Powerful-CB

Project Progress Report

December 2017

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Contents

Glossary

Term	Description
ABB	Our technology partner for Method 1
AMAT	Applied Materials, our technology partner for Method 2
BAU	Business As Usual
CB	**Circuit Breaker** – Protection device that interrupts the flow of current in an electric circuit in the event of a fault
DG	Distributed Generation
DNO	Distribution Network Operator
ENA	The Energy Networks Association
EPN	Eastern Power Networks plc
ENWL	Electricity North West Limited
FCL	Fault Current Limiter – a FLMT that attenuates fault current by increasing its impedance (only) during a fault.
FLMT	**Fault Level Mitigation Technology** – a technical solution that reduces fault levels on the network
FLCB	**Fault Limiting Circuit Breaker** – a FLMT that blocks fault level contributions from a transformer / bus coupler / generator by disconnecting it before the first current peak of the fault
FNC	Frazer-Nash Consultancy
FSP	The Powerful-CB Full Submission Proposal - http://bit.ly/powerful-cb-fsp
GB	Great Britain
HSE	The Health and Safety Executive
Imperial	Imperial Consultants (Imperial College London's consultancy company)
IPR	Intellectual Property Rights
LPN	London Power Networks plc
M1	Method 1 - Installation of a FLCB at a substation
M2	Method 2 - Installation of a FLCB at a customer's premises
NIC	Network Innovation Competition
RIIO-ED1	The current electricity distribution regulatory period, running from 2015 to 2023
SDRC	Successful Delivery Reward Criteria
SPN	South Eastern Power Networks plc
TRL	Technology Readiness Level
UKPN	UK Power Networks
WS1/2/3/4	Workstream 1/2/3/4

1 Executive summary

1.1 Background

Powerful-CB aims to demonstrate that fault-limiting circuit breakers (FLCBs) can enable us to connect more distributed generation (DG) to our 11kV distribution networks.

A FLCB is a solid-state circuit breaker that operates 20 times faster than existing ones. This high-speed operation can mitigate fault level contributions from DG, allowing us to connect more DG (particularly combined heat and power) to fault-level constrained networks in dense urban areas. This will help accelerate the decarbonisation of heat, which is a key element of the Government's Carbon Plan.

We are working with two technology partners to develop two types of FLCB. ABB will develop a FLCB for use at a primary substation, known as Method 1 (M1). Applied Materials (AMAT) will develop a FLCB for use at a customer's premises, known as Method 2 (M2). We believe Method 1 will be the world's first demonstration of a FLCB with a fast commutating switch, and Method 2 will be GB's first demonstration of a FLCB, or any kind of FLMT (other than an Is-limiter), at a customer's premises..

We are also working with Frazer-Nash Consultancy (FNC) and Imperial Consultants (Imperial) to develop the safety cases for these devices.

The project started on 1 January 2017 and is due to complete on 31 August 2021.

1.2 Key updates

Two of the three roles on the core project team are filled. In this reporting period, the Project Lead and WS3 & 4 Lead were recruited. The Project Lead, with the support of a graduate innovation engineer, will lead on WS1 & 2 activities until we secure a resource to lead.

We **launched the Powerful-CB customer working group**, to discuss the trial and future requirements of FLCBs, with a launch event consisting of interested parties and potential trial participants.

We **identified key internal stakeholders at UK Power Networks** and invited them to join an internal working group to ensure smooth installation and to aid transition to BAU.

We have **received expressions of interest from potential M2 trial participants** and are currently reviewing potential trial sites based on site selection criteria.

We have **conducted a number of workshops contributing to the safety case** and are continuing to work with FNC to develop the safety case further.

We have **identified potential M1 substation trial sites** and are working with the relevant stakeholders within UK Power Networks to select the site.

We have **submitted our first Successful Delivery Reward Criteria (SDRC) report (9.3.1 – Understanding customers' needs)** on time.

We have **presented the project at a number of events to raise awareness and aid with M2 trial recruitment** as detailed in this report.

1.3 Outlook for next period

Workstream 1 (Prototype and validation testing) will continue focus on developing the preliminary safety case, working towards SDRC 9.1.3 (Independent review of safety case) due in May 2018. We will also finalise the collaboration agreement with AMAT, so that they can start work on Method 2 development in early 2018. The Project Lead will lead these activities with the support of a graduate innovation engineer whilst we recruit a resource to lead WS1 & 2.

Workstream 2 (Demonstration on the network) will select trial sites for both M1 and M2 and will focus on developing the FLCB network design standard and a preliminary design for the selected trial sites. The Project Lead will lead these activities with the support of a graduate innovation engineer whilst we recruit a resource to lead WS1 & 2.

Workstream 3 (Understanding customers' needs) will focus on site selection and customer liaison for M2 trial. WS3 will also carry out the design of the commercial offering of FLCB devices by working with interested customers and internal UKPN stakeholders and working with AMAT on FLCB technical design offerings.

Workstream 4 (Knowledge dissemination) will begin to disseminate knowledge learned from the trial recruitment phase. In addition we will continue to publish relevant documents as they are produced and will provide a dissemination event timeline in the next period of reporting.

1.4 Issues

Finding the right people for specialist project roles (section 2.2) and negotiating terms and conditions with the project partners (section 2.3) have remained key challenges for the project in this reporting period.

The key summary of progress to date:

- **All activities related to the delivery of SDRCs are on schedule**
- The Bid Lead has managed WS1 & 2 activities and handed over to the Project Lead with the support of a graduate innovation engineer
- Key internal stakeholders have been identified and engaged with the project
- We continue to work closely with legal and commercial teams to discuss the AMAT collaboration agreement
- We will monitor and manage progress to minimise the risk of delays

2 Project Manager's report

Powerful-CB aims to demonstrate that fault-limiting circuit breakers (FLCBs) can enable us to connect more distributed generation (DG) to our 11kV distribution networks.

The project started on 1 January 2017 and is due to complete on 31 August 2021.

This section describes the progress made in the reporting period from June to December 2017. Key issues, deliverables or events are drawn out and described in detail; referring where necessary to other sections of the report. This section also provides an outlook onto the next reporting period, and describes any key issues or concerns that we consider will be a major challenge in the next reporting period.

2.1 Project team

The core project team comprises three dedicated roles:

Role	Status	Appointed date	Start date
Project Manager	Appointed	15 May 2017	28 June 2017
Workstream 1 & 2 Lead	Recruitment ongoing		
Workstream 3 & 4 Lead	Appointed	5 April 2017	3 July 2017

We had planned to mobilise the project team sooner, however finding the right people for these specialist roles has been difficult. For example:

- We have interviewed three groups of candidates for the WS1 & 2 Lead, although we have not yet found a suitable candidate.

In order to mitigate any delays:

- The Bid Lead has led WS1 & 2 activities and has subsequently handed over to the Project Lead
- A graduate innovation engineer has supported tasks, predominantly in WS1 & 2 and will continue to do so until a resource has been found
- We have delayed any tasks not on the critical path to an SDRC, to allow us more time to find the right people for those roles
- We will monitor and manage progress to minimise the risk of further delays

2.2 Consultants

We have appointed two consultants:

WS	Role/Scope	Appointee	Status	Start date
WS1	**Deliver preliminary safety cases in May 2018**	Frazer-Nash Consultancy (FNC)	Contract signed	16 March 2017
WS1	**Provide expert advice on power electronics**	Imperial Consultants	Contract signed	20 June 2017

2.2.1 Safety case consultant (FNC, WS1)

To ensure we deliver the safety case on time and on budget, we are contracting the safety case consultant in phases:

- Phase 1: Deliver preliminary safety case in May 2018
- Phase 2: Update safety case in May 2019 with data and learning from factory testing
- Phase 3: Update safety case in June 2021 with data and learning from field trials

We selected FNC to deliver phase 1 via a competitive fixed-price tender. We invited five consultants to tender for phase 1, and received three conforming bids, which we evaluated in terms of experience, methodology, scope, and price.

We will tender for phases 2 and 3 closer to the date, when their scope will be more certain. We will decide when the time comes whether to let another competitive tender for these phases, or re-appoint FNC as the incumbent.

There has been some difficulty in ensuring availability of relevant stakeholders to attend workshops and dates have been pushed back where appropriate - including invoicing dates. All work for SDRC 9.1.3 and 9.1.4 are on track and we are working with FNC closely to ensure that inputs required from workshop attendees are provided in a timely fashion.

FNC's milestones for phase 1 are as follows:

FNC Milestones	Due Date	Status
Safety case process & principles FNC will work with UK Power Networks to agree and explain how we will develop the safety cases for FLCBs.	May 2017	Completed
Hazard assessment FNC will determine the hazards and failure modes that the safety case needs to address, using pre-existing analyses where available, and collaborative workshops with UK Power Networks, ABB, AMAT, and Imperial, scheduled for 20-21 June 2017.	June 2017	Completed

FNC Milestones	Due Date	Status
Risk assessment FNC will assess the risks of utilising FLCB devices, using a combination of deterministic and probabilistic safety analysis.	August 2017	Completed
Mitigations FNC will identify and analyse proposed risk reduction mitigations, including independent backup protection schemes, and identify any device design changes needed to achieve acceptable levels of overall risk.	September 2017	Completed
Claims, arguments & evidence FNC will define claims and arguments, together with the detailed assessment of risks under a number of plant configurations and fault conditions, for each of the FLCB devices. To support these claims and arguments, they will present evidence from a number of sources, including: design verification and validation; calculated reliability; historical reliability data for components; and historical data for use of mitigations.	November 2017	Ongoing
Safety acceptance criteria FNC will develop safety acceptance criteria for laboratory testing and field trials, based on the safety functional requirements, analysis, and evidence derived in support of the safety case.	December 2017	On schedule
Preliminary safety case FNC will deliver the preliminary safety case, incorporating comments from UK Power Networks and other stakeholders, for submission to the ENA review panel.	March 2018	On schedule

2.2.2 Power electronics consultant (Imperial Consultants, WS1)

We have contracted Professor Tim Green from Imperial Consultants (Imperial College London's contracting entity) on a time and materials basis to provide ad hoc expert advice on power electronics. His first engagement was participating in the safety case hazard assessment process. He has not been engaged further in this reporting period but will remain available when required.

2.3 Collaboration agreements

We intend to sign collaboration agreements with two project partners:

WS	Role/Scope	Project Partner	Status	Commentary
WS1	**Develop Method 1 FLCB prototype**	ABB	Contract signed	Use schedule contingency to mitigate two-month late start on ABB tasks.
WS1	**Develop Method 2 FLCB prototype**	Applied Materials (AMAT)	Negotiations ongoing	No AMAT tasks scheduled until early 2018 but design work is continuing ahead of the contract being signed.

We had originally planned to sign all collaboration agreements by end of March 2017, but negotiating terms and conditions with the project partners has been a challenge. We reported this in the last progress report and this remains a challenge in this reporting period. We have been working with our project partners to resolve key legal and commercial issues in a way that allows all parties to protect their interests, complies with the NIC governance, and ensures the best value for our customers' money. We have made progress in this area, signing off the ABB collaboration agreement and reaching consensus on several components of the AMAT collaboration agreement. We hope to resolve remaining issues by the start of 2018 to minimise any delay to AMAT's tasks.

2.3.1 Method 1 – ABB

In this reporting period, ABB have conducted a number of activities relating to Method 1:

- Met deadlines according to the new schedule defined in the last reporting period
- Ordered parts and begun testing
- Provided input to safety case

ABB's key deliverables are as follows:

Ref	ABB Deliverable	Evidence	Original Date	Revised Date	Status
1	Sub parts delivered for one prototype unit	Copies of the relevant invoices and delivery notes	12/06/2017	12/08/2017	Complete
2	First complete prototype assembled	Evidence that the prototype is ready, e.g. completed punch list and results from basic functional tests	08/12/2017	08/02/2018	On schedule
3	Validation testing at ABB's corporate research facility	Validation testing report approved by UK Power Networks	06/04/2018	06/06/2018	On Schedule
4	Validation testing at high power lab	Validation tests witnessed by UK Power Networks Representative; and Validation	18/12/2018	18/02/2019	On Schedule

		testing report approved by UK Power Networks			
5	Energisation at UK Power Networks	Commissioning report approved by UK Power Networks	04/06/2019	04/08/2019	On schedule

Deliverable 4 “Validation testing at high power lab” provides the key inputs to SDRC 9.1.1 due on 31 May 2019. ABB now plans to complete this deliverable on 18 February 2019, which still gives us over three months to complete the SDRC. We will work with ABB closely in the run up to this deadline to ensure there are no impacts on the SDRC submission.

2.3.2 Method 2 – AMAT

We expected to conclude negotiations with AMAT during this reporting period i.e. at the latest by December 2017 but there are some negotiations still ongoing. We are hoping to resolve these issues at the earliest opportunity, to minimise impact on Method 2 development, scheduled to start in January 2018.

We have signed a non-disclosure agreement with AMAT that enables us to collaborate with them on the safety case in the meantime.

2.4 Workstream 1 – Prototype and validation testing

The ultimate objectives of Workstream 1 (WS1) are:

- Deliver one working Method 1 (ABB) prototype to the Method 1 trial site
- Deliver one working Method 2 (AMAT) prototype to the Method 2 trial site
- Develop preliminary safety cases for both FLCBs

2.4.1 Key achievements

- **We continued with the safety case work – moving to mitigations and cost benefit analysis**
- **We signed the collaboration agreement with ABB**

2.4.2 Outlook

ABB will continue to focus on building their first full scale FLCB prototype

We have provided a list of ABB’s deliverables in section 2.3.1.

FNC will continue developing the safety case, working towards SDRC 9.1.3 and 9.1.4 (independent review of the preliminary safety case) due in May 2018

We have provided a list of FNC’s deliverables in section 2.2.1.

AMAT will continue design work for the Method 2 solution

2.5 Workstream 2 – Demonstration on the network

The ultimate objectives of Workstream 2 (WS2) are:

- Install and commission the FLCBs at the trial sites
- Collect adequate data to prove that FLCBs are safe and effective
- Update the preliminary safety case to consider data and learning from the field trials

2.5.1 Key Achievements

We have progressed **site selection and preliminary design** for the Method 1 trial site. Once the preliminary design is complete, we will present it to both the project design authority and our BAU design review board for approval to proceed to detailed design.

We have completed a **feasibility study on a sample of primary substation sites**, to confirm the applicability of FLCBs to our network. We selected a representative sample of sites that have fault level constraints, and will conduct a high-level study on each to determine whether a FLCB would be a feasible solution.

2.5.2 Outlook

The Bid Lead has handed over project management duties to the Project Lead who has led WS2 activities in this reporting period. The Bid Lead has now handed all duties to the Project Lead who is leading WS2 activities with the support of a graduate innovation engineer until a permanent resource is secured for this role.

We will develop a **FLCB network design standard**, which will explain where and how we would implement FLCBs on our network. As with the FLCB technical specification, we will work with our key stakeholders to ensure that this document is fit for purpose. We will also incorporate learning from the aforementioned feasibility study.

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2.6 Workstream 3 – Understanding customers' needs

The ultimate objectives of this Workstream 3 (WS3) are:

- Understand our customers' needs
- Ensure that we design the solutions to meet our customers' needs
- Recruit a trial participant for the Method 2 demonstration

2.6.1 Achievements

We have held a number of customer surgeries with interested parties

We have submitted SDRC 9.3.1 (Understanding Customers' requirements) to Ofgem on time

We presented the project to potential Method 2 trial participants at the following events:

- UK Power Networks DG Customer Forum on 18 July 2017.
- The Association of Decentralised Energy District Heating and Cooling Forum on 11 October 2017; and
- The Associated of Decentralised Energy Commercial Forum on 18 October 2017.

2.6.2 Outlook

We will continue to hold **customer dialogue sessions** to develop understanding of our customers' requirements for FLCBs on their premises.

We will select a Method 2 trial participant (i.e. a DG customer who is willing and able to let us install a Method 2 FLCB on their premises) by the end of 2017/early 2018 from those customers who have already expressed interest.

We will sign the collaboration agreement with AMAT so that site selection visits can be conducted by UKPN and AMAT staff.

2.7 Workstream 4 – Knowledge Dissemination

The ultimate objective of Workstream 4 (WS4) is to disseminate knowledge to our key stakeholders.

2.7.1 Achievements

- **We have submitted and published the SDRC 9.3.1 – Understanding customers' requirements**
- **We have been accepted to present our findings on trial recruitment at the Chartered Institute of Building Services Engineers (CIBSE) Technical Symposium 2018**
- **We are exhibiting at the ADE Heat Conference**
- **We will be speaking about the project at the LCNI conference**

2.7.2 Outlook

We will continue to publish documents as we produce them (see list in section 9.2, and details of safety case deliverables in section 2.2.1).

We will continue to share learning directly with ENWL, with whom we have been discussing opportunities to collaborate on the safety cases for Powerful-CB and Respond (ENWL's innovation project addressing fault level constraints).

3 Business case update

This section notes any developments or events which might affect the benefits to be gained from the Project. Where possible we have quantified the changes these developments or events have made to the Project benefits compared to those outlined in the FSP.

We have not discovered any new information that affects the business case. The business case thus remains consistent with our FSP.

4 Progress against plan

This section summarises the project's progress in the previous period. It describes issues we faced and how we managed them, key achievements, notable events, key planned activities for the next reporting period, and any issues we expect in the next reporting period.

4.1 Overview

All SDRCs are on schedule, although we have consumed some schedule contingency to mitigate challenges with resourcing, and negotiating collaboration agreements.

4.2 Issues affecting progress

The main challenges affecting progress in this period were:

- Finding the right people for specialist project roles (see section 2.2 for details)
- Negotiating terms and conditions with the project partners (see section 2.3 for details)

The key points relating to progress are:

- **All SDRCs are on schedule**
- The Project Lead is managing the project and delivering any tasks on the critical path to an SDRC
- We have delayed non-critical tasks by consuming contingency (float) in the schedule
- We will monitor and manage progress to minimise the risk of delays

5 Progress against budget

This section is provided as a confidential appendix.

6 Bank Account

This section is provided as a confidential appendix.

7 SDRC

This section provides a brief narrative against each of the SDRCs set out in the Project Direction. The narrative describes progress towards the SDRCs and any challenges we may face in the next reporting period.

SDRC	Evidence	Progress/Status
9.1 Work with industry to advance new FLMTs based on FLCB technology		
9.1.1 Prototype and lab test a substation-based solution (Method 1)	**Publish Learning Report – Development of a FLCB for substations**, which will include: recommendations for specifying a substation-based FLCB; results and learning from type tests (including a short circuit test) conducted at an accredited high power laboratory; and requirements for integrating FLCBs into existing networks and ensuring safety. (31 May 2019)	• **On schedule**, despite delays in negotiating collaboration agreement and FLCB specifications. • We finalised the **collaboration agreement with ABB** on 02/06/2017 • We finalised the **FLCB specification** on 08/05/2017
9.1.2 Prototype and lab test a customer-based solution (Method 2)	**Publish Learning Report – Development of a FLCB for customers**, which will include: recommendations for specifying a customer-based FLCB; results and learning from type tests (including a short circuit test) conducted at an accredited high power laboratory; and requirements for integrating FLCBs into existing networks and ensuring safety. (31 August 2019)	• **On schedule** • We are currently negotiating the **collaboration agreement with AMAT**. We expect to finalise and sign it before AMAT need to start work on Method 2 development.
9.1.3 Independent review of safety case	**Issue preliminary safety case to relevant ENA panel(s) for independent review** which will include: Definition and justification of acceptable levels of risk; analysis of failure modes and effects; details of proposed mitigations; and claims, arguments, and evidence to demonstrate that the proposed mitigations reduce the overall level of risk to an acceptably low level. (31 May 2018)	• **On schedule** • We appointed Fraser-Nash Consultancy to produce the safety case, and held kick-off meeting on 16/03/2017. • We finalised the **safety case process and principles document** on 05/05/2017.

SDRC	Evidence	Progress/Status
9.1.4 Safety case for FLCB installation without back-up	**Publish preliminary safety case** which will include the technological and operational safety case to the time when the trial equipment could be deployed as BAU without the FLCBs being installed in series with a back-up circuit breaker. (31 May 2018)	• **On schedule** • See update for 9.1.3
9.2 Trial the technical suitability of these two technologies including effectiveness and safety considerations for relieving fault level constraints for 11kV networks		
9.2.1 Install and commission solution at an 11kV substation (Method 1)	**Publish Interim Learning Report – Demonstration of a FLCB for substations**, which will include results and learning from installation, commissioning, and operation to date of a FLCB at a substation. (31 July 2020)	• **On schedule**
9.2.2 Install and commission solution at a customer's premises (Method 2)	**Publish Interim Learning Report – Demonstration of a FLCB for customers**, which will include results and learning from installation, commissioning, and operation to date of a FLCB at a customer's premises. (31 July 2020)	• **On schedule**
9.2.3 Demonstration of solution at an 11kV substation (Method 1)	**Publish Final Learning Report – Demonstration of a FLCB for substations**, which will include results and learning from operating and maintaining a substation containing a FLCB, and technical performance of the FLCB and overall solution under real network conditions. (30 June 2021)	• **On schedule**
9.2.4 Demonstration of solution at a customer's premises (Method 2)	**Publish Final Learning Report – Demonstration of a FLCB for customers**, which will include results and learning from operating and maintaining a FLCB at a customer's premises, and technical performance of the FLCB and overall solution under real network conditions. (30 June 2021)	• **On schedule**

SDRC	Evidence	Progress/Status
9.3 Assess the suitability of the solutions against customers' needs		
9.3.1 Review the customer needs for these two FLCBs technologies on behalf of DNOs and DG stakeholders	**Publish Learning report – Understanding customers' requirements**, which will describe our findings from customer dialogue sessions, i.e. understanding their requirements and concerns about FLCBs, and customer feedback. (31 October 2017)	• **Complete**
9.3.2 Assess the (commercial) business case based on the technical and customer findings, focusing on investment decision criteria and trade-offs, such as cost, time to connect, space and impact on security of supply	**Publish Learning report – Suitability of FLCBs**, which will inform generation customers of the solutions, answer frequently-asked questions, and provide enough information for customers to assess whether the solution meets their requirements (e.g. cost, time to connect, space required, operational impacts, etc.). (31 March 2020)	• **On schedule**
9.4 Share the learning throughout the project with the wider utility industry		
9.4.1 Share overall learning from the project with customers, regulators, other DNOs, other manufacturers, and academia via a stakeholder event	Publish key materials from the stakeholder event (e.g. slides), and provide Ofgem with a list of invitees and attendees. (30 September 2021)	• **On schedule**

8 Learning outcomes

This section briefly describes the main learning outcomes from the reporting period, and how we have disseminated them.

We published the SDRC report 9.3.1 – Understanding Customers' Requirements

The document can be found on the ENA Smarter Networks Portal: http://www.smarternetworks.org/

The key lessons learnt while producing this document were:

- **Powerful-CB has wide-scale applicability –** FLCB technology is of interest to a wide range of customer types from a geographic spread
- **Customer Opinions on benefits and concerns** – Customers have expressed a range of potential benefits and concerns relating to Powerful-CB but some key themes emerged relating to finance and technology maturity
- **Potential commercial and logistical arrangements** – Future success will depend on an appropriate tailoring of commercial and logistical options, and arrangements

9 Intellectual Property Rights (IPR)

This section lists any relevant IPR that has been generated or registered during the reporting period along with details of who owns the IPR and any royalties which have resulted, and any relevant IPR that is forecast to be registered in the next reporting period.

9.1 IPR generated last period

IPR Description	Owner	Type	Royalties
SDRC Learning Report 9.3.1	UK Power Networks	Relevant Foreground IPR	Nil
Safety Case related documents • Mitigations • Hazard assessment • Cost benefit analysis	Frazer-Nash Consultancy	Relevant Foreground IPR	Nil

9.2 IPR forecast next period

IPR Description	Owner	Type
Safety case related documents: • Safety Case for publication	Frazer-Nash Consultancy	Relevant Foreground IPR
SDRC 9.1.3	UK Power Networks	Relevant Foreground IPR
SDRC 9.1.4	UK Power Networks	Relevant Foreground IPR

10 Risk management

This section lists the risks highlighted in the Full Submission pro forma, plus any other risks that have arisen in the reporting period. We have described how we are managing the risks we have highlighted and how we are learning from the management of these risks.

Ref	WS	Description	Bid Mitigation	Current Status	RAG
R1	WS1	ABB's costs increase because of exchange rate movements due to Brexit developments	ABB has agreed to hold their quoted price in GBP until the project commences. Once the project has commenced, we will agree the ABB contract price in GBP, or agree the price in EUR and take steps to hedge the exchange rate risk.	Now the contract has been agreed and signed in GBP, this risk is mitigated.	G
R2	WS3	Unable to find a suitable site / willing customer for customer trial	We will engage with customers to understand their motivations for participating in the trial, so that we can design the trial and recruitment campaign to provide the right incentives and target the right customers. We will also consider relevant customer research and learning from ENWL's FCL Service trial.	We have spoken with a number of interested customers and continue to work with them and internal stakeholders to select a suitable site.	G
R3	-	Not used	-	-	
R4	WS1	Delay and/or cost overrun - prototype development	ABB and AMAT have agreed to take all risk of cost overruns within their control. UK Power Networks will use our existing change control procedures to minimise the risk of changes that cause additional costs for ABB and AMAT.	We have negotiated the collaboration agreements with ABB and AMAT to minimise the risk of cost overruns and should have both of these signed in the next reporting period.	G
R5	WS1	Delay and/or cost overrun - safety case (due to unforeseeable requirements)	We have allowed specific contingency for the safety case, based on Frazer-Nash's experience of required effort in the event of unforeseen requirements.	Despite difficulty in arranging suitable workshop dates, FNC have worked to the deadlines agreed in the previous reporting period.	G

Ref	WS	Description	Bid Mitigation	Current Status	RAG
R6	WS1	Prototype as delivered is not fit for purpose	UK Power Networks, ABB, AMAT, FNC to collaborate to develop the FLCB specifications; Safety consultant to develop safety case in parallel; engage with other HSE, ENA, and other DNOs.	We ensured that ABB, AMAT, FNC, and UKPN technical experts collaborated on the FLCB specification and continue to work on the safety case.	G
R7	WS1	Solution does not deliver the necessary reliability and/or redundancy to be able to prove the safety case	Safety case feasibility study completed before full submission. Safety case to be developed in close collaboration with FLCB designers and engineering standards.	We have invited key stakeholders, including ABB, AMAT, and UKPN technical experts, to the safety case workshops.	G
R8	WS1	Solution is not suitable for general population of GB sites due to operational or physical space constraints	We will engage with other DNOs to understand any operational or physical space constraints that are unique to their networks.	N/A this period	G
R9	WS2	Trial site does not experience enough HV network faults to prove that the solution is safe and reliable	We will use history of HV network faults as a criterion when selecting trial sites. We will use the safety case to determine how much data is required to prove that the FLCB is safe.	We are using historic fault data when looking at potential sites – recognising that fault history is not necessarily an indicator of future faults.	G
R10	WS2	Trial fails to capture the data necessary to prove that the solution is safe and reliable	We will ensure that our data capture solution has adequate reliability and redundancy so that we don't miss any opportunities to capture data from real network faults.	N/A this period.	G

Ref	WS	Description	Bid Mitigation	Current Status	RAG
R11	WS2	Solution fails to operate correctly during field trial (i.e. faults to limit fault current)	We will not allow fault levels to exceed equipment ratings until the FLCB has been proven safe and reliable. This minimises the risk of an unsafe situation if the FLCB fails to operate correctly.	N/A this period.	G
R12	WS2	Customer trial has adverse impacts on customer	We will identify the potential impacts on the customer and work with them to ensure the risks are well managed.	We are using impact to customer site as a criterion when selecting a M2 site and working with interested customers to mitigate or manage any on site impacts.	G
R13	WS4	ABB decides not to offer a commercial product	ABB have confirmed that if they are unable to offer their foreground IPR to Licensees in the form of a commercial FLCB product, they are willing, in principle, to licence any relevant foreground/background IPR to a third party for the purpose of developing a commercial FLCB product.	N/A this period.	G
R14	WS4	Solution is not accepted by other DNOs	We will engage with other DNOs at key stages of the design and specification processes to ensure that their requirements and concerns are addressed.	N/A this period.	G
R15	WS1	Project partners unable to deliver on commitments on time because of lack of resources and/or other commitments	We will agree heads of terms and scopes for collaboration agreements with all project partners in advance of project kick-off.	Negotiating collaboration agreements has been a challenge. We hope to have all agreements signed by the end of the next reporting period	A

Ref	WS	Description	Bid Mitigation	Current Status	RAG
R16	PM	UK Power Networks not able to deliver on commitments because project delivery team is under-resourced	We will secure resources for the core project delivery team in advance of project kick-off, and ensure adequate succession planning to manage the risk of staff movements.	Finding the right people for specialist project roles has been difficult. We are interviewing for the final project role presently.	A
R17	PM	UK Power Networks not able to deliver on commitments because other teams supporting the project are under-resourced	We have engaged the relevant business units within UK Power Networks to confirm their support of the project, and will confirm resourcing commitments during project mobilisation.	We are working with the relevant business units actively in site selection and trial operation activities.	G
R18	PM	Partner withdraws from project for financial, commercial, or technical reasons	If one technology partner withdraws from the project, we will consider using the same technology at both substation and customer sites, or if this would not provide value for customers' money, we would de-scope the project to only trial one technology at one site. If FNC withdraw from the project, we will seek an alternative partner who can provide the necessary safety case expertise.	N/A this period.	G
R19	WS2	Customer (trial participant) withdraws from the project because the trial is impacting their business activities	To minimise probability, We will only consider customers where the risk of adverse impact on their business activities is minimal or can be managed.	N/A this period.	G
R20	PM	Breach of data protection regulations	We will ensure that all customer's details are handled and stored in accordance with our data protection procedures.	N/A this period.	G

Ref	WS	Description	Bid Mitigation	Current Status	RAG
R21	WS2	Solution has adverse impacts on protection grading, causing unacceptable fault clearance times	We will complete a protection coordination study to ensure that the solution does not have any adverse effects on protection coordination.	N/A this period.	G
R22	WS2	Solution fails, causing unplanned outages	We will install additional circuit breakers that enable the FLCB to be remotely bypassed and isolated to minimise the risk of unplanned outages in the event that it fails.	N/A this period.	G
R23	WS2	Solution is not suitable for general population of UK Power Networks sites due to operational or physical space constraints	We have already completed a preliminary feasibility study on a sample of LPN sites, and will complete a feasibility study on a sample of LPN, EPN, and SPN sites as part of the project.	N/A this period.	G
R24	WS3, WS4	BAU method cost is higher than expected	If we discover any issues that could increase the BAU method cost to the point where the project business case is no longer viable, we will assess whether the project should be halted or de-scoped.	N/A this period.	G
R25	WS1	Equipment fails to pass high power type tests	ABB and AMAT have both allowed adequate contingency to build another prototype, in the event that the device intended for the field trials fails catastrophically during type testing and cannot be salvaged.	N/A this period.	G

Ref	WS	Description	Bid Mitigation	Current Status	RAG
R26	WS2	Unable to find a suitable site for substation trial	If we are unable to find a suitable site in LPN (e.g. there are sites that would be suitable for a BAU deployment but not suitable for a trial for business/commercial/safety reasons), we will also consider sites in SPN or EPN that have similar operational and/or physical constraints as typical LPN sites.	N/A this period.	G
R27	WS4	Learning from the project is not disseminated effectively to the DNO community	We will benchmark our knowledge dissemination strategy against other projects and other DNOs to ensure its effectiveness.	N/A this period.	G
R28	WS4	Solution is not approved by UK Power Networks	We will involve key UK Power Networks stakeholders to champion the design and specification of the solution to ensure that it is accepted.	Key UK Power Networks stakeholders (i.e. technical experts) are forming an internal working group to discuss issues that may arise in the BAU adoption of FLCB technology.	G
R29	WS3	Solution is not accepted by customers	We will engage with customers to understand their requirements and motivations, and ensure the solution is designed to meet their needs.	We have listened to customer requirements and published our findings in SDRC 9.3.1 – Understanding customers' requirements.	G
R30	WS2	Delay and/or cost overrun - civil works	We will leverage the expertise of our in-house capital delivery teams to ensure that all site works are well managed.	N/A this period.	G

Ref	WS	Description	Bid Mitigation	Current Status	RAG
R31	WS2	Delay and/or cost overrun - electrical installation works	We will leverage the expertise of our in-house capital delivery teams to ensure that all site works are well managed.	N/A this period.	G
R32	WS1	Project kick-off delayed by negotiations with project partners	We have agreed heads of terms and scopes for collaboration agreements with all project partners before full submission.	Getting the final collaboration agreement signed before work is due to commence by AMAT is crucial to not causing delays.	A
R33	WS1, WS2	Project delivery team lacks necessary technical expertise	We have engaged technical experts within the business to serve as the project design authority. We will also engage an expert on power electronics to provide assurance on ABB and AMAT's designs and specifications.	We are working closely with any relevant business units where necessary.	G
R34	WS2	Delay and/or cost overrun - commissioning	We will leverage the expertise of our in-house capital delivery teams to ensure that all site works are well managed.	N/A this period.	G
R35	WS3	Delay and/or cost overrun - customer engagement/recruitment	We will leverage the expertise of our in-house capital delivery teams to ensure that all site works are well managed.	N/A this period.	G
R36	WS2	ABB-provided (conventional) circuit breakers do not comply with UK Power Network's requirements	We have allowed adequate contingency for UK Power Networks to supply approved circuit breakers, which would be connected to the FLCB by joggle panels.	N/A this period.	G

11 Accuracy assurance statement

The project implemented a project governance structure as outlined in our innovation policies and procedures that effectively and efficiently manages the project and all its products. All information produced and held by the project is reviewed and updated when required to ensure quality and accuracy. This report has gone through an internal project review and a further review within UK Power Networks to ensure the accuracy of information.

We hereby confirm that this report represents a true, complete and accurate statement on the progress of the Powerful-CB project in its second six-month reporting period and an accurate view of our understanding of the activities for the next reporting period.

Signed .....

Date 15/12/17

Suleman Alli

Director of Safety, Strategy and Support Services

UK Power Networks