Installation and Interfacing HVDC Control Replicas at The National HVDC Centre

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1. Context
   a. HVDC in GB
   b. The National HVDC Centre
   c. Caithness – Moray (CM) HVDC Link

2. Replicas for CM
   a. Specification
   b. Testing
   c. Interfacing
   d. Applications and Benefits

3. Summary
Context
HVDC Context

HVDC - 2018

Current Interconnectors
1) Cross Channel (IFA)
2) Moyle
3) BritNed
4) EWIC
5) Western Link
6) Caithness – Moray
10) Nemo

New Interconnectors
11) ElecLink
12) NSL
13) Viking
14) IFA 2
15) FABLLink
16) NorthConnect
17) IceLink
18) Aquind
19) GreenLink

Embedded HVDC
7) Western Isles
8) Eastern Link
9) Wylfa – Pembroke
25) Shetland

Offshore Wind farms
20) East Anglia
21) Hornsea
22) Dogger Bank
23) Firth of Forth
24) Moray Firth

Based on National Grid’s Electricity Ten Year Statement (2013):

HVDC ~ 2030

Reason:
Best or only technical solution

Challenges:
Adverse interactions (HVDC Schemes, FACTS and Generators)
Multiple vendors and different technologies
Multi-terminal
The National HVDC Centre is an Ofgem funded simulation and training facility available to support all HVDC schemes.

Using state of the art simulators, we model and resolve potential issues in real-time before they impact delivery of your project or the Grid Network.
The National HVDC Centre Timeline

- NIC Bid (MTTE Project) April-August 2013
- MTTE NIC Bid Successful December 2013
- Design & Contractual Agreements 2014
- Detailed Design & Procurement 2015
- Recruitment, Building & IT Install 2016
- Formal Opening April 2017
- Replicas Installed May 2018
- PROMOTioN (WP15 & WP9) 2018
- CM Commissioning Sept-Dec 2018
- CM Energisation Dec 2018

Phase 1 is a point-to-point scheme between Spittal and Blackhillock
Type: Voltage Source Converter

Design: Symmetrical Monopole

Voltage: ±320kV

Active Power: 1200MW (Blackhillock), 800MW (Spittal)

Reactive Power: ±394 MVAr (Blackhillock), ± 263MVAr (Spittal)

Design choice:
- AC option was slightly more expensive and had a number consenting issues
- Multi-terminal scheme; VSC was only option due to requirement to connect to low SCC system (Shetland, offshore..)
- VSC technology attractive due to
  - 4-quadrant PQ operation and power reversal achieved with change in current polarity
  - Can be designed with no minimum short-circuit strength requirement
  - Reduced converter size compared to other technologies
  - Symmetrical monopole allows standard AC transformer use and operation during temporary faults
CM Support: Multi-Terminal Design

Future Station A
Future Station B
Alt mainland connection
N/O

Spittal 800MW
DC Switching Station
Blackhillock 1200MW

Shetland
Replicas for CM
Replica Specification

Replica panels are physical duplicates of the control system, and offer the ability to simulate HVDC performance in real time.
Testing

- Process
- Comparison
- Customer Representation
RTDS Hardware

3 x RTDS Racks, each including
(5 x PB5 cards, 1 x GTWIF)

3 x MMC Support Units

I/O cards: GTNET, GTA0, GTAI, GTDO and GTDI

2 x NovaCor chassis (5 cores activated)

6 x GTFPGA

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6 x GTFPGA

2 x NovaCor chassis (5 cores activated)
RTDS Hardware Meets Replica

AC Network

Transformer

FILTER

I_AC

I_DC

R

DC Line

R

V_DC

RSCAD / RTDS

Firing Pulses

System Voltage and Current

Protection and Control Cubicles

OWS (Operator Work Station)
<table>
<thead>
<tr>
<th>Week 1</th>
<th>Electrical contractors arrive on site and begin initial wiring works</th>
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<tbody>
<tr>
<td>Week 2</td>
<td>Replicas arrive on site. Wiring work continues.</td>
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<tr>
<td>Week 3-8</td>
<td>Complete wiring</td>
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<tr>
<td>Week 9</td>
<td>Supplier begins pre-commissioning work</td>
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<tr>
<td>Week 10</td>
<td>Supplier testing</td>
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<tr>
<td>Week 11</td>
<td>Supplier testing</td>
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<tr>
<td>Week 12</td>
<td>User Acceptance Testing (UAT)</td>
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<td>Week 13</td>
<td>Supplier provided training on use of Replicas</td>
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Applications and Benefits

- FST4
- Commissioning
- Operational Support
  - Respond to Network Changes
  - Diagnose Faults/Alarms
  - In-House Training
  - Scheme Updates/Upgrades
  - Long-term Model

- Operator Training
- EPC
Summary
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• **Owners of HVDC schemes** require Replica HVDC controls to minimise project delays and outages.

• **Transmission system owners/operators** require Replica HVDC controls to ensure system stability and minimise adverse interactions.

• A powerful **real time simulator** is required to accurately model the AC Network connected to Replicas.

• Replicas are an additional project activity and expense, but **pay-back many time over** throughout the life of an HVDC scheme.
Thank you!