



The National HVDC Centre

Part of  **Scottish & Southern
Electricity Networks**

Commissioning & Operational Support

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1 Introduction

This paper describes the support that the HVDC Centre intends to provide the Caithness-Moray (CM) HVDC Link, during its commissioning and ongoing operation.

The HVDC Centre can also provide this support to other HVDC Schemes connecting to the GB Network during their commissioning and operation.

This support is categorised under the following headings:

- Commissioning Support
- Operational Support – Faults
- Operational Support – Training
- Operational Support – Planning

2 Commissioning Support

During the commissioning of the CM link, the HVDC Centre is able to support the on-site commission team, by providing an off-line facility to review commissioning outputs and solutions (using the replicas control hardware).

Support Area	Support Description	Benefits
Commissioning Support	<p>During the commissioning of an HVDC link, the Centre can:</p> <ul style="list-style-type: none"> ○ Run the commissioning test in parallel in a real-time environment; ○ Review daily on-site commissioning results/output plots to identify potential issues; ○ Recreate any issues in the real-time environment to test scenarios and resolutions; ○ Test any proposed solutions from the supplier (using the replicas) before deploying on the real control hardware. <p>Such support can be provided after the end of each on-site commissioning day (i.e. in the evenings) so that results are available at the start of the next day.</p>	<ul style="list-style-type: none"> ● Speed-up the identification and resolution of commissioning issues.
Trial Operation Support	<p>During the trial operation of the HVDC link, the Centre can:</p> <ul style="list-style-type: none"> ○ Recreate any issues in an off-line environment to test scenarios and resolutions. 	<ul style="list-style-type: none"> ● Speed-up the resolution of issues identified during trial operation.

3 Operational Support – Faults

During the ongoing operation of the CM link, the HVDC Centre can support the management of alarms and faults, to help reduce system downtime.

Support Area	Support Description	Benefits
Faults During Operation	On request from the operations team, when a fault does occur, replicas can be used to diagnose the fault and prove solutions to speed up a return to service.	<ul style="list-style-type: none">• Reduce unplanned outages• Increased speed of fault resolution.
Diagnosing Alarms	Replicas can be used to demonstrate, train and diagnose alarms on the Owner’s high-level control system.	<ul style="list-style-type: none">• Faster fault identification, potentially reducing downtime.
Operational Performance	The Centre can assist with the review of operational experience of the control and protection system.	<ul style="list-style-type: none">• Identification of potential improvements.

4 Operational Support – Training

During the ongoing operation of the CM link, the HVDC Centre can provide a range of ongoing training.

Support Area	Support Description	Benefits
In-House Training	<p>Replicas can be used to train those involved in the Operation of the HVDC link, including:</p> <ul style="list-style-type: none"> ○ Control Room Operators; ○ Maintenance personnel; and ○ Network planners. <p>Such training would include:</p> <ul style="list-style-type: none"> ○ System operation of the HVDC link (from both TO and SO perspective); ○ Use of the SCADA system (GE PowerOn) to control the link; ○ System Alarms; ○ Working with control engineers (and SO) in using HVDC link for mitigation of network issues; 	<ul style="list-style-type: none"> • Develop technology expertise and knowledge. • In-house familiarity reduces reliance on equipment supplier and speeds up fault resolution. • Provide training package (scenario's, documentation etc.) for control engineers and operational planners.
Planned Maintenance Outages	<p>Supporting planned maintenance outages through:</p> <ul style="list-style-type: none"> ○ Rehearsing maintenance procedures, using replicas, to streamline on-site activity; and ○ Liaising with outage planning team on issues relevant to the link i.e. transition-related 275kV network and Short Circuit Strength issues. 	<ul style="list-style-type: none"> • Minimises HVDC asset downtime during planned outages.

5 Operational Support – Planning

During the ongoing operation of the CM link, the HVDC Centre can support and de-risk the future planning and development of the scheme and surrounding network.

Support Area	Support Description	Benefits
Scheme Updates/ Upgrades	<p>Any proposed changes to the control hardware or software of the HVDC link can be tested in a safe environment using the replicas.</p> <ul style="list-style-type: none"> ○ Provide assistance for refurbishment or replacement; and ○ Testing software and hardware upgrades and their effect on network. 	<ul style="list-style-type: none"> ● Reduce the likelihood of mal-operation. ● Reduced maintenance outage.
Multi-Terminal Extension	<p>When the multi-terminal extension to the CM link goes ahead, the Centre can perform ‘Factory System Testing’ of the 3rd terminal’s control hardware, in conjunction with the replicas for the other terminal.</p>	<ul style="list-style-type: none"> ● Using replicas is the only feasible way to perform FST for the 3rd (and subsequent) terminals.
Network Interactions	<p>The surrounding electricity network will continue to be developed; by having replicas the interactions between the HVDC scheme and the wider network can be checked as developments are planned.</p>	<ul style="list-style-type: none"> ● Potentially detrimental controller interactions can be identified and resolved in advance. ● Reduce unplanned outages. ● Reduce the risk of damage to the equipment.
HVDC Converter Interactions	<p>More specifically, where new HVDC schemes are planned in electric proximity to the CM link; the Centre can perform detailed interactions studies, and anticipate adverse control interactions.</p>	<ul style="list-style-type: none"> ● Potentially adverse HVDC controller interactions can be identified and resolved in advance.
Long-term Model	<p>Replicas provide the asset owner with a long term reliable and accurate representation of their HVDC link; which is independent of the supplier, and simulation software.</p>	<ul style="list-style-type: none"> ● Hardware replicas do not go out of date. ● Offline models can be validated against the real controls.

Transmission Planning	<p>The Centre can provide a range of support to the Transmission Planning team, including:</p> <ul style="list-style-type: none"> ○ Supporting HVDC model development and maintenance; ○ Post-event analysis, faults, and interaction studies to improve network reliability and reduce constraints; ○ Supporting transmission planning in integrating HVDC and power electronics into system models; ○ Model validation to improve modelling accuracy; ○ Develop, test and maintain power electronic models (HVDC and FACTS); and ○ Post-event analysis including faults, stability studies and interactions. 	<ul style="list-style-type: none"> ● Reports covering all activities. ● Model version control to maintain master models. ● Specifications for short-circuit levels and control modifications.
System Optimisation	<p>Working across the different teams in trialling the use of control modifications to aid in the reliability of the network and/or added capabilities of the link (such as introduction of Emergency Fast Frequency Response), including:</p> <ul style="list-style-type: none"> ○ Support in the implementation of changes or additional functionality associated with the link; and ○ Use of system measurements in auxiliary control of HVDC i.e. transient stability constraint relief using EPC function. 	<ul style="list-style-type: none"> ● Algorithm development and documentation for auxiliary controls. ● Verification of external controller operation and compatibility. ● Verification of additional terminal operation and compatibility.

6 Conclusion

The National HVDC Centre is able to provide a range of support during commissioning and the ongoing operation of HVDC Schemes.

This support will minimise down-time of the HVDC asset and de-risk its integration into the AC Network.

We provide support in the following areas:

- Commissioning Support;
- Trial Operation Support;
- Faults During Operation;
- Diagnosing Alarms;
- Operational;
- Performance;
- In-House Training;
- Planned Maintenance Outages;
- Scheme Updates/ Upgrades;
- Multi-Terminal Extension;
- Network Interactions;
- HVDC Converter Interactions;
- Long-term Model;
- Transmission Planning; and
- System Optimisation.