



General Validation Test Program for Wind Power Generating Stations Connected to the Hydro-Québec Transmission System

Module B – Type Tests

April 2026

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PREAMBLE

This document specifies the tests that must be performed to meet the requirements of Module B of the *General Validation Testing Program for Wind Generating Stations Connected to the Hydro-Québec Transmission System*. It also outlines the methods Hydro-Québec considers acceptable for carrying out the tests.

DEFINITIONS

CHIL

control hardware in the loop

HIL

hardware in the loop

PHIL

power hardware in the loop

SIL

software in the loop

power producer

the entity responsible for the wind generation site

1 Purpose of tests

The testing required by Hydro-Québec has two objectives:

1. To demonstrate that the wind generating station meets Hydro-Québec's technical requirements for low-voltage ride-through (LVRT), high-voltage ride-through (HVRT), advanced control modes and severe disturbance response.
2. To validate the numerical models and associated parameters of the wind farm, specifically those submitted by the power producer to Hydro-Québec. To this end, model response shall be compared to behaviour recorded during testing when the final model is submitted to Hydro-Québec during the validation tests of the wind generating station.

To achieve this, Module B requires fault testing on a turbine and the application of undervoltages across its terminals using a grid simulator, a test rig or other method to demonstrate the turbine's LVRT performance.

The tests in this document do not apply to grid-forming technologies. Validation testing for these technologies will be addressed in a procedure tailored to the project and specific to the facility being tested.

Should a wind generating station include a storage system or other combination of technologies, tests in addition to those mentioned herein are required. These will be specified in the detailed validation testing procedure.

Successful completion of the validation testing is a requirement for Hydro-Québec's final acceptance of the interconnection, confirming that the wind farm meets requirements for LVRT performance and disturbance response.

2 Test requirements

The test results must demonstrate that the wind generating station meets the *Technical Requirements for the Connection of Generating Stations to the Hydro-Québec Transmission System* [1]. Test results must also meet supplementary technical requirements for wind generating stations. Note that individual wind turbines are not required to meet these requirements on their own, but their performance will be considered in the overall assessment of the generating station.

3 Test methodology

The tests may be performed in various ways, provided the following conditions are met:

- The proposed testing procedure must be approved by Hydro-Québec prior to its implementation. At a minimum, it must contain all information required to reproduce the tests at a later date, including but not limited to the description and impedance of the simulated grid, switching operation timestamps and the sequence of test steps.
- Hydro-Québec reserves the right to witness the tests or appoint an independent third party to represent it for purposes of certifying the validity of the tests.
- A log of parameters for the wind turbine systems, any controllers and all auxiliary equipment must be provided to Hydro-Québec to describe the wind turbine generator being tested. The technology targeted by the tests must be identical to that installed at the wind generating station.
 - If the wind generating station technology is similar to another technology already validated under this module, a request may be submitted to Hydro-Québec, together with technical justification describing how the already validated technology exhibits the same behaviour as the technology to be installed at the new wind generating station. Hydro-Québec reserves the right to comment on or deny the request if the technical explanation is deemed unsatisfactory.
 - The parameters implemented in the test turbine must be similar to those to be used in the wind farm turbines whose behaviour is validated by the tests.
 - Tests performed on a 50-Hz power source or system may be acceptable. Prior approval must be obtained from Hydro-Québec to ensure the validity of the tests.
 - If the power producer wishes to proceed with testing in conjunction with the manufacturer using CHIL, HIL, PHIL, SIL or other techniques, approval from Hydro-Québec is required.

4 Test descriptions

The tests are conducted on a single wind turbine. The turbine must be isolated from any secondary voltage control systems. For each test, the turbine output must exceed 30% of its rated capacity, unless otherwise recommended by the manufacturer. Two series of tests are carried out, the first at a high short-circuit ratio (SCR > 3) and the second at the lowest SCR the turbine will encounter. The SCR is assessed at the turbine connection point. This value will be provided by Hydro-Québec prior to testing.

4.1 Part 1 – Low-voltage ride-through (LVRT)

The undervoltages in Part 1 are applied at the turbine terminals as balanced three-phase events.

Test	Resulting positive-sequence voltage	Pre-event voltage (regulation point)	Duration
1.1	0.95 p.u.	1.00 p.u.	1 hour
1.2	0.90 p.u.	1.00 p.u.	10 minutes
1.3	0.85 p.u.	1.00 p.u.	30 seconds
1.4	0.75 p.u.	1.00 p.u.	2 seconds

Table 1: Tests for Part 1, Module B

4.2 Part 2 – Faults

Test	Fault type	Faulted phase voltage	Pre-event voltage (regulation point)	Duration
2.1	Three-phase	0.00 p.u.	1.00 p.u.	9 cycles
2.2	Phase-to-phase	0.00 p.u.	1.00 p.u.	9 cycles
2.3	Phase-to-phase-to-ground	0.00 p.u.	1.00 p.u.	9 cycles
2.4	Single-phase	0.00 p.u.	1.00 p.u.	9 cycles
2.5	Single-phase or phase-to-phase depending on configuration ¹	0.00 p.u.	1.00 p.u.	18 cycles
2.5	Three-phase with impedance	0.25 p.u.	1.00 p.u.	45 cycles
2.6	Phase-to-phase-to-ground with impedance	0.50 p.u.	1.00 p.u.	45 cycles
2.7	Phase-to-phase with impedance	0.60 p.u.	1.00 p.u.	45 cycles
2.8	Single-phase with impedance	0.70 p.u.	1.00 p.u.	45 cycles

Table 2: Tests for Part 2, Module B

1. Depending on the configuration of the windings of the wind farm transformers. The purpose is to simulate a sustained single-phase fault on the transmission system as seen from the wind turbine.

5 Recordings

The following signals are to be recorded:

- Three-phase voltages on the low-voltage side of the turbine transformer. For technologies with different voltage levels at the stator and the converter, the three-phase voltages for both are required.
- Three-phase currents on the low-voltage side of the turbine transformer. For technologies with different current levels at the stator and the converter, the three-phase currents for both are required.
- Three-phase voltages on the medium-voltage side of the turbine transformer
- Three-phase currents on the medium-voltage side of the turbine transformer
- Rotor speed of the turbine tested

6 Reference

- [1] *Technical Requirements for the Connection of Generating Stations to the Hydro-Québec Transmission System*, Decision D-2022-088 – effective July 15, 2022. Online at the Hydro-Québec public website. https://www.hydroquebec.com/data/transenergie/pdf/Exigences_raccordement_centrales_ang_2022-07-15.pdf