The Hydro Québec De-icer Project at Lévis Substation

Presenter

Chris Horwill : AREVA T&D

HVDC and FACTS Subcommittee, Calgary, July 29 2009

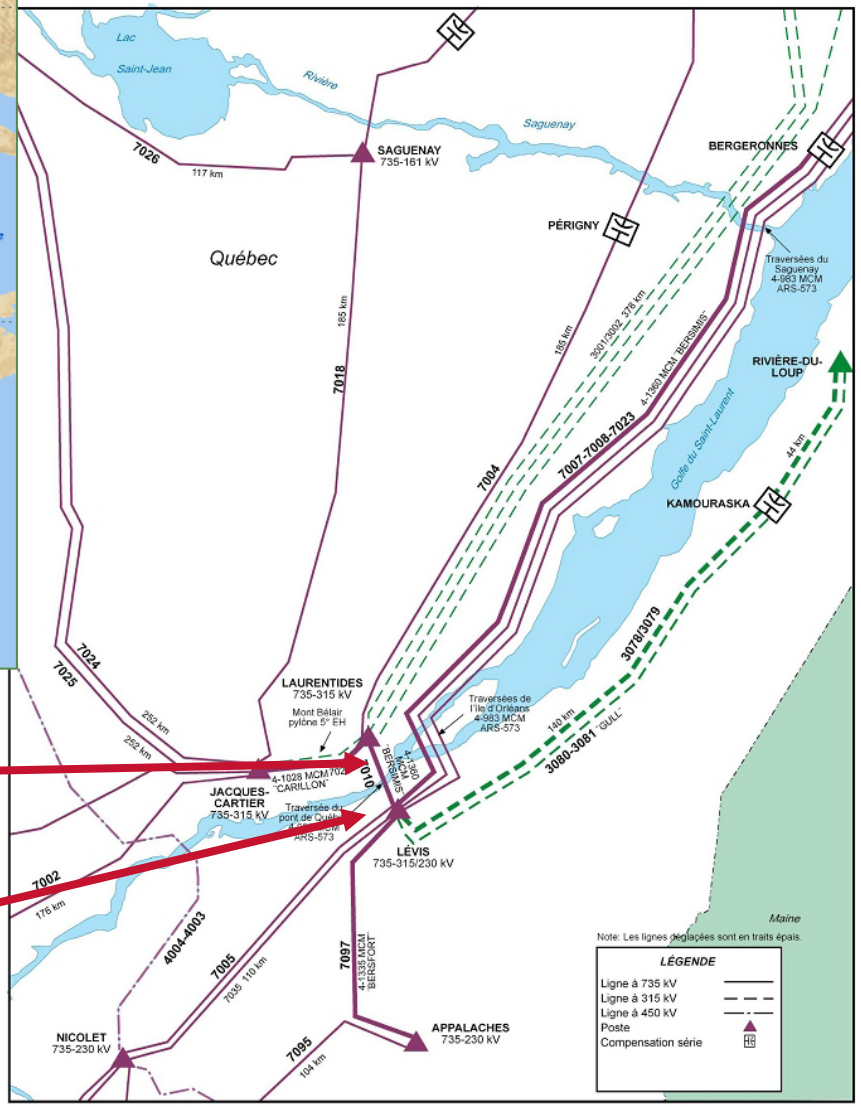
Background

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

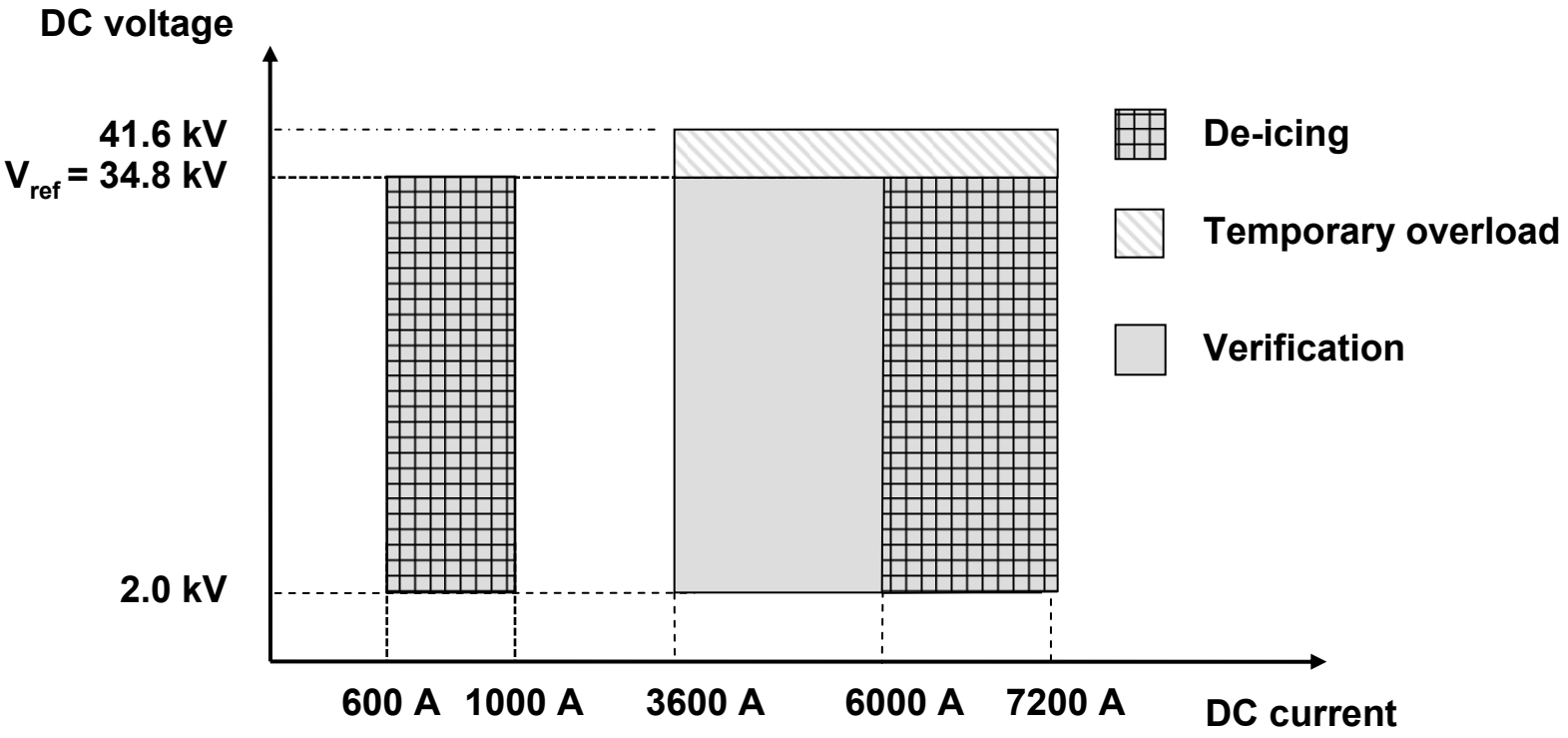
Lines for de-icing

Line	Destination	Length	Voltage
7010	Laurentides	27km	735 kV
7010 +7020	Jacques Cartier	62km	735 kV
7097	Appalaches	78km	735 kV
7007	Bergeronnes	242km	735 kV
3078 / 3079	Rivière du Loup	183km	315 kV

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



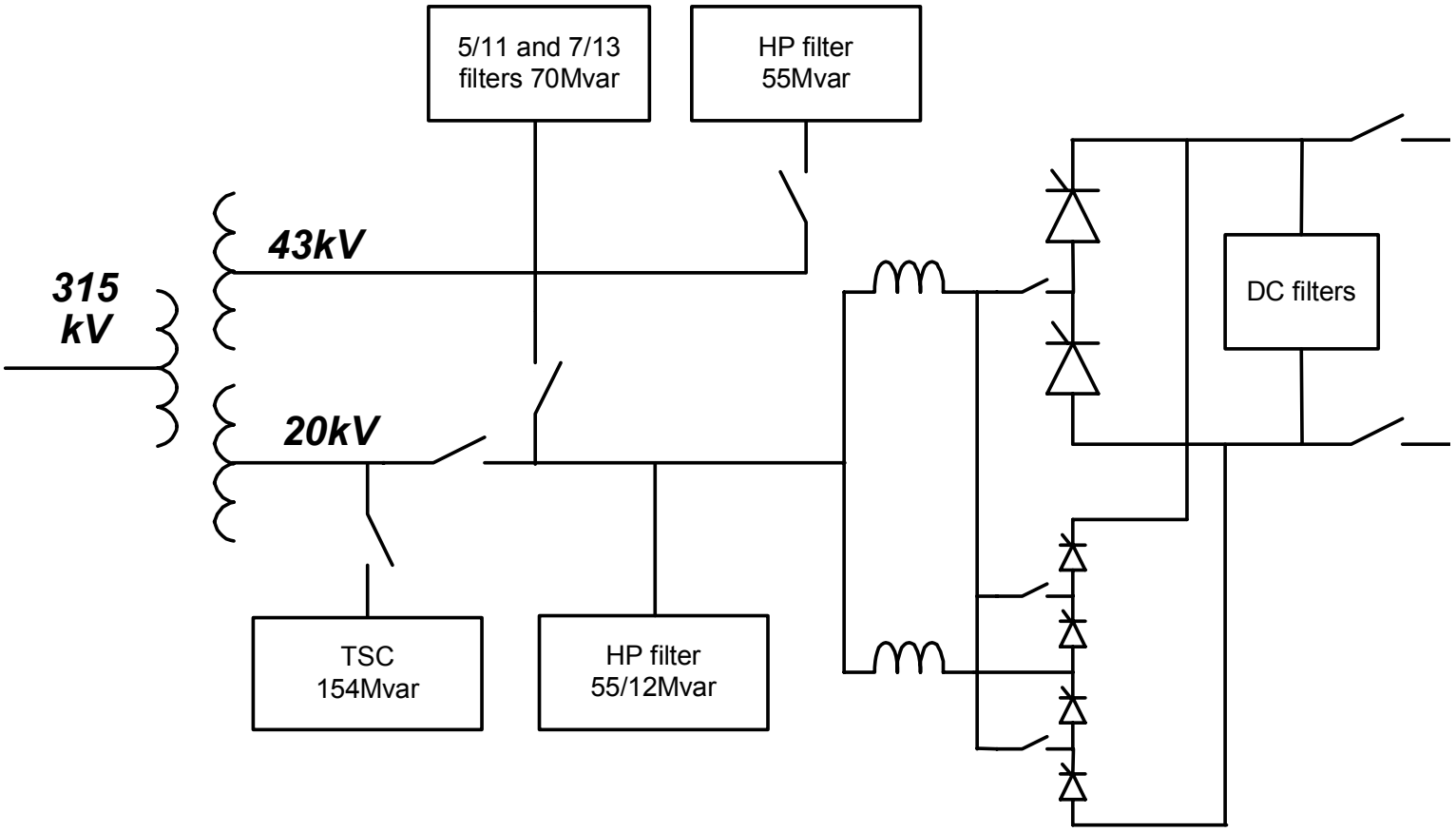
- Because of the different characteristics of the sections, the operating range of current and voltage is large

SVC Mode: Main design ratings

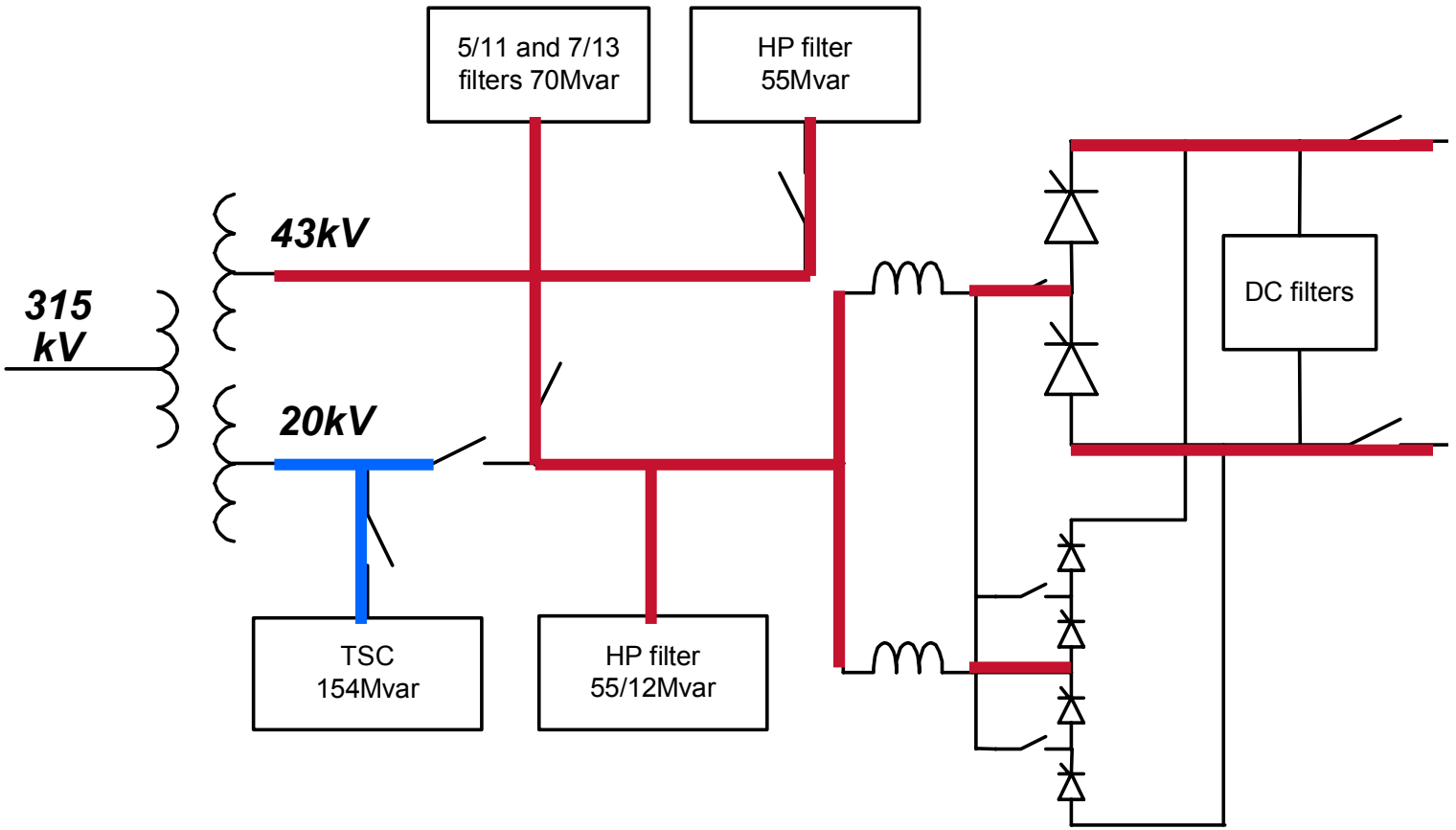
- Main ratings
  - Dynamic range
    - +225 Mvar / -115 Mvar at nominal voltage
  - Target voltage
    - 315 kV ± 5%
  - Slope
  - 3% on 225 Mvar

Solution

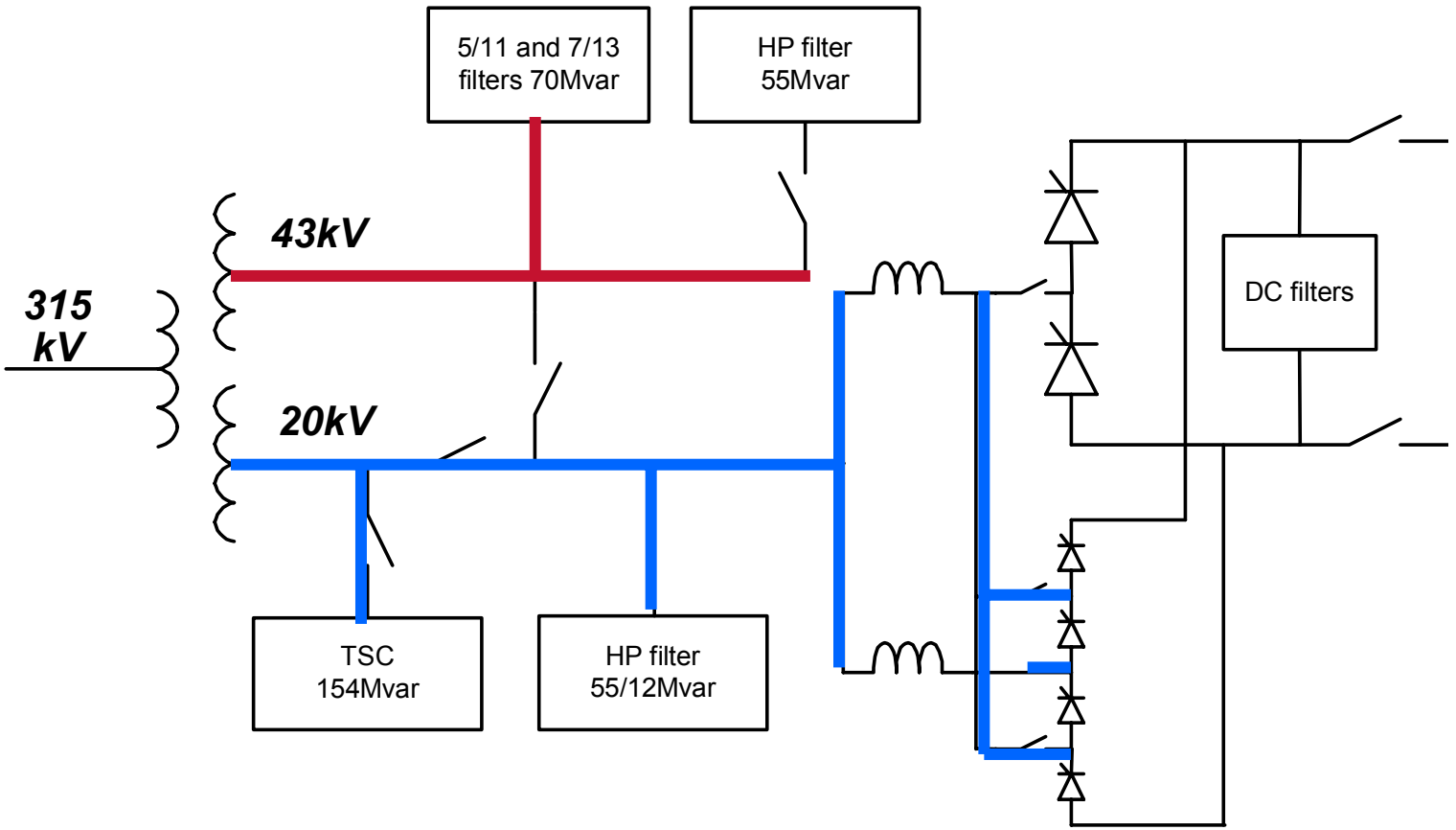
One line diagram



One line diagram: De-icer mode



One line diagram: SVC mode



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

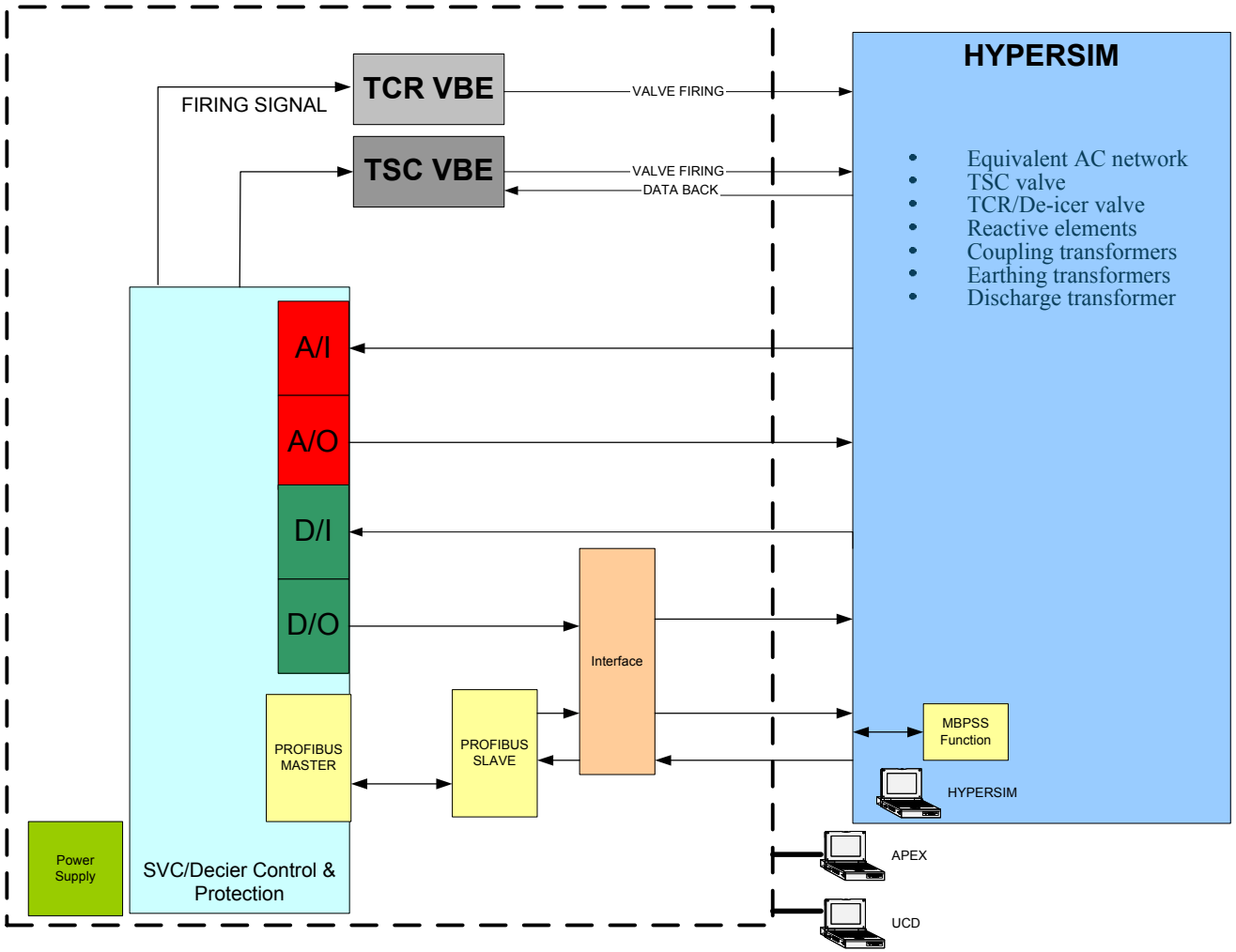
Additional Testing on a Control Replica (RSPC1)

Replica connected to HYPERSIM (IREQ simulator)

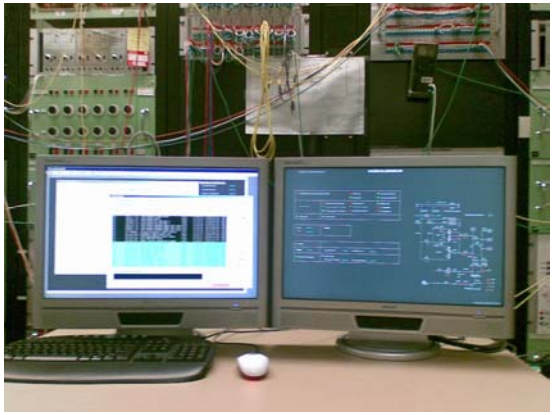
Primary Objectives

- 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)

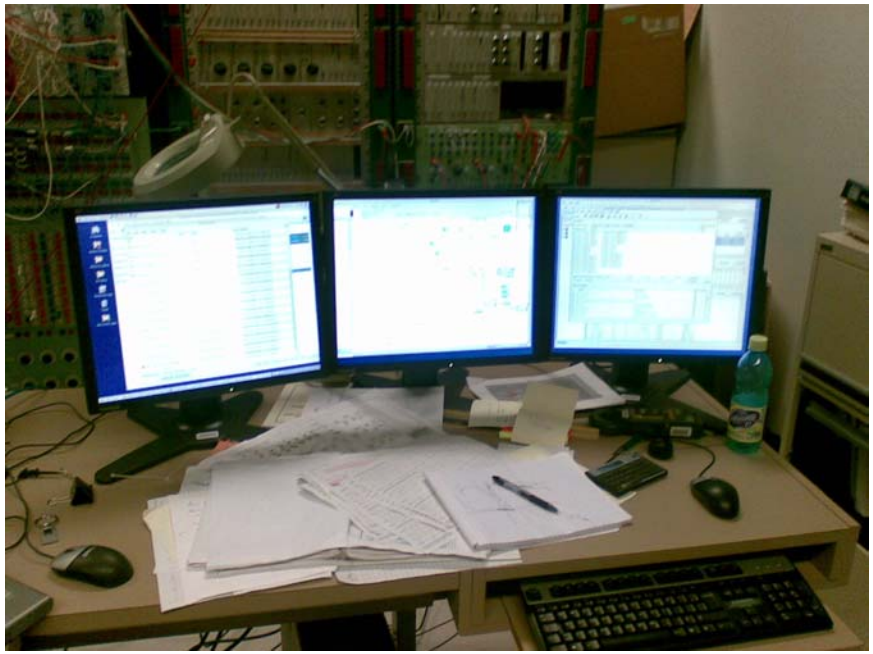
Additional Testing on a Control Replica (RSPC1)



Simulator Setup



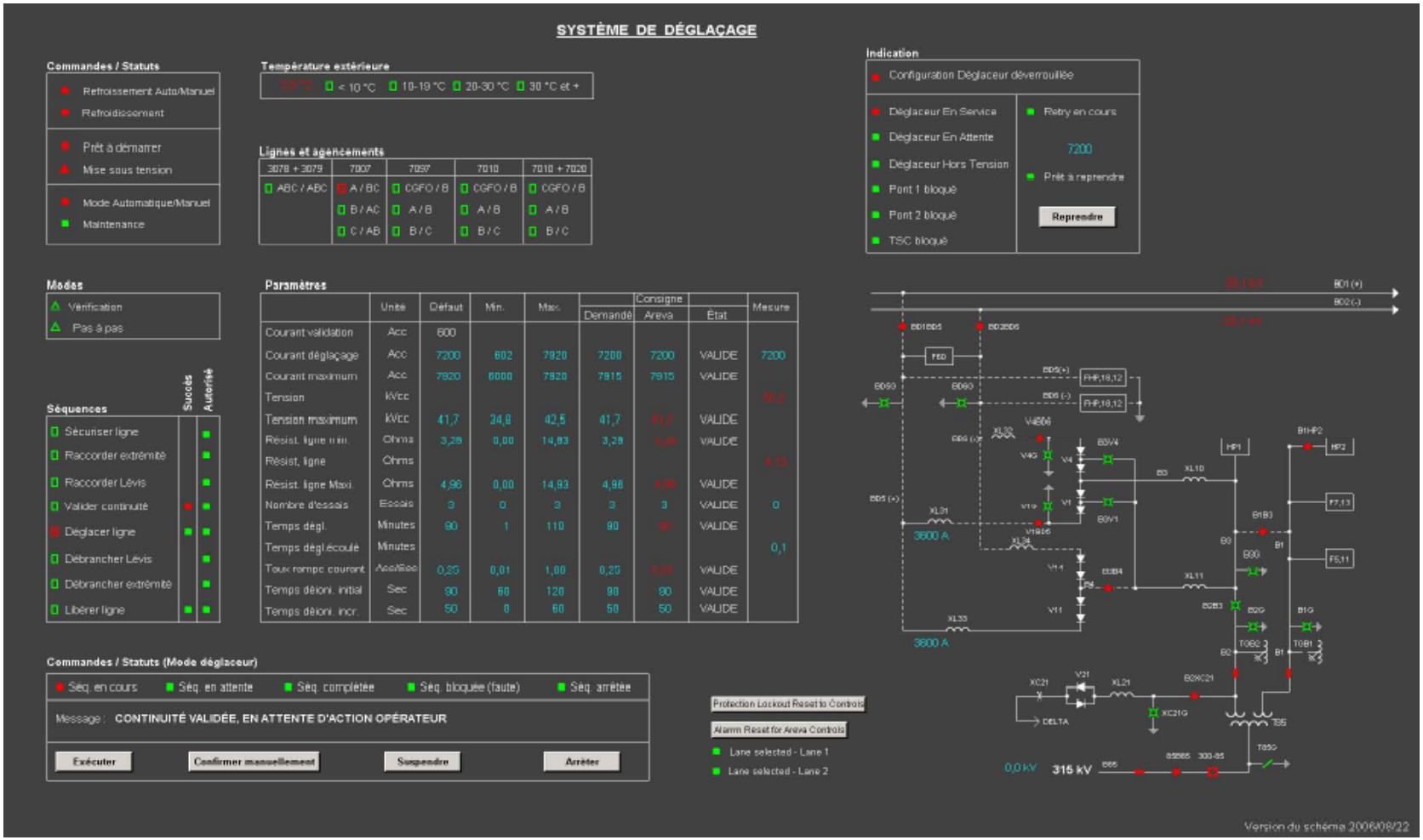
UCD



HYPERSIM

RSPC1

De-icer mode

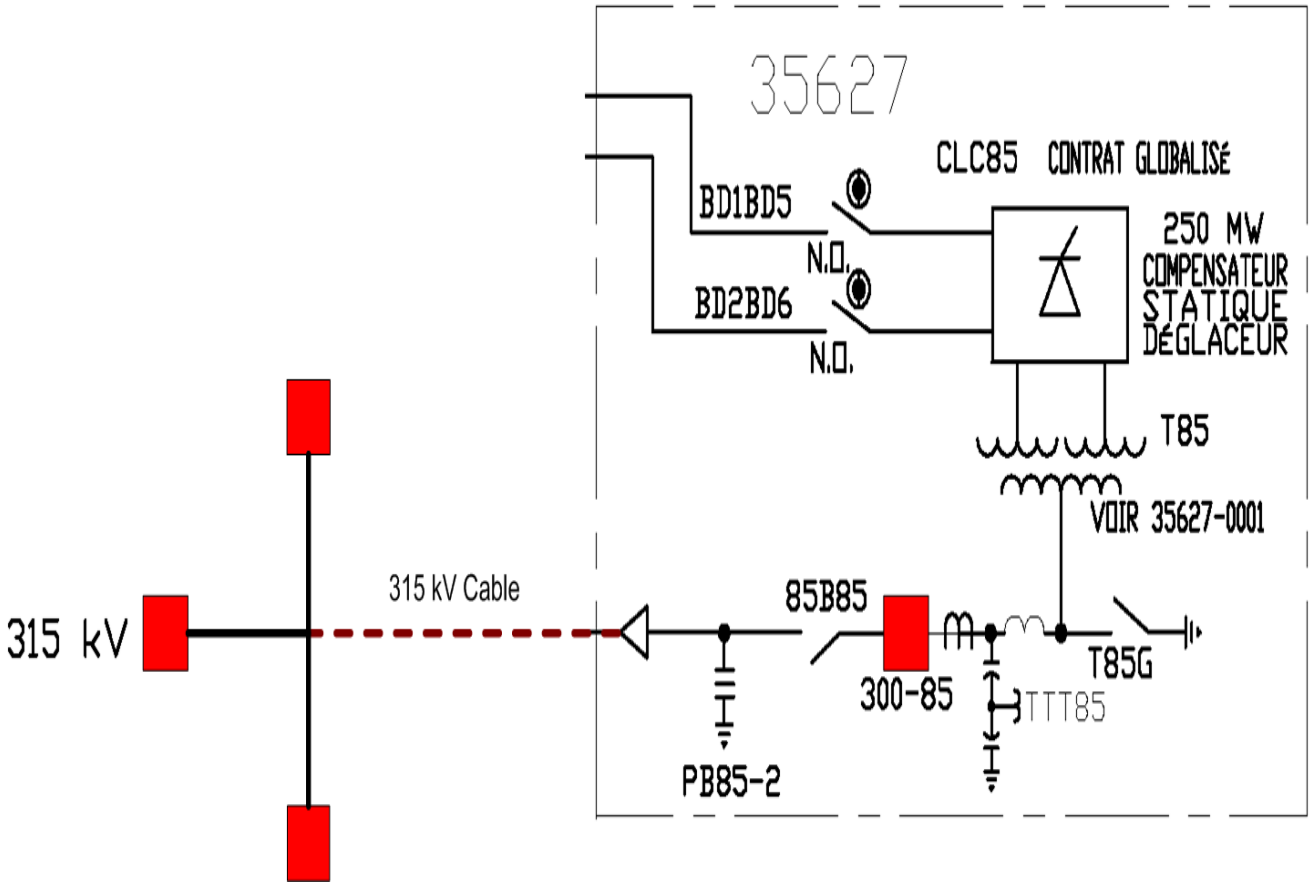

SYSTÈME DE DÉGLAÇAGE
Commandes / Statuts
Refroissement Auto/Manuel
Refroidissement
Prêt à démarrer
Mise sous tension
Mode Automatique/Manuel
Maintenance
Température extérieure
< 10 °C
10-19 °C
20-30 °C
30 °C et +
Lignes et agencements
3078 + 3079
7007
7097
7010
7010 + 7020
ABC / ABC
A / BC
B / AC
C / AB
CGFO / B
A / B
B / C
CGFO / B
A / B
B / C
CGFO / B
A / B
B / C
Indication
Configuration Déglaceur déverrouillée
Déglaceur En Service
Déglaceur En Attente
Déglaceur Hors Tension
Pont 1 bloqué
Pont 2 bloqué
TSC bloqué
Retry en cours
7200
Prêt à reprendre
Reprendre
Modes
Vérification
Pas à pas
Paramètres
Unité
Défaut
Min.
Max.
Consigne
Demandé
Areva
État
Mesure
Courant validation
Courant déglaçage
Courant maximum
Tension
Tension maximum
Résist. ligne min.
Résist. ligne
Résist. ligne Maxi.
Nombre d'essais
Temps dégl.
Temps dégl écoulé
Taux rampe courant
Temps déioni. initial
Temps déioni. incr.
Séquences
Succès
Autorisé
Sécuriser ligne
Raccorder extrémité
Raccorder Lévis
Valider continuité
Déglacer ligne
Débrancher Lévis
Débrancher extrémité
Libérer ligne
Commandes / Statuts (Mode déglaceur)
Séq. en cours
Séq. en attente
Séq. complétée
Séq. bloquée (faute)
Séq. arrêtée
Message : CONTINUITÉ VALIDÉE, EN ATTENTE D'ACTION OPÉRATEUR
Exécuter
Confirmer manuellement
Suspendre
Arrêter
Protection Lockout Reset to Controls
Alarm Reset for Areva Controls
Lane selected - Lane 1
Lane selected - Lane 2
3600 A
3600 A
DELTA
0,0 kV
315 kV
Version du schéma 2006/09/22

Preparation for commissioning

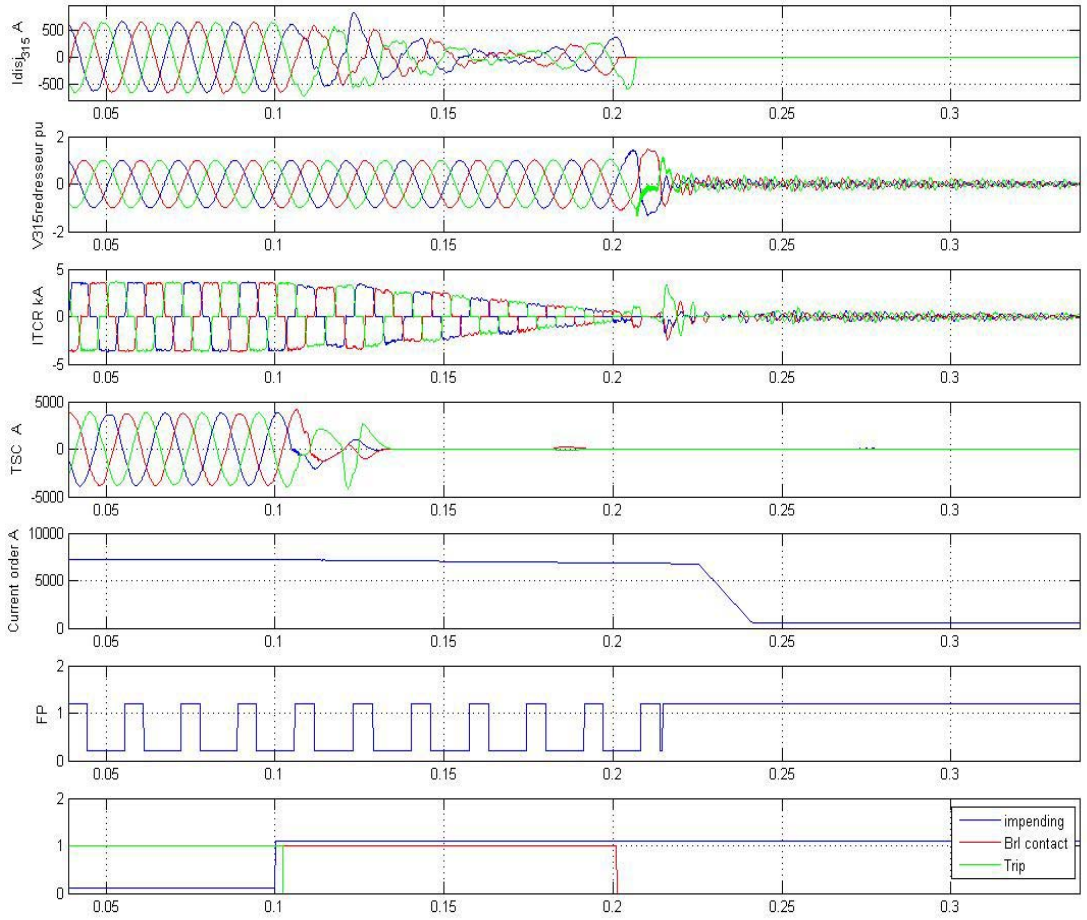
Deicer mode - particular tests singled out

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)

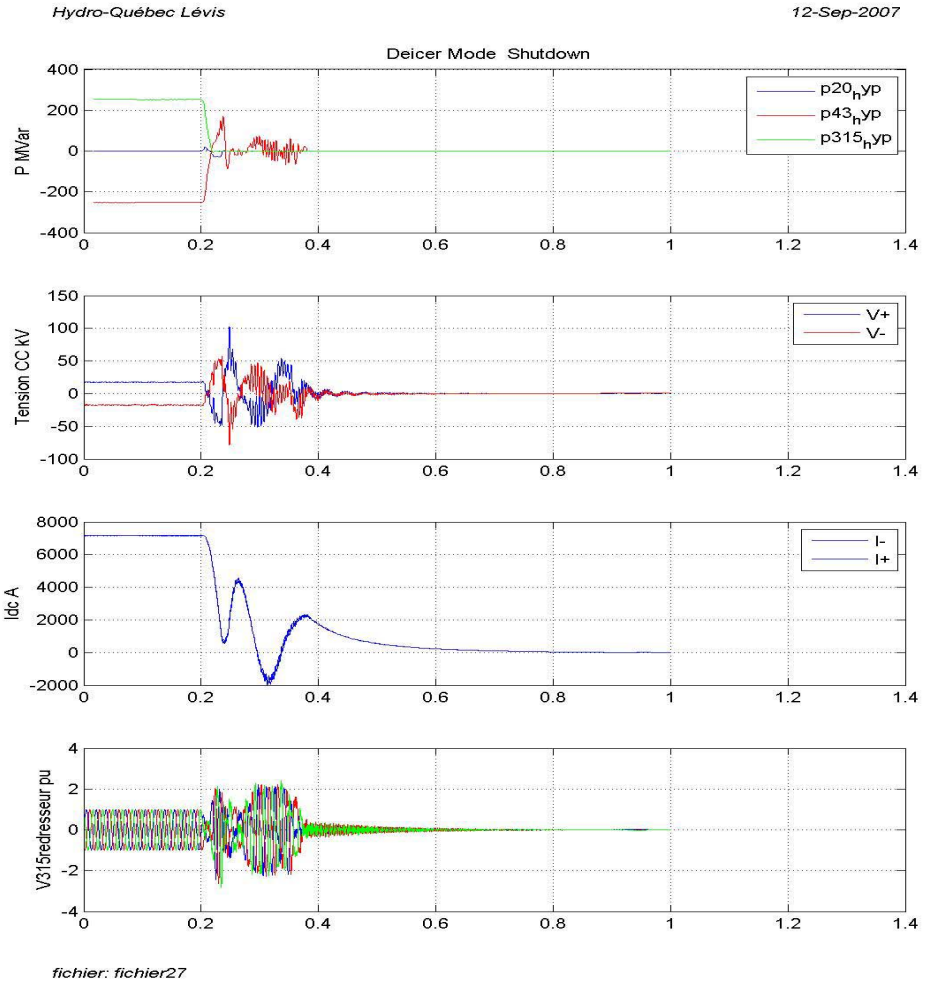
Remote Isolation of the Converter



Normal Shutdown Sequence
by local breaker opening



Deicer mode – Remote Shutdown



No control action

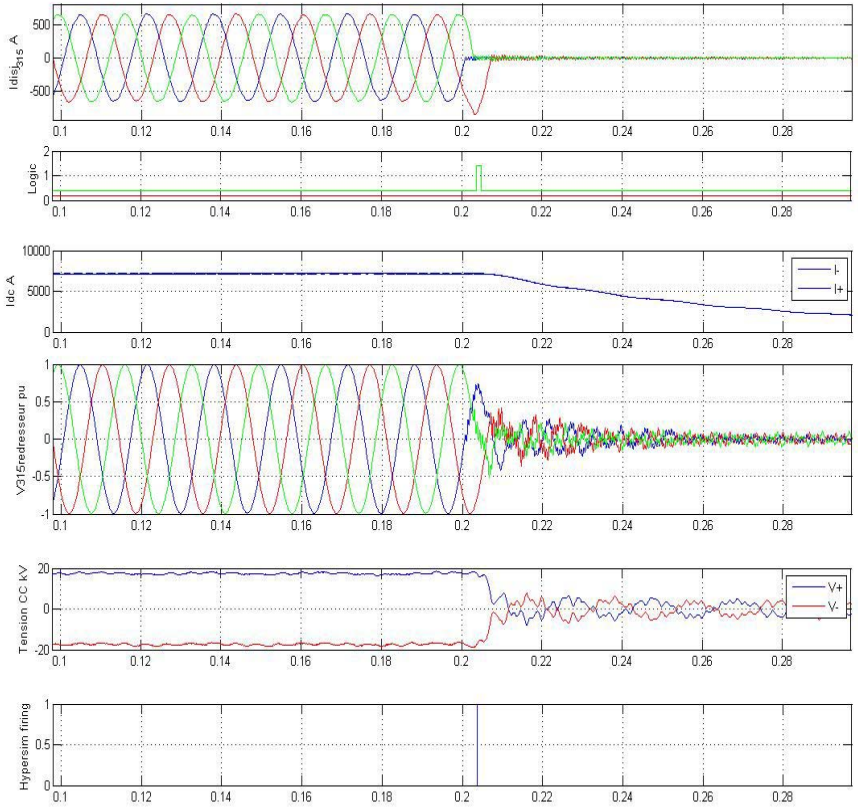
Severe Overvoltage

when connected to longest (247km) line

Deicer mode – Remote Shutdown

Preliminary investigation

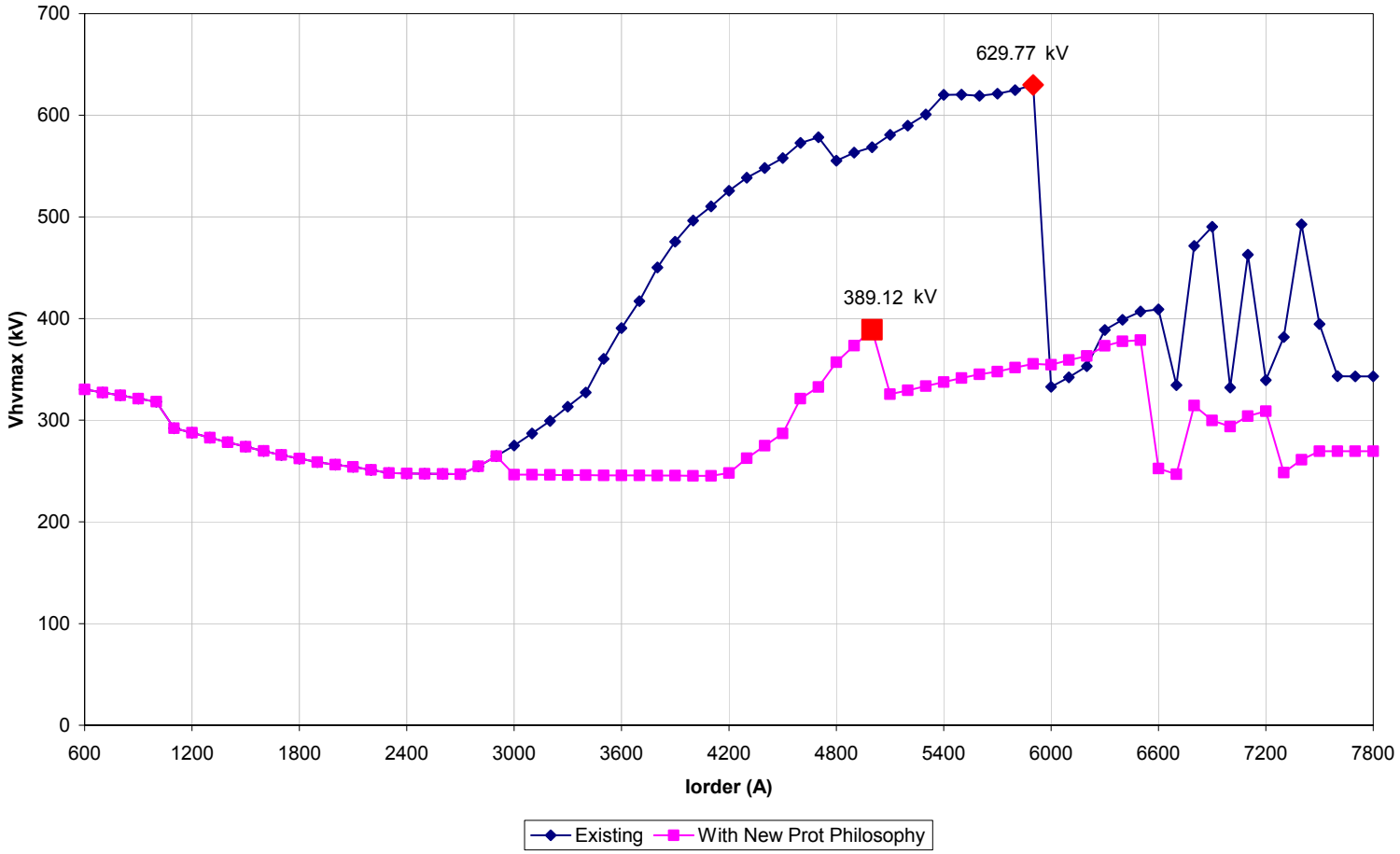
Local detection preferred



Current detection & Control action

No Overvoltage

Limitation of Overvoltage New Protection Philosophy



De-icer installation

De-icer installation

DC converter valves

De-icer installation

AC coupling reactors

De-icer installation

HV connections and transformer

De-icer installation

Harmonic filters

De-icer installation

DC filters and DC bus

De-icer installation

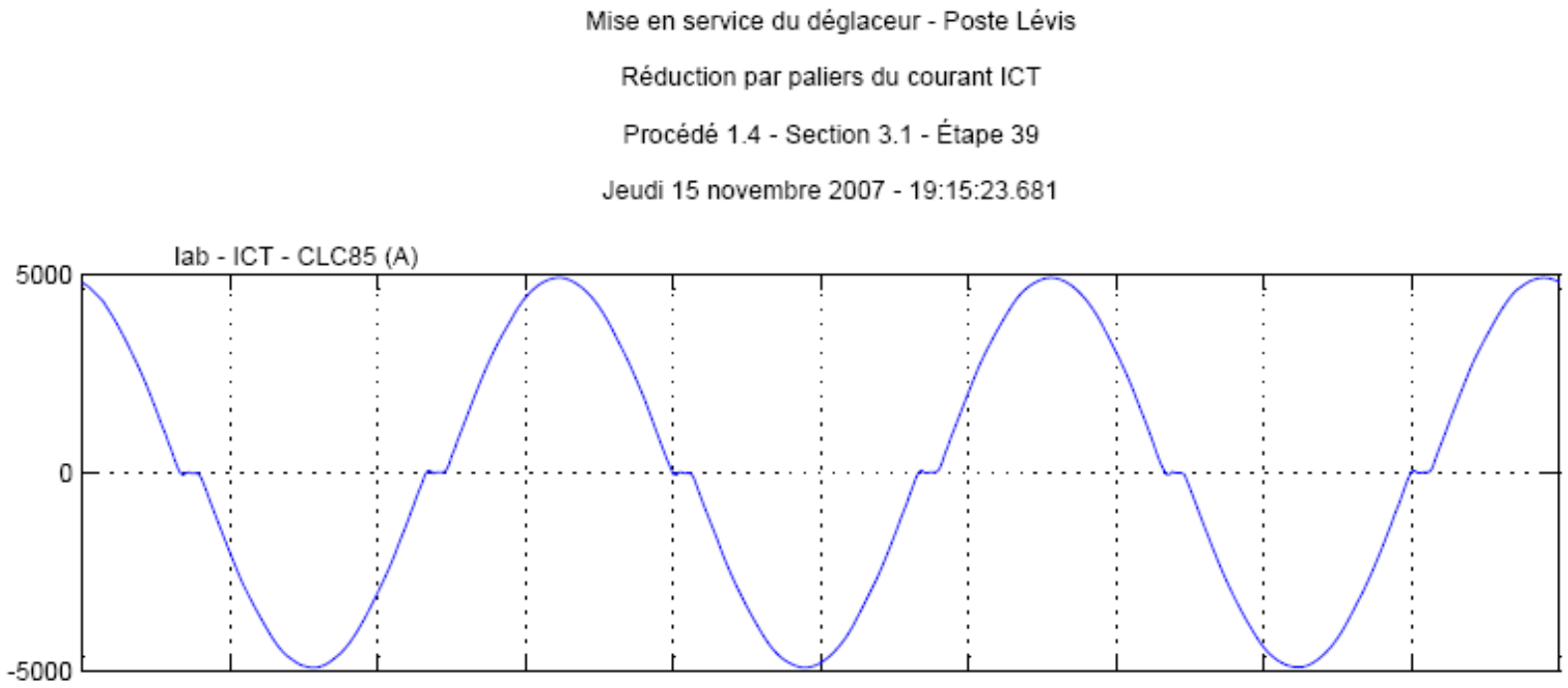
Aerial view of the de-icer

De-icing tests

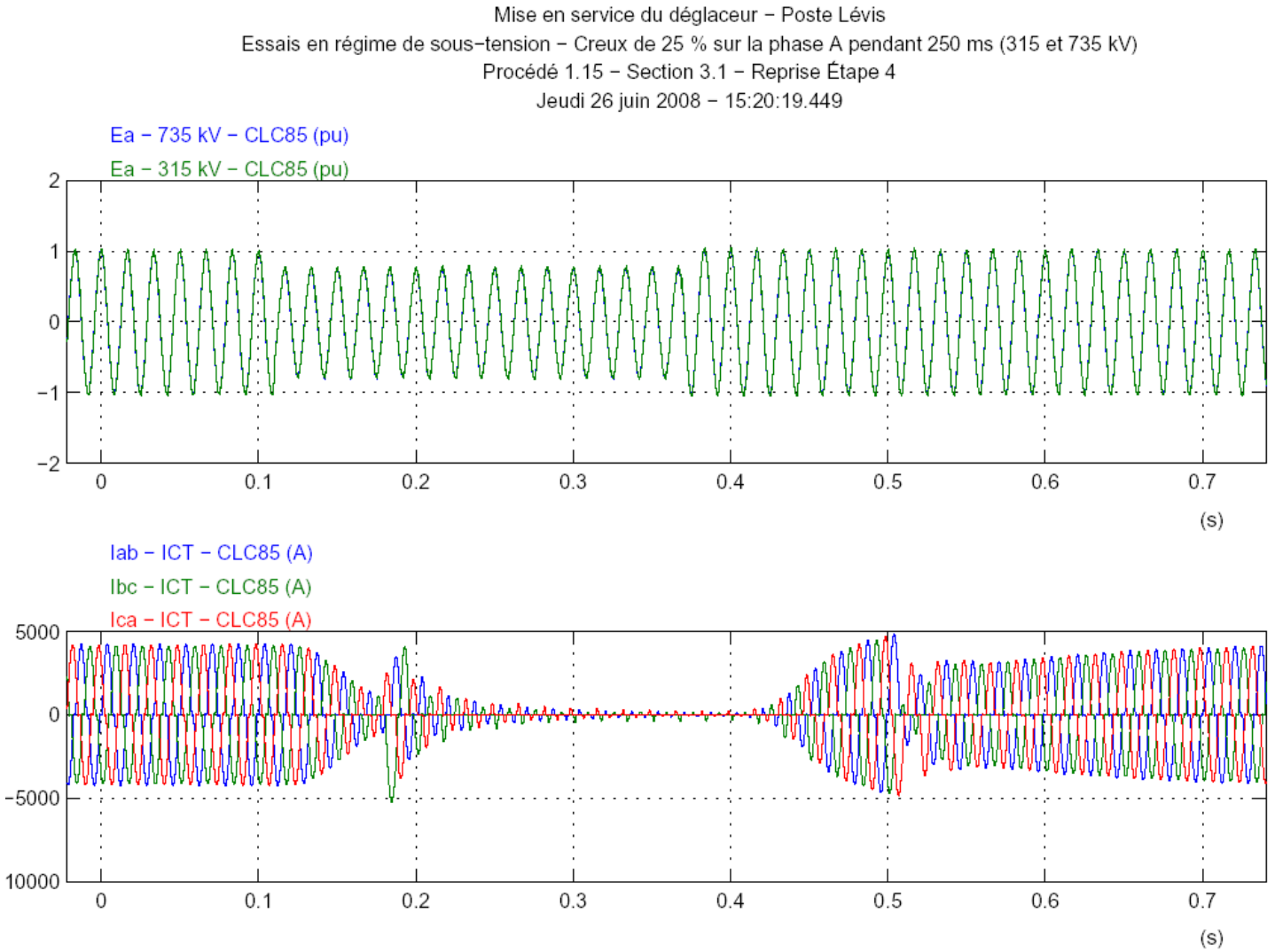
Connecting de-icer to line

Commissioning

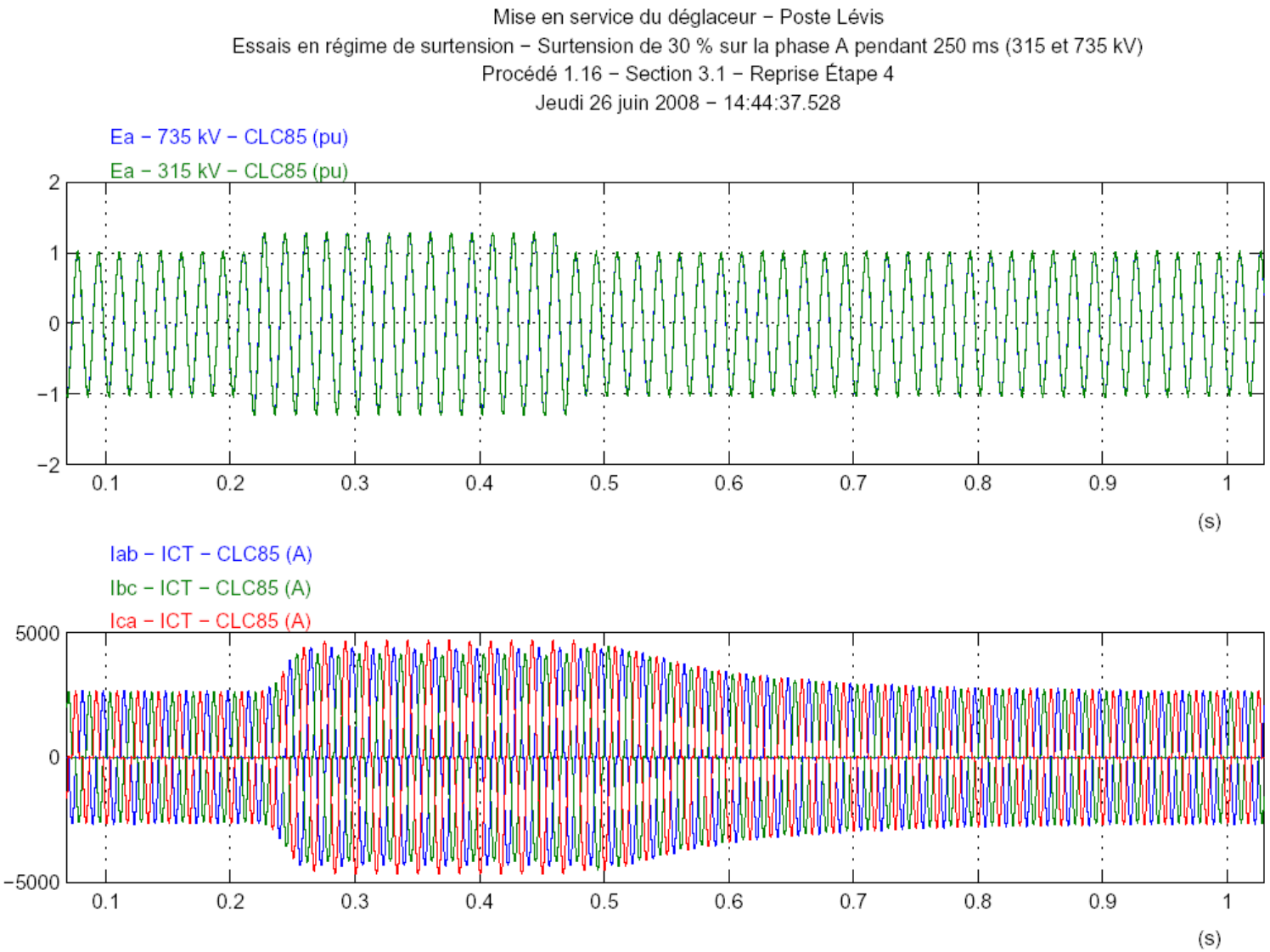
TCR current


Mise en service du déglaceur - Poste Lévis
Réduction par paliers du courant ICT
Procédé 1.4 - Section 3.1 - Étape 39
Jeudi 15 novembre 2007 - 19:15:23.681
Iab - ICT - CLC85 (A)
5000
0
-5000

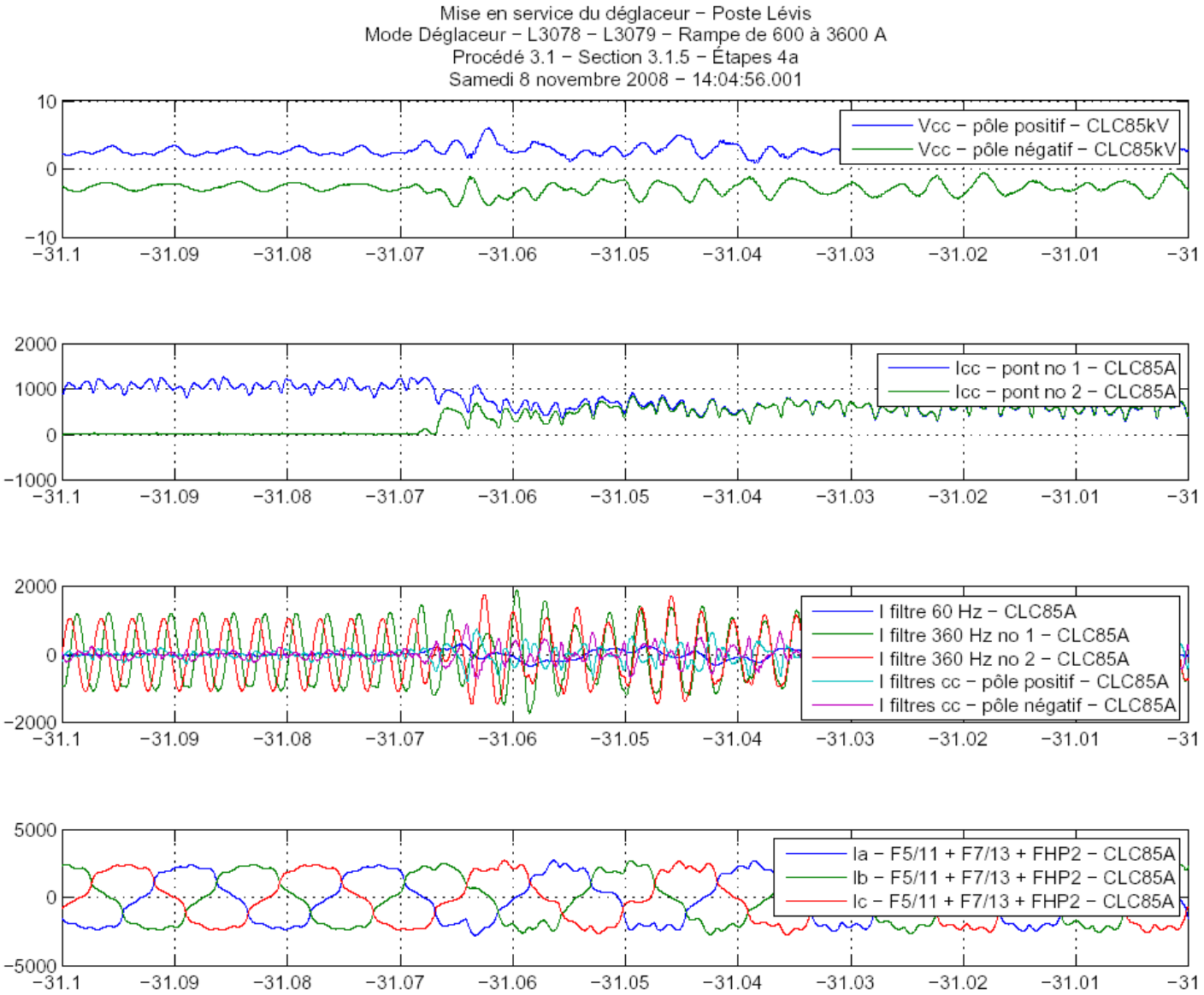
Response to undervoltage



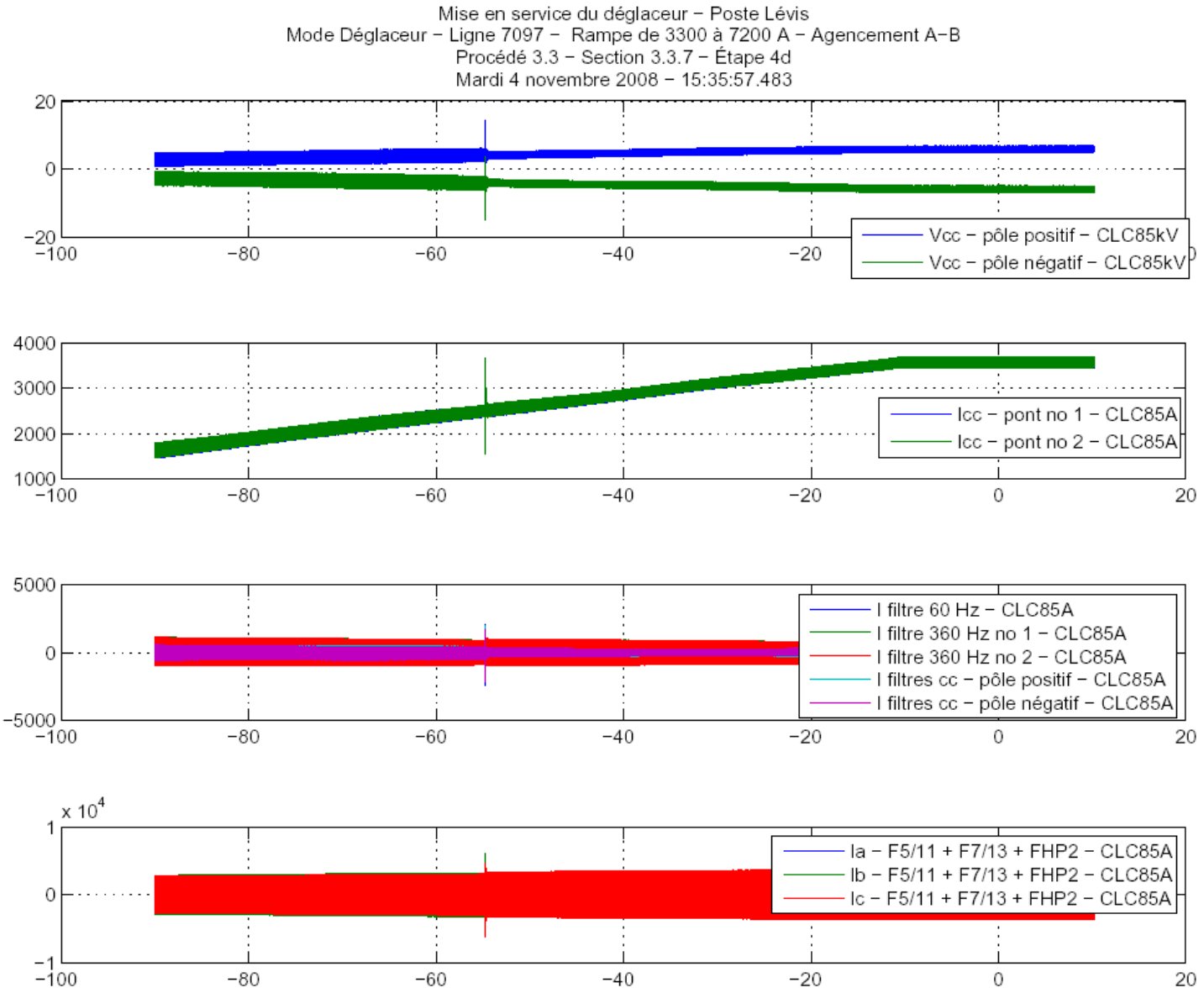
Response to overvoltage



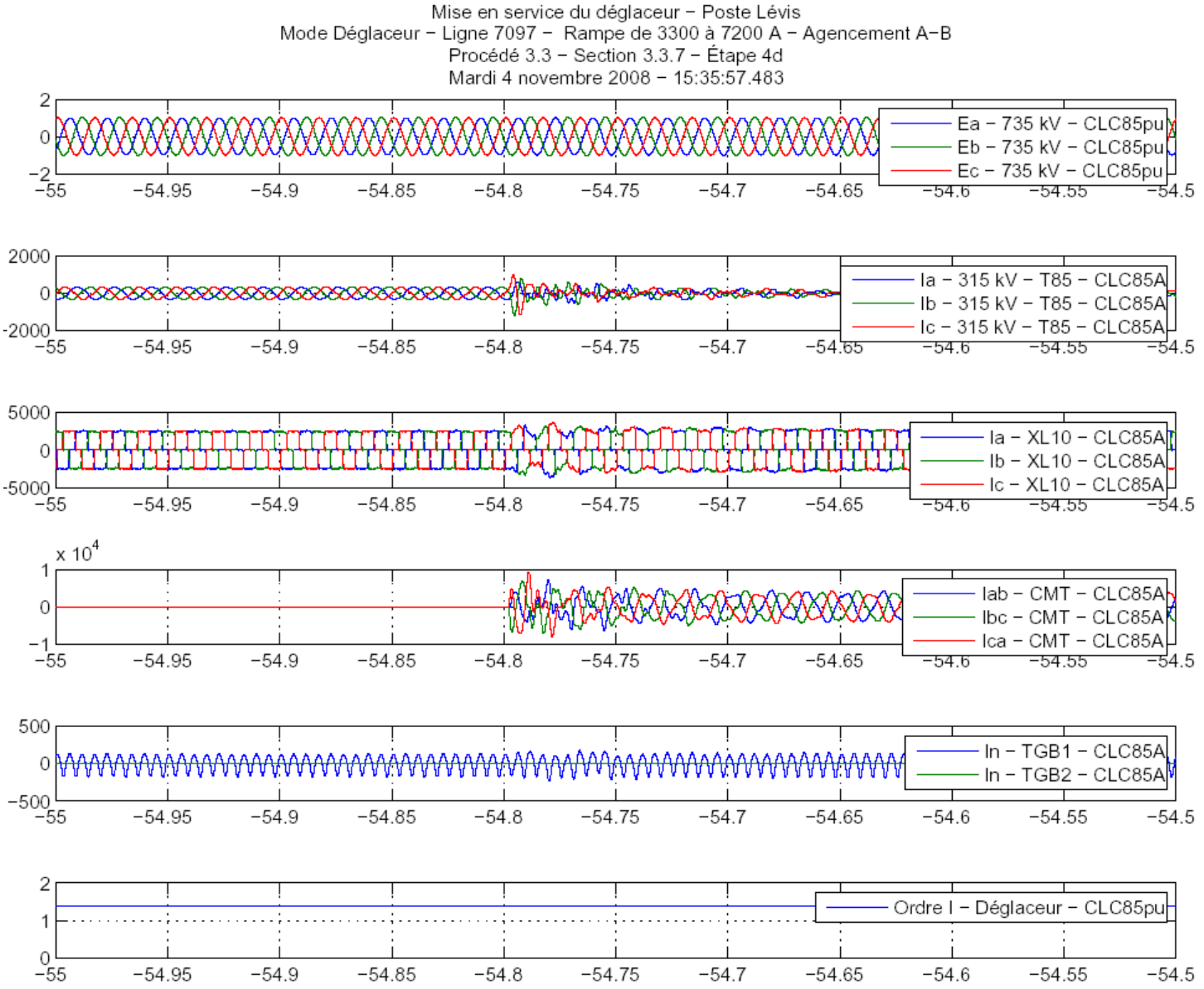
Bridge 2 deblocked



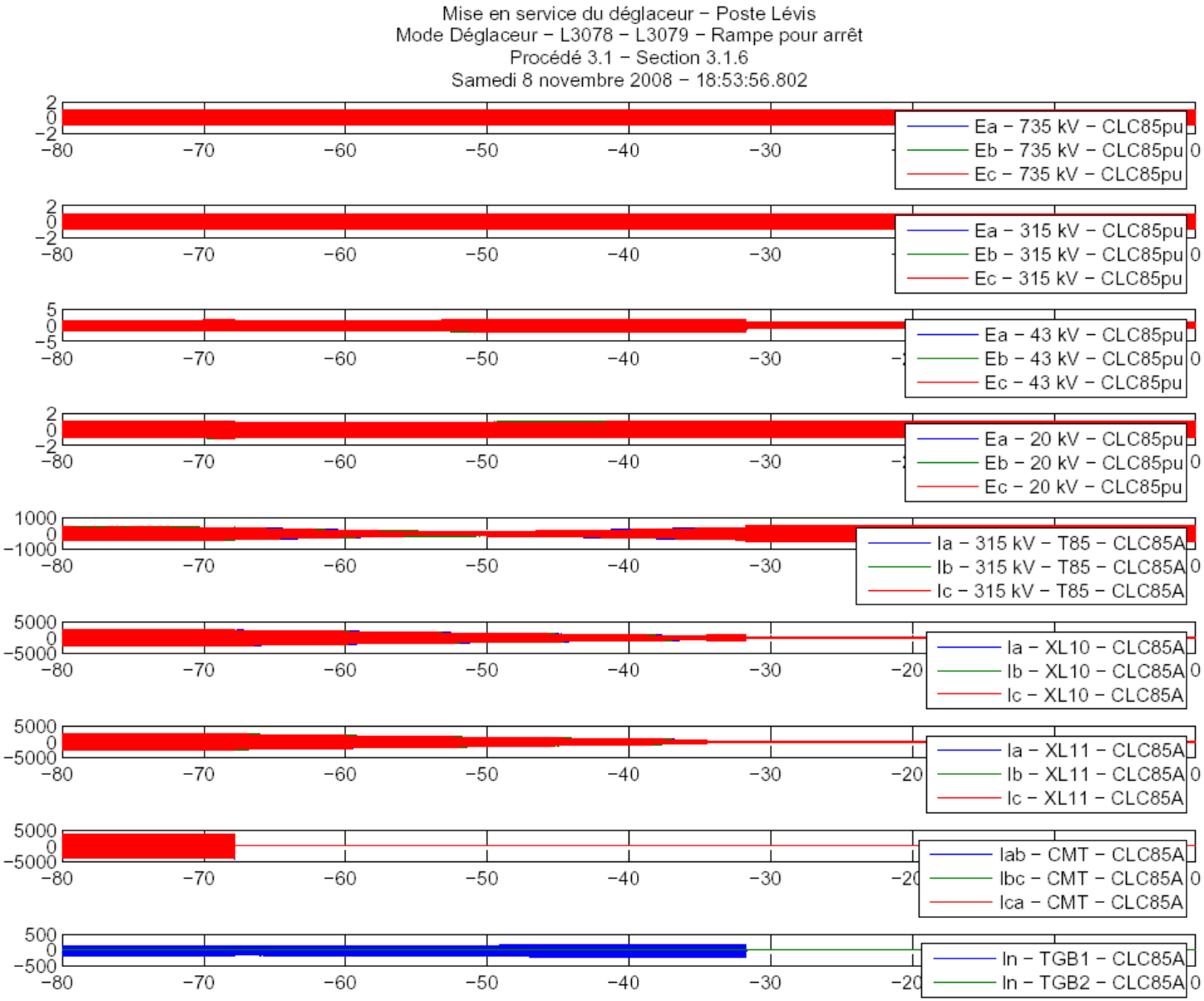
Ramp Up 3300A to 7200A



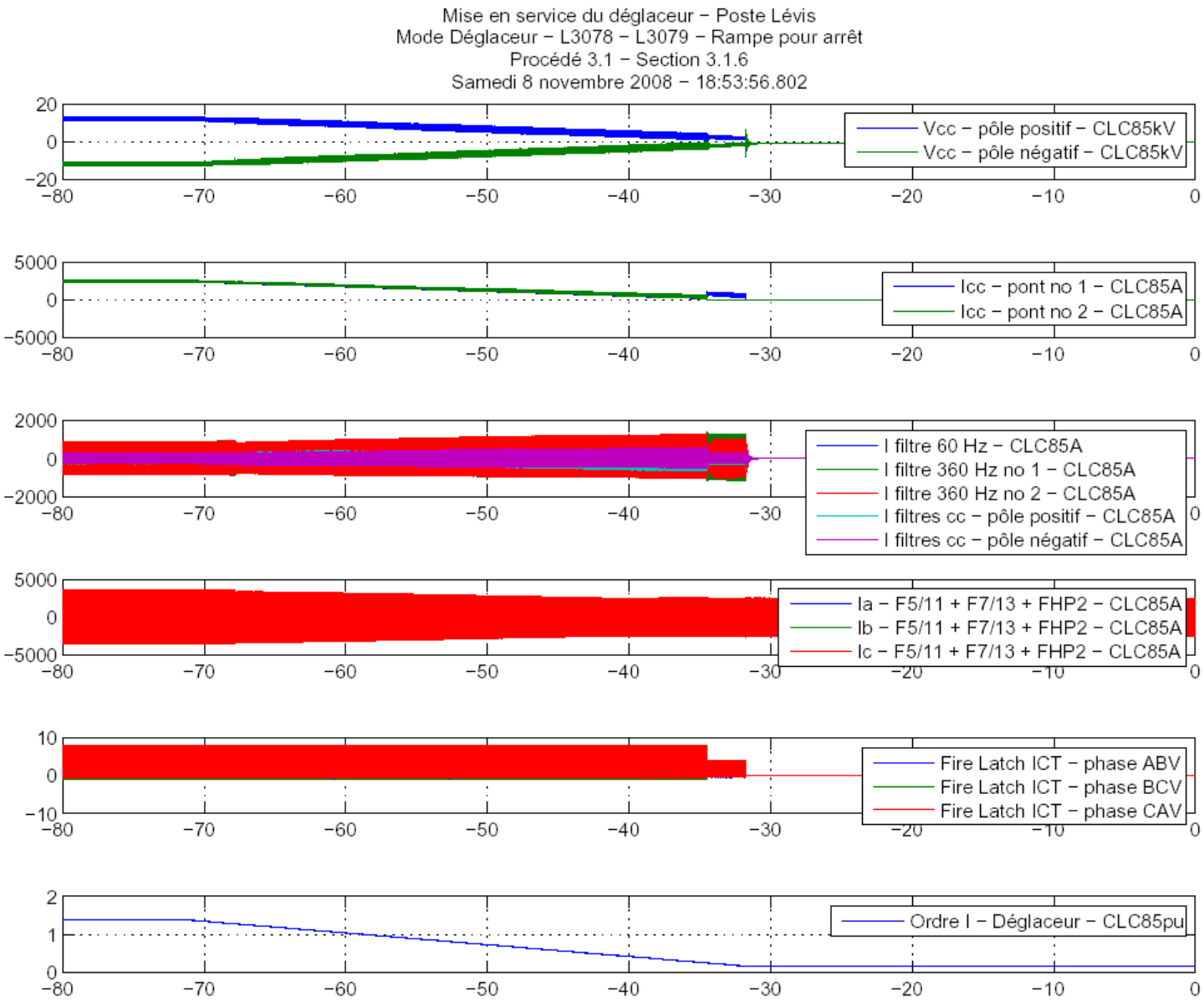
Ramp Up 3300A to 7200A TSC Unblocked



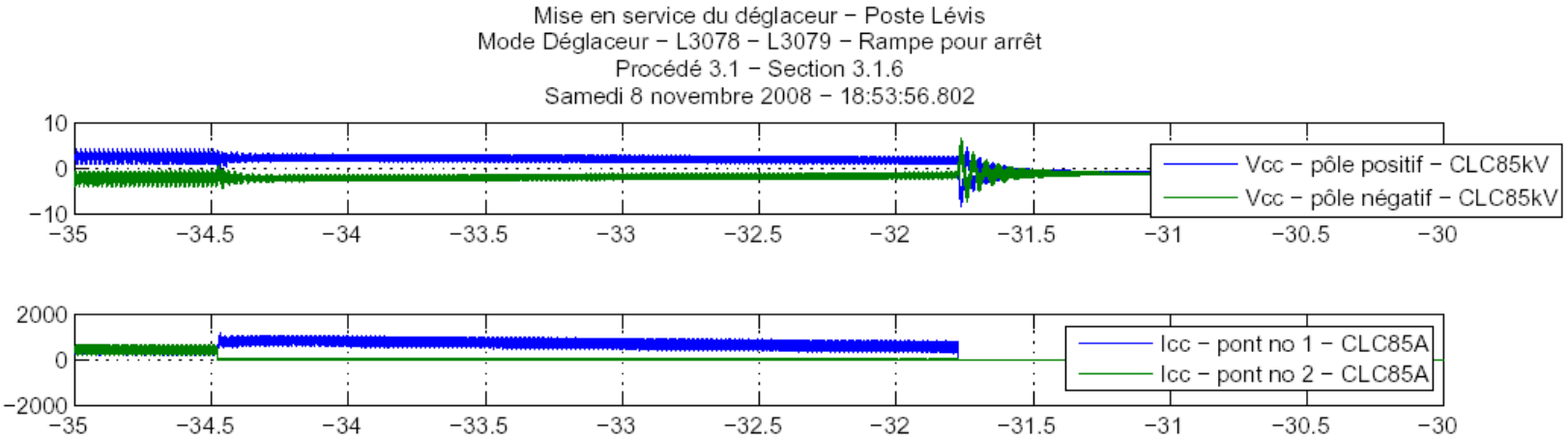
Ramp Down 5000 A to Standby



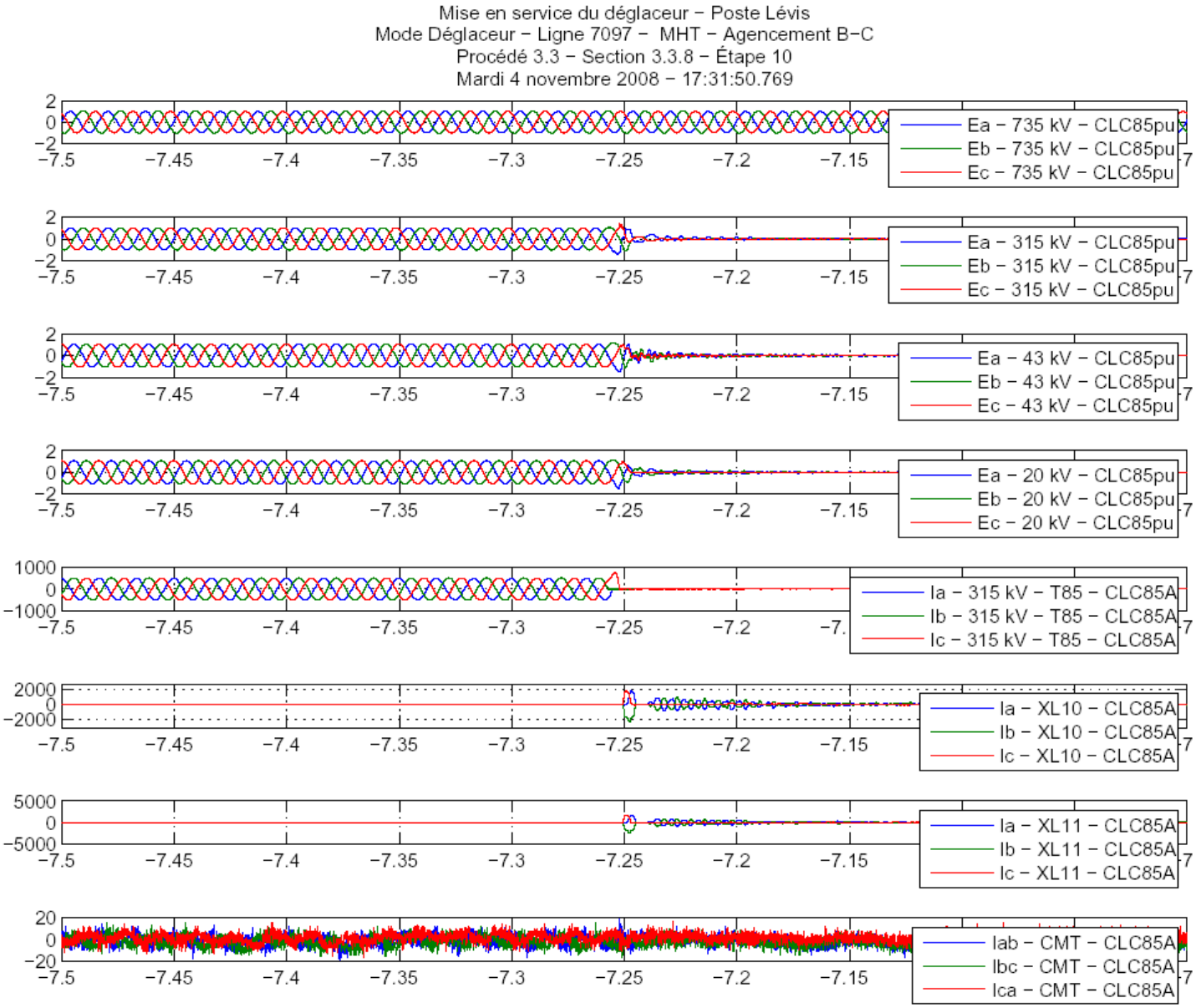
Ramp Down 5000 A to Standby



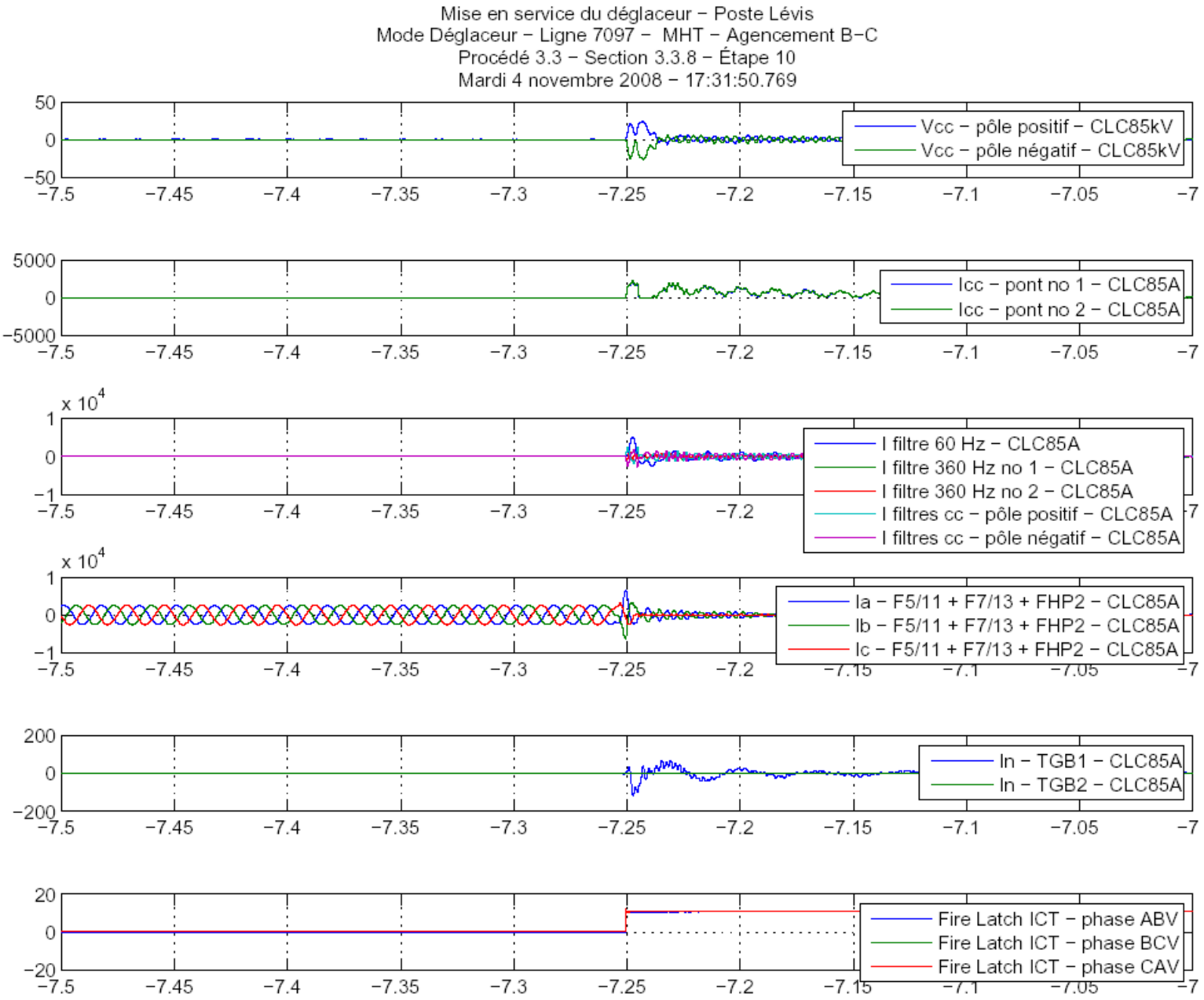
Ramp Down 5000 A to Standby



Shutdown


Mise en service du déglaceur – Poste Lévis
Mode Déglaceur – Ligne 7097 – MHT – Agencement B–C
Procédé 3.3 – Section 3.3.8 – Étape 10
Mardi 4 novembre 2008 – 17:31:50.769
Ea – 735 kV – CLC85pu
Eb – 735 kV – CLC85pu
Ec – 735 kV – CLC85pu
Ea – 315 kV – CLC85pu
Eb – 315 kV – CLC85pu
Ec – 315 kV – CLC85pu
Ea – 43 kV – CLC85pu
Eb – 43 kV – CLC85pu
Ec – 43 kV – CLC85pu
Ea – 20 kV – CLC85pu
Eb – 20 kV – CLC85pu
Ec – 20 kV – CLC85pu
Ia – 315 kV – T85 – CLC85A
Ib – 315 kV – T85 – CLC85A
Ic – 315 kV – T85 – CLC85A
Ia – XL10 – CLC85A
Ib – XL10 – CLC85A
Ic – XL10 – CLC85A
Ia – XL11 – CLC85A
Ib – XL11 – CLC85A
Ic – XL11 – CLC85A
Iab – CMT – CLC85A
Ibc – CMT – CLC85A
Ica – CMT – CLC85A

Shutdown – Action of ERM



De-icer

- 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