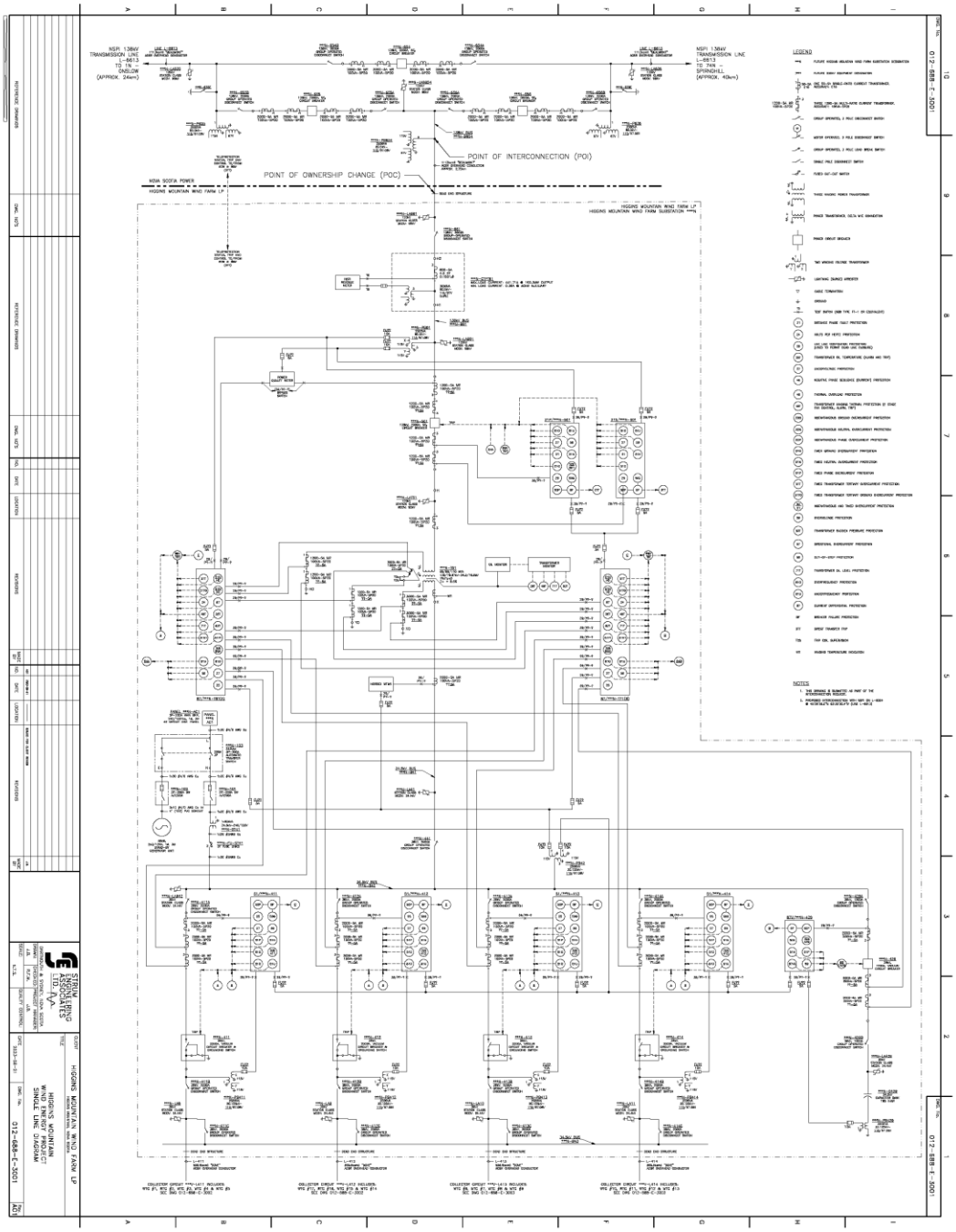
## Appendix H – Revenue Metering

NSPI Standards 5.7 and 5.12




10-POLE TEST SWITCH
R
Y
B
N
R/W
R/BK
Y/W
Y/BK
B/W
B/BK
X1
X2
A
B
C
N
LINE
LOAD
NOTES:
1. BILLING MULTIPLIER IS METER MULTIPLIER X CT X PT RATIO.
2. REFER TO STD 5.7 FOR CONNECTIONS BETWEEN THE TEST SWITCH AND THE METER.
3. WITH INDEPENDENT POWER PRODUCERS, THE GENERATOR SIDE IS THE LINE SIDE AND NSPI IS THE LOAD SIDE.
Nova Scotia Power Inc.
Halifax, Nova Scotia, Canada
METERING STANDARD
3 ELEMENT.PRIMARY METERING RACK
APPROVED
DAVE STANFORD
DATE
2009-05-22
STD 5.12

## Appendix I – 101N-Higgins Mountain Wind Terminal Station One Line

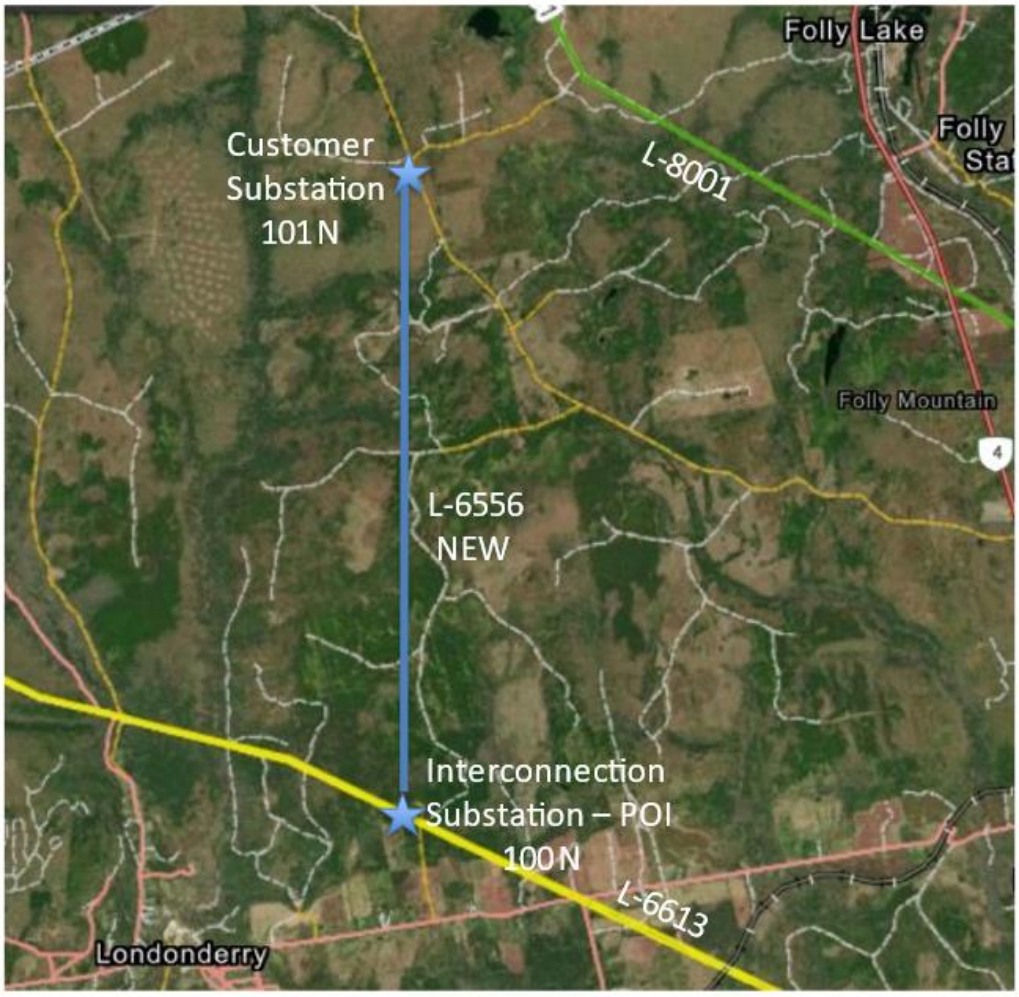


## Appendix J – 101N-Higgins Mountain Wind SCADA Points List

Note: The SCADA Points listed are preliminary and may change during final design.

| 101N - Higgins Mountain Wind SCADA Points | | |
|---|---|---|
| Control | **Binary Outputs** | **Destination** |
| | PERMIT TO OPERATE DENIED | Comms to WFC |
| | PERMIT TO OPERATE 33% | Comms to WFC |
| | PERMIT TO OPERATE 66% | Comms to WFC |
| | PERMIT TO OPERATE FULL | Comms to WFC |
| | Control Circuit Breaker 101N-601 | Hard-wired |
| | | |
| | **Analogue Outputs** | |
| | Active Power Setpoint | Comms to WFC |
| | Voltage Setpoint | Comms to WFC |
| | | |
| Status | **Binary Inputs** | **Source** |
| | Status of PERMIT TO OPERATE DENIED | Comms from WFC |
| | Status of PERMIT TO OPERATE 33% | Comms from WFC |
| | Status of PERMIT TO OPERATE 66% | Comms from WFC |
| | Status of PERMIT TO OPERATE FULL | Comms from WFC |
| | L-6556 #1 Transfer Trip Received | Hard-wired |
| | L-6556 #2 Transfer Trip Received | Hard-wired |
| | Status of circuit breaker 101N-601 | Hard-wired |
| | Circuit Breaker 601 Control Blocked | Hard-wired |
| | Status of Collector Circuit Breaker 411 | Hard-wired |
| | Status of Collector Circuit Breaker 412 | Hard-wired |
| | Status of Collector Circuit Breaker 413 | Hard-wired |
| | Status of Collector Circuit Breaker 414 | Hard-wired |
| | Circuit Breaker 601 URGENT | Hard-wired |
| | LOCAL CONTROL (101N-601) | Hard-wired |
| | Circuit Breaker 601 Auto-Reclose Off | Hard-wired |
| | Circuit Breaker 601 Breaker Back-up Lockout Operate | Hard-wired |
| | TELEPROTECTION URGENT | Comms from SEL relay |
| | ISLANDING INTERTRIP | Comms from SEL relay |
| | URGENT | Hard-wired |
| | NON-URGENT | Hard-wired |
| | SUBSTATION ENTRY (if NSPI have a separate room/entrance) | Hard-wired |
| | PROTECTION/DC FAIL | Hard-wired |
| | | |
| Analogs | **Analog Inputs** | |
| | 101N Net Watts | Comms from XFMR protection, or revenue meter |
| | 101N Net Vars | Comms from XFMR protection, or revenue meter |
| | 101N Volts | Comms from XFMR protection, or revenue meter |
| | Wind speed | Comms from WFC |
| | Wind direction | Comms from WFC |
| | Ambient Temperature | Comms from WFC |
| | Active Power Setpoint confirmation | Comms from WFC |
| | Expected Wind Output for AGC | Comms from WFC |

**Appendix K - Proposed Transmission Line Routing for L-6556**



## Appendix L – Minutes of Facilities Study Review Meeting

Notes: Meeting notes sent to IC on November 07th 2023

- Attendees:
- Introductions
- Review of questions provided by the Interconnection Customer (IC) on the draft Facilities Study (FAC):- Schedule // Own Forces
- o With NSPI's in service date not able to meet IR 669's target in-service date, we would like to explore completing all scopes possible under our own forces (contracting out these scopes of work). Let's discuss 2.10 in detail.
  o This option would apply to Stand Alone upgrades only and can be agreed to in the GIA.

- TPIF (Tap Line) – We would look to engineer, procure and construct this transmission line in accordance with NSPI requirements. We would look to a company like CAUS or similar to support this scope from design to final build.
- o We will need to understand the working interface between NSPI and Customer, have a clear delineation for who is responsible for what materials and procurement, and confidence that NSPI will meet our support requirements from both a bandwidth and supply perspective.
  NSPI will provide a Basis Of Design that includes specifications, standards, and NSPI review requirements. Contract design must be performed by a consultant on NSPI's pre-approved list.

- o 3-Breaker Ring Bus (/IC Substation) – We would look to engineer, procure and construct the 3-breaker ring bus in accordance with NSPI requirements. We would look to Strum Engineering to design the 3-breaker ring bus and work closely with a company like CAUS to procure and build.
- o We will need to understand the working interface between NSPI and Customer, have a clear delineation for who is responsible for what materials and procurement, and confidence that NSPI will meet our support requirements from both a bandwidth and supply perspective.
- NSPI are familiar with Strum's capability to design the substation and would have no concerns. Full scope delineation would be defined in the GIA. Typically, if the IC takes responsibility for the substation than they are responsible for procurement of all equipment, material, and contracts although all must conform with NSP's standards and specifications as well as NSP review.

- - Long-Lead Substation Procurement
- o Customer Substation
- ▪ We currently have confirmation from suppliers and expectations that we can meet an early Q3, 2025, installation and be ready for energization with long-lead items.
- ▪ We are holding on turbines being critical path outside of I/C Substation.
- ▪ Where are the IC sourcing the 138kV circuit breaker for this substation?

- o I/C Substation
- ▪ What item(s) is/are driving schedule and are critical path items?
- • Specifications on those components are urgent for Customer to begin to procure.
- • What is the process for deviating from a specific list of manufacturers? Note: Additional options for procurement is best for all moving forward is specifications can be met.
  NSP are currently being quoted 24-month deliveries for 138kV circuit breakers and disconnect switches. These are the primary components driving the schedule. Another item that could also be long delivery but has not yet have been tested in the market would be the turn-key control building. These items are critical path and should be placed on order as soon as possible. NSP are currently looking for alternate breaker suppliers and the possibility of using live tank breakers instead of deadtank but have not yet found a breaker that can be delivered shorter than 24-months. All options must meet NSP's specifications.
- 

- Next steps:GIA in accordance with GIP Section 11