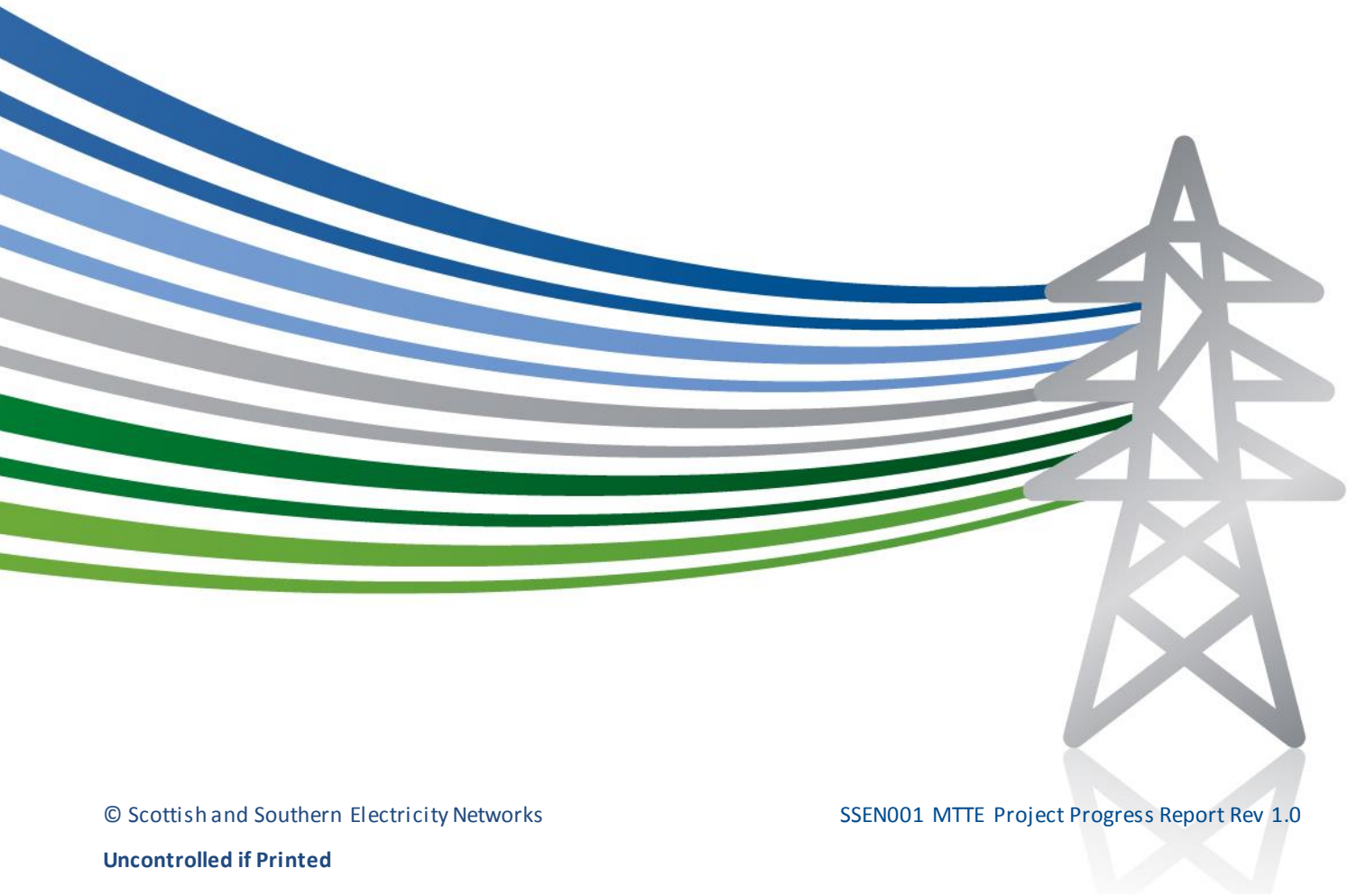
Scottish & Southern Electricity Networks

SHE Transmission

Multi-Terminal Test Environment for HVDC Systems (SSEN001)

Project Progress Report

June 2017



1) Executive Summary

Overview of MTTE

The Multi-Terminal Test Environment for HVDC (MTTE) Project is a collaboration across the Transmission Owners (TOs) to support the feasibility, specification, procurement, testing, operation and maintenance of HVDC transmission systems in Great Britain (GB) and de-risk control interactions; using real-time simulation and replica control panels from HVDC vendors.

This will reduce the cost, increase the efficiency and de-risk GB's investment in HVDC systems.

The MTTE Project is funded through the Electricity Network Innovation Competition (NIC) for 7 years; however the Project aims to create a long-term facility to support HVDC solutions in GB.

The name of this new facility is 'The National HVDC Centre'.

The National HVDC Centre will combine advanced real-time simulation capability with replica control panels from HVDC schemes, to maximise the benefits of GB's significant investment in HVDC systems by:

- Supporting transmission planning and improve specification of HVDC schemes;
- Facilitating multi-terminal solutions and interconnected DC hubs;
- De-risking control interactions between converters in electrical proximity, and with other fast acting power electronic controllers embedded within the AC network;
- Training and developing Transmission Planning and Operations Engineers;
- Undertaking post-commissioning scenario planning and network analysis; and
- Modelling multiple HVDC technologies.

The National HVDC Centre will provide a facility where multiple HVDC schemes on the GB transmission network can be studied to anticipate and resolve potential issues, to ensure the integrity and security of the network.

Progress within this Reporting Period

The key progress this period has been the formal opening of The National HVDC Centre. This was delivered under budget, ahead of schedule and with no safety incidents.

The Centre team have started work, and the RTDS® system has been commissioned.

This has enabled the Centre to commence its operation (and thereby meet SDRC 9.6).

SDRCs

The first five Project SDRCs have been successfully completed in previous reporting periods.

During this reporting period, the project successfully completed SDRC 9.6 (Commencement of MTTE Operations) ahead of schedule.

2) Project Manager's Report

Project Summary

The opening of the Centre was a major milestone for the Project, and also a transition for the team. The Project has moved from focusing on creating the Centre to operating the new facility, and delivering a programme of complex technical work.

While the team is justifiably proud of delivering the Centre, it is now embracing the challenge of delivering world-class technical work to benefit the GB Network and its customers.

The Project is managed as a number of workstreams; an update on the progress made on each workstream during this reporting period is provided below.

Safety

- The project has completed all building works, with no safety incidents.

IT Infrastructure and RTDS®

- The completed IT infrastructure of the new Centre has been commissioned.
- The RTDS® system has been installed and commissioned. The Centre received the worlds-first installation of RTDS®'s latest generation hardware, NovaCor™.
- *Refer to Appendix V for details of the IT infrastructure.*

Replica Control Panels

- The replica control panels for the Caithness-Moray scheme are progressing on-plan, and are expected to be installed on-site during Q2 2018.
- The project team have held monthly teleconferences with ABB to keep updated with their progress.

Building

- There were some delays during the building works, however these were compensated for during the installation works to enable the building to be opened on schedule.
- The Centre was officially opened, as planned, on 26 April 2017.
- *Refer to Appendix IV for details of the completion of the building.*

Academic Programme

- The project "Stability assessment in multi-infeed HVDC systems" with the University of Manchester has been completed, and the learnings will be disseminated through the website.
- The project is working with Strathclyde University to define its support for the project.
- SHE Transmission has also recently closed down its NIA project with the University of Aberdeen on DC-DC converters; due to the relevance, these reports will also be published on the Centre's website.

Communication & Stakeholder Engagement

- **Opening Event**: The main stakeholder engagement during this period was the opening event on 26 April. This provided an opportunity to demonstrate our capabilities to a wide range of Project stakeholders and future potential users of the Centre.
- **Technical Advisory Board:** Also on 26 April, we held the inaugural Technical Advisory Board meeting, which brought together Scottish Power Energy Networks, National Grid (TO & SO) and SHE Transmission to discuss the future plans and direction of the Centre.
- **2nd HVDC Operator's Forum:** Following the success of the 1st Operators' Forum (October 2015), this event (27 April) again brought together owners and operators of HVDC schemes in GB to share knowledge and experiences.

2) Project Manager's Report

- **IET's ACDC Conference:** Simon Marshall (The National HVDC Centre Manager) chaired the conference, and Yash Audichya (Head of HVDC Technology) led the workshop programme at this prestigious event; both sharing knowledge and raising the profile of the new Centre.
- **Website (hvdccentre.com):** The website has been changed to reflect the transition from a delivery project, to an operational centre.
- **Newsletter:** The eighth and ninth editions of the quarterly Newsletter were published in January and April, providing updates to stakeholders and other interested parties [*refer to Appendix I for copies of the Newsletters].*
- **Social Media:** LinkedIn and Twitter are being used to communicate key messages on the Project and also to share Newsletters.

Recruitment

- The Centre Director, Technical Director and IT Engineer have been recruited internally.
- Three experienced simulation engineers have been recruited externally, and a fourth may be recruited depending on workload.
- *Refer to Appendix VI for details of the resourcing of the Centre.*

Project Management & Governance

- The Project has held bi-monthly Steering Group meetings; and has passed Gate 4 and Gate 5 of SSE's LCP (Large Capitol Projects) process, this period.
- From now on the Project will be overseen by the Governing Board of the Centre.

SDRCs

The Project has previously met the first five Project SDRCs (which are detailed in prior Progress Reports).

This period the project successfully completed SDRC 9.6 (Commence Operation of the MTTE), on 26 April 2017.

The criteria consolidate a number of different requirements, and evidence of each of these are provided in the Appendices.

- **Completion of the building of the MTTE facility:** Refer to Appendix IV for details of the completion of the building.
- **Commissioning of the IT/RTS infrastructure**: Refer to Appendix V for details of the commissioning of the IT and RTS infrastructure.
- **MTTE Resourcing:** Refer to Appendix VI for details of the resourcing of the Centre.
- **Management structure in place:** Refer to Appendix VII for details of the management and governance arrangements in place.
- **Processes and procedures agreed:** Refer to Appendix VIII for details of the policies, processes and procedures which are in place for the Centre.
- **Data sets of the AC network received:** and Refer to Appendix IX for details of the models and data which are being used at the Centre.
- **Plan of studies and tests agreed:** Refer to Appendix X for details of the Centre's work plan.

With all of these components in place the Centre became operational on 26 April 2017.

3) Business Case Update

No changes have been made to the Business Case for the MTTE Project, described in the NIC Full Submission document.

4) Progress Against Plan

Summary of Progress

The project has delivered the operational HVDC Centre within budget, ahead of schedule, and with no safety incidents.

The formal opening of the Centre (26 April 2017) successfully engaged a wide range of relevant stakeholders, and received very positive feedback *(refer to Appendix IV for details).*

Risks

Refer to Appendix III for an extract of the project risk Register.

There are currently no 'high' risks, however there are five 'medium' risks which are highlighted below:

- **R004 A sustainable business model is not achieved for the MTTE after the funded period:** From the start of the Project, it was intended that a self-sustaining business model for the Centre would be developed with the Project partners. Scottish Enterprise is employing a Business Development Manager for the Centre, whose role will include developing the long term operating model.
- **R005 The two planned multi-terminal links in GB are cancelled; no other multi-terminal links in GB go ahead:** If no multi-terminal HVDC links are built in GB, the benefit of the MTTE is reduced. However, most of the benefits are applicable to point-to-point links.
- **R012 Lack of continuity in the project team resource during the project**: Project team members are working closely together and sharing knowledge so that knowledge is not held by a single individual.
- **R015 Insufficient external utilisation of the facility:** The Centre team is actively engaged with a number of organisations to specify work, and has already secured the European PROMOTioN project. Furthermore, we are recruiting (through Scottish Enterprise) a dedicated Business Development Manager.
- **R019 The Caithness-Moray (CM) Project is delayed with a knock-on delay to the provision of replicas to The National HVDC Centre:** Significant measures have been built into the CM Project agreements to mitigate this risk.

Following the successful opening of the Centre, the following risks have been closed:

- **R003:** The opening of the MTTE is delayed due to unforeseen circumstances.
- **R020:** SSE's IT, Telecoms or IT security are not engaged early enough, which causes subsequent delays to the project.
- **R028:** There is a risk that the building works runs over time and/or over budget.

Focus This Reporting Period

As reported in the December 2016 Progress Report, the focus over this reporting period has been:

- The formal opening of The National HVDC Centre; and
- Completion of SDRC 9.6 (Commence Operation of the MTTE).

Both of these have been successfully completed on time, the formal opening taking place on 26 April 2017.

Key Activities Next Reporting Period

The Key Activities during the next reporting period are planned to be:

- Delivering the work plan of studies, and disseminating their results; and
- Developing further work for the Centre.

5) Progress Against Budget

The table below details the spend to date against the Project budget for each cost category.

Cost Category [10]	Total Budget	Spend to Date [2]	Comment [1]
Labour			
Project team resource costs	£2,181.68k	£980.13k	26.7% below plan [refer to Note 3]
MTTE resource costs	£2,032.13k	£65.01k	0.2% above plan
Contractors			
Project team resource costs	£288.44k	£42.23k	80.5% below plan [refer to Note 3]
IT			
IT Infrastructure (incl RTS and Replica Panels)	£3,828.21k	£990.88k	51.7% below plan [refer to Note 4]
Annual Running Costs of the MTTE	£304.37k	£6.24k	48.9% below plan [refer to Note 12]
Travel & Expenses			
Travel & Expenses	£197.40k	£14.79k	81% below plan [refer to Note 5]
Other			
Academic Support	£827.07k	£107.11k	69.8% below plan [refer to Note 6]
Learning & Dissemination	£165.41k	£18.60k	73.8% below plan [refer to Note 7]
MTTE Building Facility	£2,916.20k	£2,171.42k	25.5% below plan [refer to Note 8]
Annual Running Costs of the MTTE	£515.09k	£1.1k	94.7% below plan [refer to Note 12]
Recruitment & Training	£137.90k	£0	Below plan [refer to Note 9]
Total [11]	**£13,393.91k**	**£4,397.51k**	38.6% below plan

5) Progress Against Budget

Notes:

1) The percentage below plan refers to spend-to-date as a percentage of the budget-to-date. The budget-to-date is calculated as a pro-rata of the annual budget in the Full Submission Spreadsheet (to May 2017).
2) Project Spend as extracted from the finance system (Harmony) on 6 June 2017.
3) Current spend on project team resource costs is lower than the average spend profile assumed in the Full Submission Spreadsheet; the total spend is forecast to be within 5% of the total budget.
4) Payment for the RTDS® system and Replicas will come through in the next reporting period.
5) Travel and expenses spend is being kept to a minimum.
6) Academic support projects started on 1 June 2016, later than assumed in the Full Submission Spreadsheet; the total spend is forecast to be within 5% of the total budget.
7) Current spend on Learning & Dissemination is lower than the average spend profile assumed in the Full Submission Spreadsheet.
8) The spend on the MTTE Building will be within 5% of the budget, though not all invoices have been received and processed yet.
9) The recruitment of the Centre team has been coordinated by SSE's Human Resources team; some external recruitment costs have been incurred, but have not yet been processed through the finance system.
10) There is no Project budget nor Project spend under the Cost Categories: Equipment, IPR Costs, Payments to Users, Contingency and Decommissioning.
11) Up to 22 November 2016 the project spent £2,565,236; and from 23 November 2016 to 26 May 2017 the project spent £1,689,671 (which has been processed through the Project Bank Account, see Appendix II for details), totalling spend of £4,254,907. From 27 May 2017 to 5 June 2017 the project spent £142,600, which has yet to be processed through the Project Bank Account, so the total project spend to 5 June 2017 is £4,397,509 (as detailed in the table above).
12) Annual running costs (both IT and non-IT) are currently below plan; however the total spend is forecast to be within 5% of the total budget.

6) Bank Account

A copy of the current project bank account statement is provided in Appendix II.

7) SDRCs

An update on the Project's SDRCs is provided below.

The MTTE identified eight Successful Delivery Reward Criteria (SDRC) which span both the objectives and the lifecycle of the Project. Furthermore Ofgem's decision letter, dated 27 March 2015, added an additional criteria (SDRC 9.9).

The following table lists each SDRC in chronological order and details the Project's progress towards their achievement.

SDRC	Due	Description	Evidence	Status
9.1	31/8/2014	Formal Agreement with Project Partners. The success of this Project will be crucially dependent on the involvement of the Project partners & stakeholders. Therefore, an early indication of success of the Project is the establishment of formal agreements with the Project partners (National Grid, Scottish Power and NETSO) and HVDC expert support.	Signed agreements with Project partners (National Grid, Scottish Power and the NETSO) (note, agreement will include IP security requirements) and HVDC expert support. Refer to Appendix I for the Agreement between SP Transmission, National Grid Electricity Transmission and SHE Transmission.	Completed (SDRC met) Formal agreements with Scottish Power and National Grid were signed and concluded on 29 August 2014. Parsons Brinkerhoff was engaged as external HVDC expert support in February 2014.
9.2	31/10/2014	**OFTOs and Renewable Developers Event** Given the anticipated number of HVDC schemes in GB for connection of offshore renewable, the engagement of OFTOs and Renewable Generators is important to ensure the benefits of the MTTE are maximised, therefore the MTTE Project will hold an event to inform and encourage their participation.	Holding an event to which all OFTOs and Renewable Generators are invited, to inform and encourage their participation in the MTTE. Refer to Appendix II for the Letter of Support from the ENA OFTO Forum. Refer to Appendix III for a detailed report on the Engagement Event.	**Completed (SDRC met)** The OFTOs and Renewable Generators Event was held in Glasgow on 11 September 2014. In addition, the Project presented to the ENA's OFTO Forum on 20 August 2014.
9.3	31/12/2014	**Engagement with 1st HVDC Project** The purchase of the 1st set of replica control panels for the MTTE will be key to its success, and the panels will be purchased through an HVDC Project. Therefore the formal engagement of the initial HVDC Project is an important early milestone.	Formal agreement between the MTTE Project and an HVDC Project, which includes the intention to purchase/supply replica control panels through the HVDC Project's procurement process. Refer to Appendix IV for the Memorandum of Understanding between the MTTE Project and the Caithness-Moray Project.	**Completed (SDRC met)** A memorandum of understanding has been signed, between the MTTE Project and the Caithness-Moray Project, confirming the arrangement for the provision and use of replica control panels.
9.4	31/5/2015	**Complete Design of MTTE Facility** The completed design of the MTTE facility, both technical design and physical design, and the agreement of this design with the Project stakeholders (including vendors), is a key milestone for the Project. The detailed design will be consolidated within the Design Development Document, and will adhere to the requirements defined in the requirements specification.	Design development document and requirements specification for the MTTE facility endorsed by participating vendors and signed-off by SHE Transmission, NGET, NETSO and SPT.	**Completed (SDRC met)** The Design Development Document and Functional Specification were reviewed at the Design Workshop on 23rd April 2015, following which each stakeholder provided written confirmation of their endorsement.

7) SDRCs

SDRC	Due	Description	Evidence	Status
9.5	31/10/2015	**Establishing HVDC Operators' Forum and Website** A key component of our knowledge and dissemination strategy is the establishment of the HVDC Operators' Forum (to which all Network Licensees, including OFTOs will be invited), the associated members' Website (which provides a secure area to share the MTTE outputs with Transmission Licensees), and the public Website.	The establishment of the HVDC Operators' Forum (including holding the 1st event), together with the publishing of the MTTE Websites.	**Completed (SDRC met)** The first HVDC Operators' Forum event was held on 8 October 2015; and the second on 27 April 2017. The website (hvdccentre.com) was launched in April 2015; to tie-in with the HVDC Operators' Forum enhanced functionality was deployed in October 2015, providing discussion forum functionality, and a secure library.
9.6	31/5/2017	**Commence Operation of the MTTE** The criteria consolidates the: ○ Completion of the building/upgrade of the MTTE facility; ○ Commissioning of the IT/RTS infrastructure; ○ MTTE Resourcing; ○ Management structure in place; ○ Processes and procedures agreed; ○ Data sets of the AC network received (from NETSO); and ○ Plan of studies and tests agreed. When all of these are in place, the MTTE will be able to commence operations, therefore this is a key milestone and measure of success of the Project.	Commencement of MTTE Operations.	**Completed (SDRC met)** The facility was formally opened on 26 April 2017. The building, IT infrastructure, resourcing, governance, processes, data/models and work plan were all in place to enable operation to commence. *[refer to Appendices for details]*
9.7	31/3/2018	**Publishing Studies & Test results** The key outputs from the MTTE are the reports on specific scenarios which are completed within the MTTE, which will be disseminated to transmission licensees. Therefore, a key success criterion is the publishing of studies or test reports on the MTTE members' Website.	Publishing the first set of reports on a specific Transmission Licensee led Project, on the MTTE members' Website.	**On Target**
9.8	31/3/2020	**Future Business Model** At least 12 months prior to the end of the funded operation of the MTTE (i.e. by end of March 2020), the MTTE management team will submit a proposal for the future operation and funding of the MTTE (post NIC funding), to Ofgem.	Submission of proposal regarding MTTE ongoing operation and funding to Ofgem.	**On Target**

7) SDRCs

SDRC	Due	Description	Evidence	Status
9.9	31/3/2021	**Second Replicas** Use reasonable endeavours to secure the provision and testing of a second set of replica control panels for the MTTE from a second vendor. The panels would be provided by an HVDC Project, a transmission Licensee or a second vendor.	Submission of evidence of the use of reasonable endeavours for the provision and testing of the second vendor's replica control panels at the MTTE facility; by the end of March 2021.	**On Target**

Completed (SDRC met)	Emerging issue, remains on target	SDRC completed late
On target	Unresolved issue, off target	Not completed and late

8) Learning Outcomes

The following learning objectives have been set for the MTTE Project:

- **Support Transmission Planning of HVDC schemes:** The National HVDC Centre will produce analysis and reports on the development scenarios investigated, and will share these with the other TOs/OFTOs to increase the understanding of the impact of HVDC development scenarios on the existing network. In addition, the models developed will be shared with Network Licensees.
- **Improve Requirement Specification of HVDC schemes:** The National HVDC Centre will produce analysis and reports advising Network Licensees on the specification of HVDC schemes. These reports will be shared with other Network Licensees to increase their understanding.
- **Facilitate Multi-Terminal HVDC solutions:** The National HVDC Centre will produce analysis and reports on the Multi-terminal scenarios, and will share these with the other TOs/OFTOs to increase the understanding of Multi-Terminal HVDC.
- **Facilitate Competition and Multi-Vendor HVDC schemes:** The National HVDC Centre will produce reports on multi-vendor compatibility to inform the development of HVDC standards and interoperability. Acceptance testing reports will also be produced.
- **De-risk Control interactions between co-located and electrically connected converters, and with other active controlled equipment:** The National HVDC Centre will produce reports on the impact of planned HVDC systems, providing detail on any control interactions with converter stations in close proximity and active controlled equipment. These reports will be shared with all Licensees to improve sector-wide understanding of the associated issues. This would include reports on the integration of generators into HVDC networks and the associated risk of adverse control interactions and their control protocols and strategies.
- **Train Transmission Planning and Operational Engineers:** The National HVDC Centre will provide on-site training (available to all Transmission Licensees) and will share the associated training material.
- **Undertake Post commissioning scenario planning and operational optimisation:** The National HVDC Centre will produce recommendation reports on specific HVDC schemes to enable optimisation which will be shared with all Licensees.
- **Model New HVDC Technologies:** The National HVDC Centre will produce analysis and reports on the performance, impact and interactions of new HVDC technologies or active controlled devices in accurately simulated GB situations and their suitability for specific applications / locations.

Learning during this reporting period

During this reporting period:

- The project "Stability assessment in multi-infeed HVDC systems" with the University of Manchester has been completed, and the learnings will be disseminated through the website.
- The HVDC Operators' Forum event (27 April 2017), shared knowledge and experience between the owners and operators of HVDC schemes in GB.

9) IPR

No relevant IPR has been generated or registered during this reporting period.

10) Risk Management

Risk Management Plan

The Project has a Project Risk Management Plan that describes how Project risks are managed throughout the Project.

The Project risk register is regularly reviewed by the Project team and the key Project risks are highlighted and discussed at the steering group meetings, where mitigating actions are agreed.

Risk Register

An extract of the current Project Risk Register is provided in Appendix III.

11) Accuracy Assurance Statement

PPR Preparation Steps

To ensure that the information contained in this report is accurate and completed, the following steps have been taken, the report has been:

- Prepared by the Project Manager;
- Reviewed by the Project Team;
- Reviewed by the Steering Group; and
- Approved by the Project Director and Regulation.

Sign-off

As the senior manager responsible for the MTTE Project, I confirm that the processes in place and steps taken to prepare this PPR are sufficiently robust and that the information provided is accurate and complete.

9 June 2017

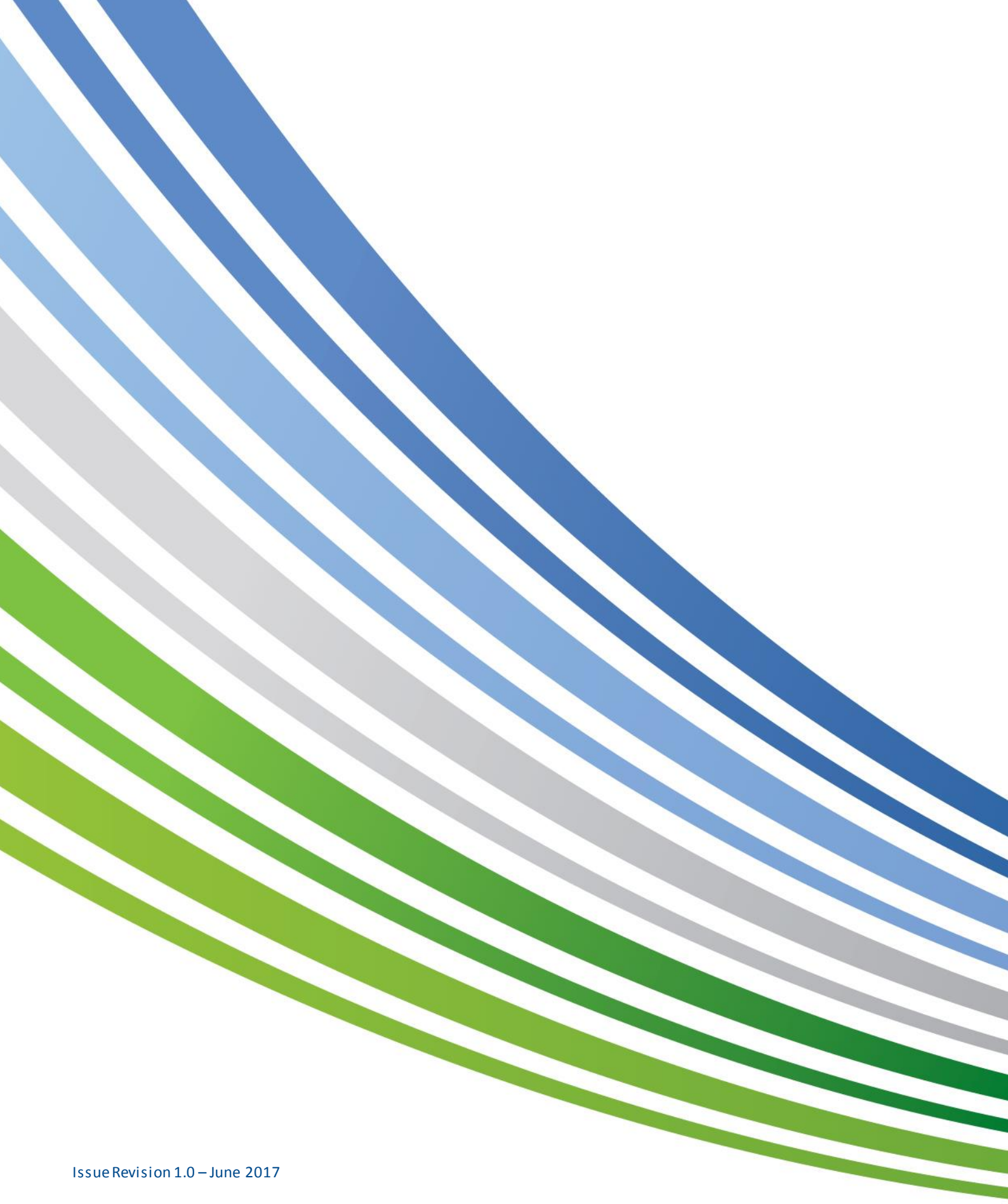
Stewart A Reid

Head of DSO & Innovation
Scottish and Southern Electricity Networks

Date **Date**

12) Appendices

Appendix I	January 2017 and April 2017 Newsletters
Appendix II	Project Bank Account Statement
Appendix III	Project Risk Register
Appendix IV	Completion of the Building
Appendix V	Commissioning of the IT/RTS infrastructure
Appendix VI	Resourcing
Appendix VII	Management structure in place
Appendix VIII	Processes and procedures agreed
Appendix IX	Data sets of the AC network
Appendix X	Plan of studies and tests



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