The Hydro Québec De-icer Project at Lévis Substation

Presenter
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Background
Why a de-icer?

In December 1998, the Québec region of Canada was hit by one of the worst ice-storms in recorded history.

The ice storm generated ice build-up as much as 75mm.

An accumulation of ice toppled hydro towers and downed hundreds of kilometres of high-voltage transmission lines.
De-icer: Location

Québec city

De-icer at Lévis Substation
## Lines for de-icing

<table>
<thead>
<tr>
<th>Line</th>
<th>Destination</th>
<th>Length</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>7010</td>
<td>Laurentides</td>
<td>27km</td>
<td>735 kV</td>
</tr>
<tr>
<td>7010 + 7020</td>
<td>Jacques Cartier</td>
<td>62km</td>
<td>735 kV</td>
</tr>
<tr>
<td>7097</td>
<td>Appalaches</td>
<td>78km</td>
<td>735 kV</td>
</tr>
<tr>
<td>7007</td>
<td>Bergeronnes</td>
<td>242km</td>
<td>735 kV</td>
</tr>
<tr>
<td>3078 / 3079</td>
<td>Rivière du Loup</td>
<td>183km</td>
<td>315 kV</td>
</tr>
</tbody>
</table>
De-icer Mode: Main design ratings

Main Ratings:

- Standard de-icer mode - “Nameplate rating”:
  - 250MW, 7200A / ±17.4kV @ +10°C

- Verification mode:
  - 200MW, 5760A / ±17.4kV @ +30°C

- 1 hour overload:
  - 300MW, 7200A / ±20.8kV @ +10°C

- Low ambient overload:
  - 275MW, 7920A / ±17.4kV @ -5°C
De-icer Mode: Main design ratings

Because of the different characteristics of the sections, the operating range of current and voltage is large.
SVC Mode: Main design ratings

- Main ratings
  - Dynamic range
    - +225 Mvar / -115 Mvar at nominal voltage
  - Target voltage
    - 315 kV ± 5%
  - Slope
  - 3% on 225 Mvar
Solution
One line diagram

- 315 kV
  - 43 kV
  - 20 kV

- TSC 154 Mvar
- HP filter 55/12 Mvar
- HP filter 55 Mvar
- 5/11 and 7/13 filters 70 Mvar
- DC filters
One line diagram: De-icer mode

- 315 kV
- 43kV
- 20kV
- TSC 154Mvar
- HP filter 55/12Mvar
- HP filter 55Mvar
- 5/11 and 7/13 filters 70Mvar
- DC filters
One line diagram: SVC mode

- 315 kV
- 43 kV
- 20 kV

- TSC 154 Mvar
- HP filter 55 Mvar
- HP filter 55/12 Mvar
- DC filters

- 5/11 and 7/13 filters 70 Mvar
- HP filter 55 Mvar
Control Performance Verification
Testing of Control System

- Development of Master Control - DCU (De-icer Control Unit)
- Validation of DNP3 Communication
- Type test on Real Control (System V)
- Static and Dynamic Performance Test on Development Control Cubicle & Simulator
- Additional tests on a Control Replica at IREQ
Additional Testing on a Control Replica (RSPC1)

Replica connected to HYPERSIM (IREQ simulator)

Primary Objectives

- Provide additional testing facility (in parallel to Factory Test)
  - MBPSS (Multi-Band Power System Stabilizer)
  - Geomagnetic influence
  - Contingencies (additional validation)
- Final validation of UCD
- Validation of Acceptance Test program
- Training (Operator and Field technician)
Additional Testing on a Control Replica (RSPC1)

- Equivalent AC network
- TSC valve
- TCR/De-icer valve
- Reactive elements
- Coupling transformers
- Earthing transformers
- Discharge transformer
Simulator Setup

UCD

HYPERSIM

RSPC1
De-icer mode
Deicer mode - particular tests singled out

1. Converter Deblocking in current control
2. Review trip sequence – Overvoltage caused by remote isolation of the converter
3. Dc voltage measurement failure
4. Ac Voltage Error (Fuse failure)
Remote Isolation of the Converter
Normal Shutdown Sequence
by local breaker opening
Deicer mode – Remote Shutdown

No control action
Severe Overvoltage
when connected to longest (247km) line
Deicer mode – Remote Shutdown

Preliminary investigation
Local detection preferred

Current detection & Control action
No Overvoltage
Limitation of Overvoltage
New Protection Philosophy
De-icer installation
DC converter valves
AC coupling reactors
HV connections and transformer
De-icer installation

Harmonic filters
DC filters and DC bus
Aerial view of the de-icer
Connecting de-icer to line
Commissioning
Mise en service du déglaceur - Poste Lévis
Réduction par paliers du courant ICT
Procédé 1.4 - Section 3.1 - Étape 39

lab - ICT - CLC85 (A)
Response to undervoltage

Mise en service du déglaceur – Poste Lévis
Essais en régime de sous-tension – Creux de 25 % sur la phase A pendant 250 ms (315 et 735 kV)
Procédé 1.15 – Section 3.1 – Reprise Étape 4
Response to overvoltage
Bridge 2 deblocked
Ramp Up 3300A to 7200A
Ramp Up 3300A to 7200A TSC Unblocked
Ramp Down 5000 A to Standby

Mise en service du déglaceur – Poste Lévis
Mode Déglaceur – L3076 – L3079 – Rampe pour arrêt
Procédé 3.1 – Section 3.1.6
Samedi 8 novembre 2008 – 18:53:56.862
Ramp Down 5000 A to Standby
Ramp Down 5000 A to Standby
Shutdown
Shutdown – Action of ERM

Mise en service du déglaceur – Poste Lévis
Mode Déglaceur – Ligne 7097 – MHT – Agencement B-C
Procédé 3.3 – Section 3.3.8 – Etape 10
Mardi 4 novembre 2008 – 17:31:50.769

- Voltage: Vcc – pôle positif – CLC85kV
- Voltage: Vcc – pôle négatif – CLC85kV

- Current: i0 – pont no 1 – CLC85A
- Current: i0 – pont no 2 – CLC85A

- Current: I filtre 60 Hz – CLC85A
- Current: I filtre 360 Hz no 1 – CLC85A
- Current: I filtre 360 Hz no 2 – CLC85A
- Current: I filtres cc – pôle positif – CLC85A
- Current: I filtres cc – pôle négatif – CLC85A

- Current: ia – F5/11 + F7/13 + FHP2 – CLC85A
- Current: ib – F5/11 + F7/13 + FHP2 – CLC85A
- Current: ic – F5/11 + F7/13 + FHP2 – CLC85A

- Current: ln – TGB1 – CLC85A
- Current: ln – TGB2 – CLC85A

- Fire Latch ICT – phase ABV
- Fire Latch ICT – phase BCV
- Fire Latch ICT – phase CAV
In service as an SVC during the winter

Unique project made possible by good collaboration between Hydro Québec and AREVA

Many technical hurdles overcome to make the installation a success