Powerful-CB

Project Progress Report

June 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
ENWL	Electricity North West Limited
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
Method 1	Installation of a FLCB at a substation
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
TRL	Technology Readiness Level
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. Applied Materials (AMAT) will develop a FLCB for use at a customer's premises, known as Method 2. 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 achievements

We have **secured resources for two of the three roles on the core project team**. The Bid Lead will continue to support the project until the project team is fully mobilised.

We **finalised the ABB collaboration agreement and the FLCB specification**, meaning that ABB can start work on Method 1 development.

We selected FNC to deliver the preliminary safety case, and **published the safety case processes and principles document** (bit.ly/pcb-sc-process). We believe this is the first document of its kind produced for a GB network licensee, and it will be useful to other network licensees who need to develop a safety case for an innovative technology or operational practice.

1.3 Outlook for next period

Workstream 1 (prototype and validation testing) will 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 Bid Lead will continue to lead these activities whilst we recruit a resource to lead Workstream 1 & 2.

Workstream 2 (demonstration on the network) will focus on developing the FLCB network design standard; a feasibility study on a sample of primary station sites; and site selection and preliminary design for the Method 1 trial site. These activities will commence as soon as we secure a resource to lead Workstream 1 & 2.

Workstream 3 (understanding customers' needs) will focus on holding customer dialogue sessions, and working towards SDRC 9.3.1 (Understanding customers' requirements) due in October 2017. We have secured a resource to lead Workstreams 3 & 4 commencing 3 July 2017.

Workstream 4 (knowledge dissemination) does not have any activities planned, but we will continue to publish relevant documents as they are produced.

1.4 Issues

Finding the right people for specialist project roles (refer section 2.2) and negotiating terms and conditions with the project partners (refer section 2.3) have been key challenges, and the focus of our efforts during this reporting period.

The key summary of progress to date:

- **All SDRCs are on schedule**
- The Bid Lead has managed the project and delivered any tasks on the critical path to an SDRC
- We have delayed non-critical tasks by consuming contingency (float) in the schedule
- ABB have mobilised resources prior to signing the collaboration agreement, and agreed to a revised schedule to avoid delays to SDRCs or the project end date
- 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 January to May 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 had to interview two groups of candidates for the Project Manager role to find a suitable candidate with the right specialist skills
- We have interviewed two groups of candidates for the WS1&2 Lead, although not yet found a suitable candidate

In order to mitigate any delays:

- The Bid Lead has managed the project to date
- The Bid Lead has delivered any tasks on the critical path to an SDRC – mainly in WS1
- 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
- Once the Project Manager has started, the Bid Lead will lead WS1&2 until we appoint a permanent resource
- 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 finalised, awaiting final approval and signature	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.

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	Complete
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	On schedule
Risk assessment FNC will assess the risks of utilising FLCB devices, using a combination of deterministic and probabilistic safety analysis.	August 2017	On schedule

FNC Milestones	Due Date	Status
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	On schedule
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; historical data for use of mitigations.	November 2017	On schedule
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 Prof 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 will be to participate in the safety case hazard assessment process, where we will be assessing the potential failure modes of the power electronics components inside the FLCBs.

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 finalised, awaiting final approval and signature	Use schedule contingency to mitigate two-month late start on ABB tasks.

WS	Role/Scope	Project Partner	Status	Commentary
WS1	**Develop Method 2 FLCB prototype**	Applied Materials (AMAT)	Negotiations ongoing	No AMAT tasks scheduled until early 2018.

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 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.

2.3.1 Method 1 – ABB

In order to mitigate delays to Method 1:

- ABB have mobilised resources prior to signing the collaboration agreement
- ABB have agreed to a revised schedule to avoid delays to SDRCs or the project end date
- We will monitor and manage progress to minimise the risk of delays

ABB's key deliverables are as follows:

Ref	ABB Deliverable	Evidence	Original Date	Revised Date
1	Sub parts delivered for one prototype unit	Copies of the relevant invoices and delivery notes	12/06/2017	12/08/2017
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
3	Validation testing at ABB's corporate research facility	Validation testing report approved by UK Power Networks	06/04/2018	06/06/2018
4	Validation testing at high power lab	Validation tests witnessed by UK Power Networks Representative; and Validation testing report approved by UK Power Networks	18/12/2018	18/02/2019
5	Energisation at UKPN	Commissioning report approved by UK Power Networks	04/06/2019	04/08/2019

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.

2.3.2 Method 2 – AMAT

We expect to conclude negotiations with AMAT during the next reporting period i.e. at the latest by December 2017. This will allow AMAT to start work on Method 2 development in January 2018 as scheduled.

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 finalised the FLCB technical specification, which defines the technical requirements for both Method 1 and Method 2 FLCBs.

This is one of two prerequisites for ABB to commence development work on Method 1 (the other being the collaboration agreement).

We worked with our internal stakeholders (i.e. technical experts from our planning, standards, telecommunications, and connections teams), to ensure that the specification captures all of our requirements; and our project partners, to ensure that they will be able to deliver prototypes that comply with the specification. We also considered learning from Western Power Distribution's FlexDGrid project.

We can provide this document to other network licensees upon request.

We published the safety case processes and principles document (bit.ly/pcb-sc-process), which explains how we will develop the safety case for FLCBs. We worked with our Operational Safety Manager to ensure that we had addressed all of his concerns.

We believe this is the first document of its kind produced for a GB network licensee. This document contains information that will be useful to other network licensees who need to develop a safety case for an innovative technology or operational practice.

2.4.2 Outlook

ABB will start work on Method 1 development, as soon as the collaboration agreement is signed. ABB's efforts during the next period will 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.

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 Outlook

WS2 will commence as soon as the Bid Lead has handed over project management duties to the Project Manager. The Bid Lead will lead WS2 until we have secured a permanent resource for this role.

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

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.

We will commence **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.

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 presented the project to potential Method 2 trial participants at the UK Power Networks DG Customer Forum on 9 February 2017. The slides from this event are available at page 84 of bit.ly/ukpn-dgf-feb17.

2.6.2 Outlook

We will hold **customer dialogue sessions** to develop understanding of our customers' requirements for FLCBs on their premises, and publish our findings in **SDRC 9.3.1 (Understanding customers' requirements)** in October 2017.

We will work towards recruiting 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. We expect a challenge to find a customer that has a suitable generator and premises, and is willing and able to mitigate the impacts of the trial. We have already identified the

issues and mitigations in our FSP (bit.ly/powerful-cb-fsp, refer sections 8.2 and 10.4.3) and we will develop these further as we talk with potential trial participants.

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 finalised the **FLCB technical specification** (available on request) and **safety case processes and principles** document (published at bit.ly/pcb-sc-process). See section 2.4.1 for a full explanation of these documents.

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).

2.8 General

We have rebranded the project from PowerFuL-CB to Powerful-CB. This is to avoid doubt about how to spell or pronounce the project name.

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 Bid Lead has managed the project and delivered any tasks on the critical path to an SDRC
- We have delayed non-critical tasks by consuming contingency (float) in the schedule
- ABB have mobilised resources prior to signing the collaboration agreement, and agreed to a revised schedule to avoid delays to SDRCs or the project end date
- 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**

SDRC	Evidence	Progress/Status
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**
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)	• **On schedule** • We have recruited a WS3 lead to start on 03/07/2017. This is later than planned, but at this stage we still plan to deliver the learning report on 31/10/2017.
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 safety case processes and principles document (details in section 2.4.1).

The document is available at bit.ly/pcb-sc-process.

The key lessons we learnt whilst producing this document were:

- **Ensure the terminology and risk thresholds align with those in the DNO's safety management system** – safety cases in other industries use terminology and risk thresholds that may be unfamiliar to DNOs
- **Ensure sufficient focus on lower-impact, higher-probability risks**, such as unplanned power cuts, which can have indirect safety consequences – safety cases in other industries tend to focus on high impact, low probability risks such as fatalities

We produced a **FLCB Technical Specification Document** (details in section 2.4.1).

We can provide this document to other network licensees upon request.

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
Safety case process & principles document	Frazer-Nash Consultancy	Relevant Foreground IPR	Nil
FLCB technical specification document	UK Power Networks	Relevant Foreground IPR	Nil

9.2 IPR forecast next period

IPR Description	Owner	Type
Safety case related documents: • Hazard Assessment • Risk Assessment • Mitigations • Claims, Arguments, and Evidence • Safety Acceptance Criteria	Frazer-Nash Consultancy	Relevant Foreground IPR
SDRC Learning Report 9.3.1	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.	We have priced all of ABB's payment milestones in GBP. The total GBP amount payable to ABB has not changed since we submitted our FSP. We will remove this risk from the register once we have signed the collaboration agreement with ABB.	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.	N/A this period	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.	G

Ref	WS	Description	Bid Mitigation	Current Status	RAG
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	N/A this period	G
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.	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.	We have invited a ENWL technical expert to participate in the safety case workshops.	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.	N/A this period	G

Ref	WS	Description	Bid Mitigation	Current Status	RAG
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
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.	N/A this period	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.	We have invited a ENWL technical expert to participate in the safety case workshops.	G

Ref	WS	Description	Bid Mitigation	Current Status	RAG
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 with ABB and AMAT has been a challenge. We are revising the project schedule to ensure SDRCs are still delivered on time. ABB have appointed a dedicated project manager and project staff.	A
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 revising the project schedule to ensure SDRCs are still delivered on time.	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	N/A this period	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

Ref	WS	Description	Bid Mitigation	Current Status	RAG
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
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

Ref	WS	Description	Bid Mitigation	Current Status	RAG
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
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) reviewed and commented on the FLCB specification.	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.	N/A this period	G

Ref	WS	Description	Bid Mitigation	Current Status	RAG
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
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.	N/A this period	G
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.	Key UK Power Networks stakeholders (i.e. technical experts) reviewed and commented on the FLCB specification. We have engaged Prof Tim Green from Imperial College London to attend the safety case workshops to provide power electronics expertise.	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

Ref	WS	Description	Bid Mitigation	Current Status	RAG
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 first six-month reporting period and an accurate view of our understanding of the activities for the next reporting period.

Signed .....

Date 14/6/17.

Suleman Alli

Director of Safety, Strategy and Support Services

UK Power Networks