Powerful-CB

Project Progress Report – June 2020

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Contents

Glossary

Term	Description
ABB	Our technology partner for Method 1
AMAT	Applied Materials, our technology partner for Method 2 (this method has been de-scoped from project following Ofgem approval of change request)
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
COVID-19	Corona Virus Disease 2019
DG	Distributed Generation
DNO	Distribution Network Operator
EMC	Electromagnetic Compatibility
ENA	The Energy Networks Association
EPN	Eastern Power Networks plc
ENWL	Electricity North West Limited
FATs	Factory Acceptance Test
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 Proforma - http://bit.ly/Powerful CB-fsp
GB	Great Britain
GT	Grid Transformer
HAZID	Hazard Identification
HMI	Human Machine Interface
HSE	The Health and Safety Executive
HV	High Voltage
Imperial	Imperial Consultants (Imperial College London's consultancy company)
IPR	Intellectual Property Rights
LCNI	Low Carbon Networks & Innovation Conference
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 (de-scoped from project following Ofgem approval of change request)
NIC	Network Innovation Competition
PPR	Project Progress Report
RIIO-ED1	The current electricity distribution regulatory period, running from 2015 to 2023
SCADA	Supervisory Control and Data Acquisition
SDRC	Successful Delivery Reward Criteria
SPN	South Eastern Power Networks plc
TRL	Technology Readiness Level
UKPN	UK Power Networks

1. Executive summary

1.1 Project background

The Powerful-CB (Power Electronic Fault Limiting Circuit Breaker) project aims to demonstrate that fault limiting circuit breakers (FLCBs) can enable distribution network operators (DNOs) to connect more distributed generation (DG) to fault level constrained 11 kV electricity networks without the need for reinforcement.

A FLCB is a solid-state circuit breaker that operates 20 times faster than existing vacuum circuit breakers (CBs). This high-speed operation can mitigate fault level contributions from distributed generation, allowing us to connect more DG (including CHP) 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.

The project team had been working with a technology partner to develop a FLCB. ABB will develop a FLCB for use at a primary substation, known as Method 1 (M1). We believe Method 1 will be the world's first demonstration of a FLCB with a fast commutating switch.

The project team continues to work with Frazer-Nash Consultancy (FNC) to develop the safety cases for the M1 device.

1.2 Summary of progress

This Project Progress Report (PPR) covers the period January to June 2020. The next reporting period will cover July to December 2020. Collectively, these PPRs form the annual progress report required by Ofgem's Network Innovation Competition Governance Document.

Overall, the project has made steady progress during the reporting period, focussing on completing commissioning of the FLCB, the existing switchgear and other equipment. However there have been some delays in finalising commissioning and energisation of the FLCB. This is due to unexpected trial site related issues:

- authorisation to energise the retrofit ABB circuit breakers;
- a cable fault on the transformer named GT1; and
- a fault associated with the high voltage (HV) door interlock of the FLCB.

However, a mitigation action plan was developed and was in delivery to minimise the impact of these issues, when all trial site works were abruptly suspended in March due to COVID-19 related restrictions. As such, the completion of commissioning and energisation has been postponed until site works can safely recommence.

According to our initial assessment, at the time of writing this report, the project is expected to fully return to pre-COVID-19 lockdown status by end of July; four months after the initiation of national lockdown on 23 March. Based on this estimate all future planned activities and deliverables for the project will be delayed by four months, including the project completion date. It must be noted that this is the best estimate at this point of time, as COVID-19 is a developing situation and we will continue to monitor and assess the return date.

As highlighted in the December 2018 and June 2019 PPRs, our project partner for M2, AMAT did not sign onto a collaboration agreement and subsequently withdrew from the project. The project team made efforts to find a suitable replacement partner by engaging the market, however no suitable partner was found and we submitted a change request to remove M2 from the project in November 2018. In this reporting period, Ofgem has confirmed the acceptance of this change by issuing an amended Project Direction, approving the removal of M2 and associated

budget from the project. These funds will be returned to customers at the completion of the project. The removal of M2 affects the scope of workstreams 1, 2 and 3 as highlighted in the amended Project Direction.

Workstream 1 – Development of a FLCB Device

All Workstream 1 (WS1) activities for the development of the FLCB were completed in 2019. A minor change requirement was identified during the commissioning process in December 2019; we identified the need to complement the power supplies within the FLCB with uninterrupted power supplies (UPS) to ensure the device is as robust, reliable and safe as possible. This required ABB to explore a suitable replacement, ship to the trial site and install the UPS within the device. Due to the lead-time of the UPS and resource unavailability, these were installed in February 2020.

Figure 1 UPS installed to complement the existing power supplies in the FLCB

Workstream 2 – Network Demonstration

During this reporting period, Workstream 2 (WS2) focused on completing commissioning of the FLCB and testing of the portable power pack for use with the retrofit ABB circuit breaker (type VOR-M); a challenge experienced and described in the December 2019 PPR. This issue was resolved and power packs successfully tested in January 2020, with ABB returning to site in February to replace the power supplies of the FLCB. In the same visit, ABB also executed a number of protection logic changes to address additional issues that were identified during commissioning in December 2019. These included the following:

- The main change being that our Supervisory Control and Data Acquisition (SCADA) system was unable to display the FLCB trip alarm due to its speed. To overcome this, ABB latched the alarm to a spare relay contact and we liaised with the manufacturer of our SCADA equipment (GE) to apply a new software patch;

Figure 2 SCADA panel with HMI screen which shows alarms from the FLCB and other protection equipment

- While retesting all alarms and functions during commissioning, we identified a fault with the HV door interlock of the FLCB requiring modification. As the interlock is a critical safety mechanism, energisation has been postponed until site works can resume due to COVID-19 in such a way that ensures employee safety while carrying out the work.

Figure 3 HV compartment of the FLCB

Workstream 3 – Understanding Customers' Requirements

During this reporting period, Ofgem approved the change request for the removal of M2 from the project. Following this, the project team informed all interested stakeholders including the project mailing list about the removal of M2. We also provided a view on general project progress and notification that learning report SDRC 9.1.1 had been published. Following the removal of M2 from the project, SDRC 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*, will no longer be produced and published.

UK Power Networks still intends to build upon the learnings generated from our engagements with customers willing to participate in such a trial, and continue to see real value in the customer placed FLCB. As such we have partnered with Western Power Distribution on an NIA project called EDGE-FCLi (Embedded Distributed Generation Electronic – Fault Current Limiter interrupter). The scope is similar to that of M2 and, although a different supplier is being used, we aim to deliver similar benefits to customers once the project is complete. The project is unique as the technology readiness level (TRL) of the device being developed is lower than what was originally proposed with AMAT in M2 and hence provides a great opportunity for the project to increase choice in the market for customers.

Workstream 4 – Knowledge Dissemination

Over the last reporting period, the project was presented at a number of external events including Low Carbon Networks Innovation (LCNI) conference. As such, with trials expected to commence in this period, the team strategically shifted the focus on internal knowledge dissemination for increased awareness and understanding.

- The project was included in an innovation newsletter which was circulated to all UK Power Networks staff. This was further shared on internal communications platform such as Yammer to hold interactive discussions;
- A second training and information session was made to staff in February following the keen interest from the first session held in the previous period. In March, we had planned to take members of the London Power Networks (LPN) Network Planning team to the trial site to showcase the FLCB such that they become familiar with the FLCB, its operations and benefits. This team will be essential in ensuring the BAU rollout of the FLCB during the next Electricity Distribution price control period (RIIO-ED2). Unfortunately due to COVID-19 restrictions, we have had to postpone the tour; and
- The project was also presented at the UK Power Networks Developer's Forum in March.

Despite the focus on internal communications, we continued to keep our external stakeholders informed. In February we issued a press release for the project, which was widely publicised through trade media outlets and saw an overwhelmingly positive reception. The release was to raise general awareness among the industry and general public about this smart solution, and more specifically to share the project progress including that of FLCB installation at the trial site.

1.3 Risks and issues

The project continues to apply robust risk management procedures to reduce the probability and impact of risks materialising. The full risk register and status of each can be found in section 11. Several risks have materialised and are impacting certain project activities or have a medium likelihood of materialising. The project team have taken mitigating actions to reduce the impact of issues and are closely managing high risk items. Further detail is provided below:

Table 1 Risks and issues identified for this reporting period

Ref	Issue	Impact	Mitigation
R34	Delay and/or cost overrun – commissioning	Additional visits to complete commissioning in February, and activities captured in R44 and R45 requiring additional time has had an impact on the budget planned for the completion of commissioning. Contingency funding will be used.	Costing exercise completed to estimate remaining costs for commissioning and energisation. These include: • Multiple remobilisation and demobilisation costs due to site shutdown from COVID-19 and returning to complete remaining commissioning;

Ref	Issue	Impact	Mitigation
			• Time to complete HV door interlock repair; • Energisation; and • Commissioning of auto-close scheme and fault recorders.
R44	Delay in GT1 cable fault repair Due to the redundancy in our network, this cable fault is currently not affecting customers or security of supply. In May cable fault was found and repaired however a second fault has been identified.	Both the auto-close scheme and the fault recording relays cannot be fully commissioned until the transformers can be taken out of service. This needs to be done to complete wiring and testing. Trial site has three transformers in total and the impact of GT1 being out of service is that GT2 and GT3 cannot also been taken out of service as two must be in service for security of supply of the network.	Return at a later date to commission auto-close scheme and fault recorders to mitigate delay in energisation. Auto-close scheme is required for running arrangement 3 (using the FLCB as a bus coupler) and the FLCB's internal fault recording mechanism could be used in the interim period until the fault is fixed.
R45	Delay in modification/repair of HV compartment door interlock on the FLCB due to COVID-19 restrictions	Delay in energisation of the FLCB as the interlock is a critical safety mechanism.	Prior to the full lockdown measures implemented by UK Government on 23 March, ABB Germany were unable to travel due to their own COVID-19 restrictions. To mitigate the uncertainty as to when ABB Germany could travel again, the project team arranged for ABB UK to carry out the modifications as directed by video from ABB Germany while maintaining safe distances between employees on site. Currently no mitigation is possible until site works can safely recommence.
R46	Delay in publication of learning report SDRC 9.2.1 – Interim	To fulfil the requirements of SDRC 9.2.1 energisation of	To minimise the impact of delays the project team has already starting drafting SDRC

Ref	Issue	Impact	Mitigation
	Learning Report – Demonstration of a FLCB for substations	the FLCB needs to be complete. The delay of this SDRC is the same assumption as for R45 – anticipated four month delay.	9.2.1 with our learnings to date from installation and commissioning.
R47	Potential extension to project trial end date (also linked to R9)	Extension of overall project end date. Delays encountered during type testing, approval to energise the retrofit circuit breakers due to the defect linked to R42 (outside the scope of the project), issues arising during commissioning have impacted the trial start date.	The project team will monitor performance of the FLCB once the trial period has started. If a number of network faults are experienced, the team will assess whether or not an extension to the project trial is required. The reliability of our network means that network faults occur infrequently. Performance data of the FLCB under network faults is vital as this maximises the learnings generated through the project and provides confidence in the reliability of the FLCB.

1.4 Outlook for next reporting period

During the next reporting period, the project will transition from installation and commissioning stage to the commencement of the network demonstration period provided COVID-19 does not restrict site works and energisation can safely take place. During the next period, the project will trial the FLCB in two running arrangements.

- Running Arrangement 1 will be a soak test for the FLCB, where the device will be idly connected and energised on the network while bus coupler, BC2, remains closed; and

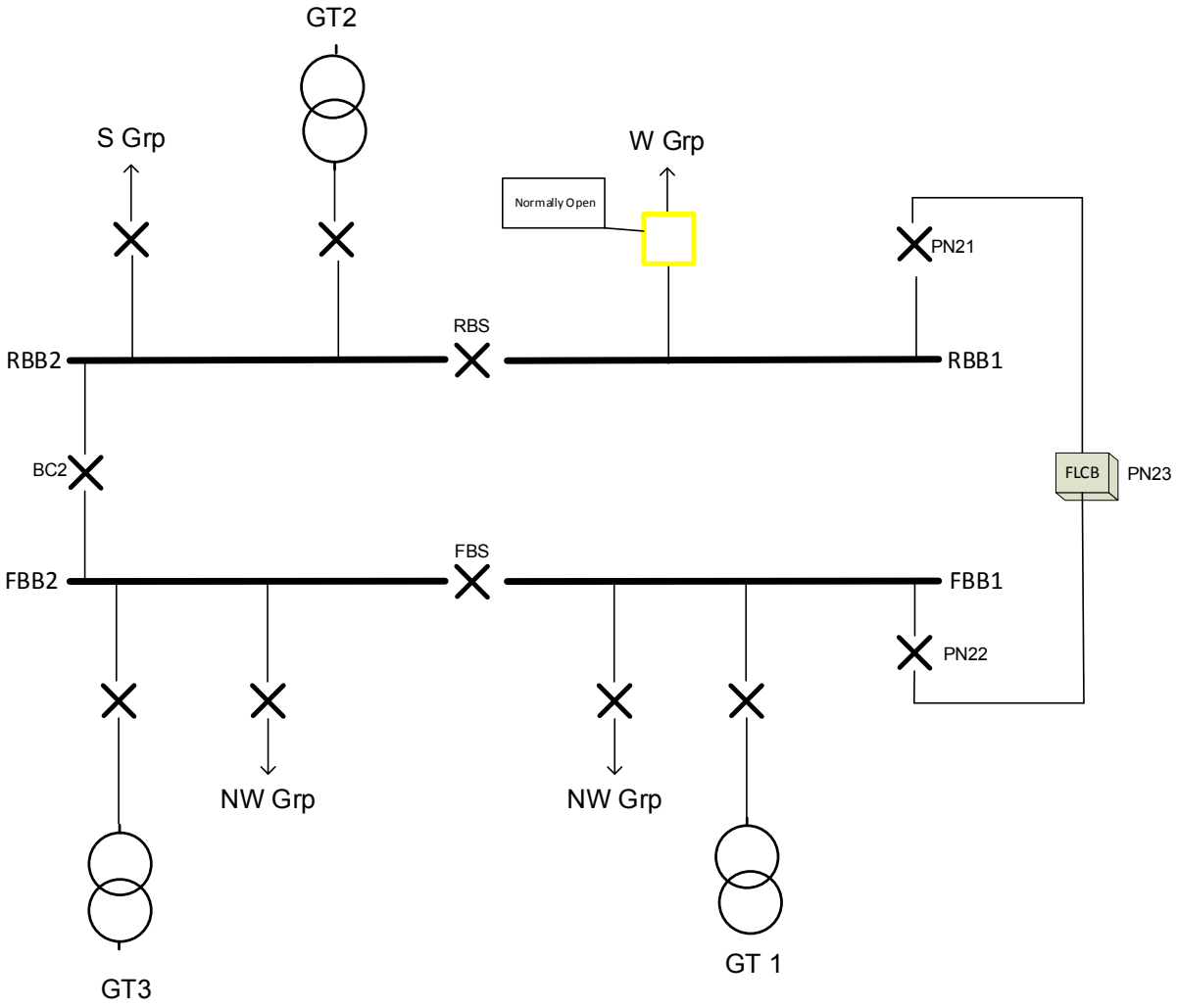

Figure 4 Running Arrangement 1 schematic diagram

- Under the second running arrangement, the FLCB will be operated as a transformer incomer circuit breaker for transformer GT1.

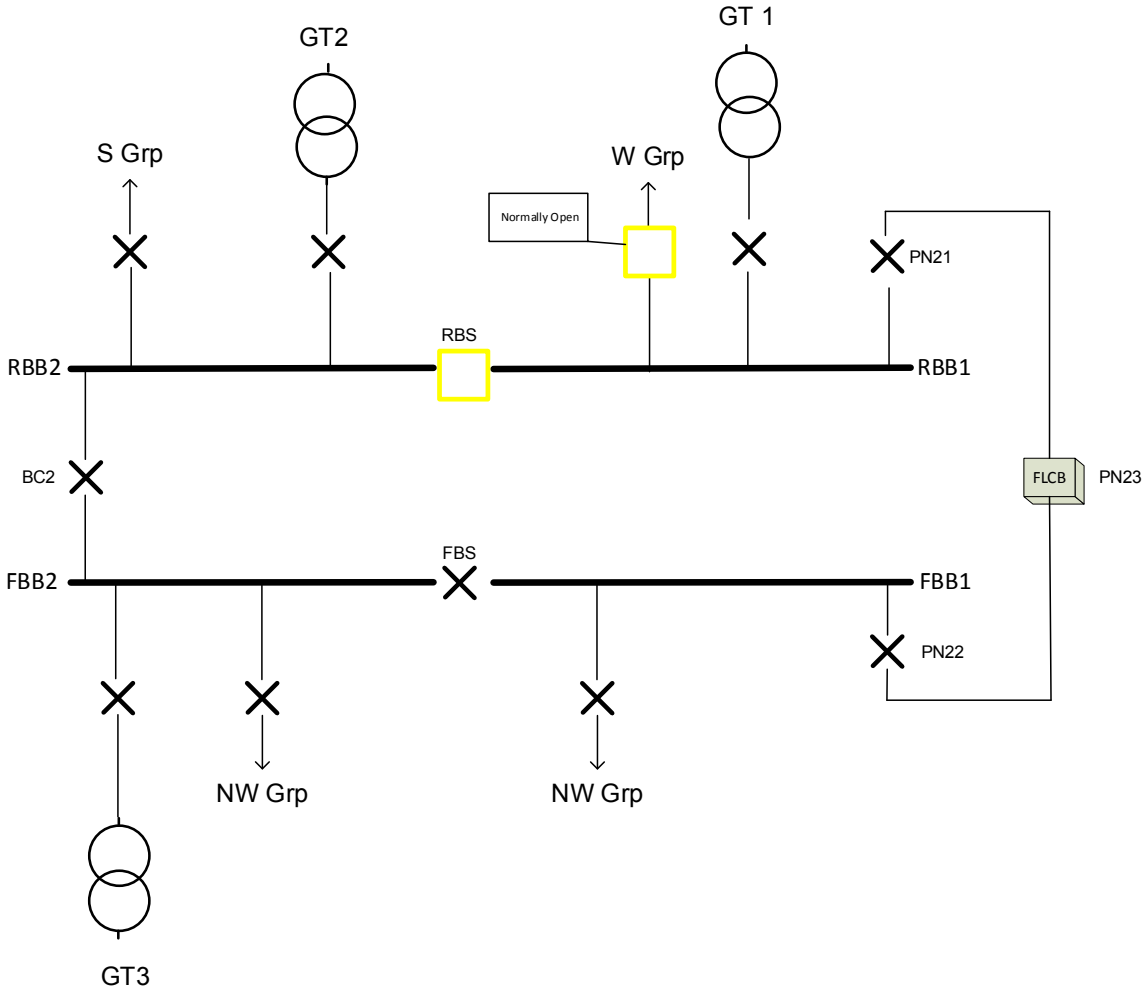

Figure 5 Running Arrangement 2 schematic diagram

The fourth SDRC of the project, SDRC 9.2.1, is also due for delivery in the next period although as previously highlighted will be delayed due to COVID-19 preventing energisation of the FLCB.

Building on the publication of the preliminary safety case report in 2018, Phase 2 of the safety case will remain active for the duration of the project. Phase 2 will include updating the preliminary safety case with any lessons learned and additional safety requirements identified during the preparation, installation, commissioning of the FLCB and any design changes during the trial.

The project team intends to keep recipients on the project mailing list (which constitutes of all interested stakeholders) informed about how M1 is progressing as it transitions from the development phase to the network demonstration phase of the project.

Knowledge dissemination planned for the next reporting period includes engaging with internal and external stakeholders to share knowledge gained from the installation work and commissioning along with publication of SDRC 9.2.1. The project will be presented at UK Power Networks led external event and any other opportunities that arise.

2. Project Manager's report

The project made steady progress during this reporting period (January-June 2020), while dealing with the impact of COVID-19, focusing on the following areas:

- Ongoing project planning;
- Completing electrical installation works for HV cables between existing switchgear and the FLCB;
- Testing of the portable power pack to be used as a back-up if a problem occurs with retrofit VOR-M CBs;
- Completing commissioning of the existing switchgear extension following approval from Asset Management after successful testing of the portable power pack;
- Completing commissioning of the FLCB following changes required during commissioning in previous period; and
- Modification/repair of the HV compartment door interlock and energisation (this was planned for March but is on hold due to COVID-19 restrictions).

The following sections present individual workstream reports covering progress made, challenges encountered, lessons learned and the outlook for the next reporting period.

2.1 Project Team

In this reporting period the project team remains unchanged and the core project team continues to comprise of three dedicated roles:

Role	Status	Start Date
Project Manager	Appointed	4 February 2019
Workstream 1&2 Lead	Appointed	23 March 2018
Workstream 3&4 Lead	Appointed	3 July 2017

The Workstream 1 (WS1) and Workstream 2 (WS2) Lead remains unchanged from the period however the role of the Workstream 3 (WS3) and Workstream 4 (WS4) Lead has been reduced to WS4 only. This is due to the change request submitted to Ofgem for the removal of M2 from the scope of the project.

2.2 Project Partners

As highlighted in the December 2018 Project Progress Report (PPR) our project partner ABB has signed onto a collaboration agreement and progressing with developing the FLCB. The M2 proposed project partner, AMAT, did not sign onto a collaboration agreement and subsequently withdrew from the project. The change request which was submitted to Ofgem has been approved and M2 will be removed from the project. The removal of M2 impacts WS1, WS2 and WS3 and as such works relating to M2 will no longer be discussed in future PPRs.

The project continues to hold fortnightly Project Partner meetings to ensure successful delivery of the project. The Project Partner meeting covers a number of key points, including:

- Workstream updates – Report on progress to date, risks and issues;
- Technical discussions requiring input from all involved in the project, including internal stakeholders;
- Collaborative planning of tasks for upcoming project milestones;

- Planning for workshops and engagement with UK Power Networks' stakeholders; and
- Risks, issues and mitigation.

2.3 Workstream 1 – Development of a FLCB Device

WS1 is responsible for designing, building and testing prototype devices suitable for installation and trial and both a primary substation and customer site within London Power Networks (LPN). With the removal of M2 from the project, a device will no longer be developed for trial at a customer site. For the remainder of the project WS1 will focus on developing and delivering M1 only.

ABB are progressing their technology from TRL4 (single-phase proof-of-concept prototype) to TRL7 (three-phase field prototype), in accordance with defined specifications provided by UK Power Networks. For WS1, ABB will design a three-phase prototype, build and integrate it into modular switchgear cubicles, and perform testing to ensure the prototype complies with UK Power Networks' requirements.

The learnings from WS1 including specifying the device, prototype development and testing have been disseminated via SDRC 9.1.1. The test reports generated from WS1 are available to other Licensees and stakeholders upon request.

Progress during this reporting period

All WS1 activities for the development of the FLCB were completed in 2019. A minor change requirement was identified during the commissioning process in December 2019; we identified the need to complement the power supplies within the FLCB with uninterrupted power supplies (UPS) to ensure the device is as robust, reliable and safe as possible. This required ABB to explore a suitable replacement, ship to the trial site and install in the device. Due to the lead-time of the UPS and resource unavailability, these were installed in February 2020. The need to change power supplies is further discussed in the next sub-section.

Challenges and lessons learned

This section describes the main challenges and lessons learned in the workstream during this reporting period:

- The original power supplies provided with the FLCB for the control system were suitable for use as the substation site has 110V DC battery backup supply. However during commissioning in December 2019, we identified with ABB that even if there was a momentary loss of supply to the control system of the FLCB, the system would then fall into a state where performance could not be guaranteed. To return the FLCB to normal operation, it would require the FLCB, including control system, to be powered down and then powered back up again. Although the risk of this occurring is low, the project team decided to mitigate against this and complement the existing power supplies with UPSs in order to make the FLCB as robust, reliable and safe as possible.

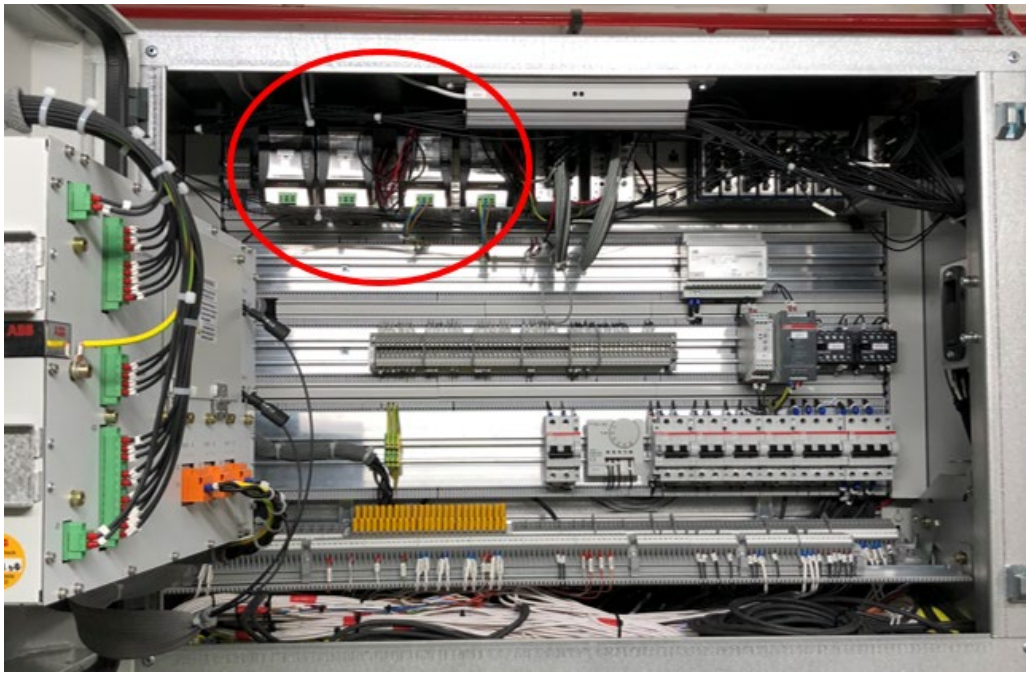

Figure 6 Existing power supplies prior to the addition of the UPS installed in the LV compartment of the FLCB

Outlook for next reporting period

The next period will see minimal progress in WS1 as the FLCB has been tested and installed on-site. The remaining activities include:

- Collating additional evidence documents required for the ongoing updates of the safety case (note that this has overlap with WS2).

2.4 Workstream 2 – Network Demonstration

WS2 is responsible for the following activities:

- Designing the interface between the FLCB and the existing network;
- Installation and commissioning of switchgear including the FLCB and ancillary equipment;
- Conducting the network demonstration;
- Collecting adequate data to prove the FLCB is safe and effective; and
- Updating the preliminary safety case.

Within WS2, UK Power Networks will continue to collaborate with ABB, and our safety case expert, to develop the engineering knowledge necessary to safely and effectively demonstrate FLCBs on GB networks. We will investigate issues such as:

- Use cases for FLCBs – for example in parallel with a bus section/coupler or in series with a transformer;
- Protection and control philosophy – FLCB trip settings, reclosing scheme, coordination and discrimination and how to handle failure of the FLCB; and

- The safety case which will be developed in parallel with the engineering investigations to ensure that safety is considered in every aspect of the business as usual (BAU) solution.

Where appropriate we will seek to engage with the Health and Safety Executive (HSE), the Energy Networks Association (ENA), and other Licensees, especially Electricity North West (ENWL) and Western Power Distribution (WPD) who have investigated similar issues with the Respond and FlexDGrid projects respectively. The learning from this phase will be captured in engineering policies, standards, and procedures and shared via learning dissemination activities.

Progress during this reporting period

During this reporting period, WS2 focused on the following activities:

- Testing of the portable power pack designed as a mitigation for the defect of the retrofit VOR-M CBs. This defect was discussed in the December 2019 PPR. The defect caused capacitor failures and form part of the magnetic actuator mechanism. Failure of the capacitor would prevent the CB from opening/tripping. The portable power pack allows for the CB to be opened following the failure of the capacitor;

Figure 7 Portable power pack (left) plugged into retrofit VOR-M CB (right) during testing of the power pack

- Finalising commissioning of adjacent retrofit CBs following approval to energise from Asset Management after the portable power pack was successfully tested;
- Finalising commissioning of the FLCB in February during the same visit ABB added the UPS to complement the existing power supplies to rectify issues identified from the first commissioning visit. These tasks included:
    - Installing new UPS for the FLCB control system as mentioned in Section 2.3;
    - Modifying the protection logic in the FLCB relay (see further explanation in the next sub-section); and
    - Retesting all signalling and protection functions following changes

- Installing and commissioning HV power cables from the busbar to the FLCB including terminations;

Figure 8 Completed HV cable terminations to the FLCB

- Completing asset registration of all newly installed equipment in our systems;
- Further training of LPN field staff;
- Remotely monitoring the FLCB status and control system by ABB following completion of commissioning of the FLCB in February;

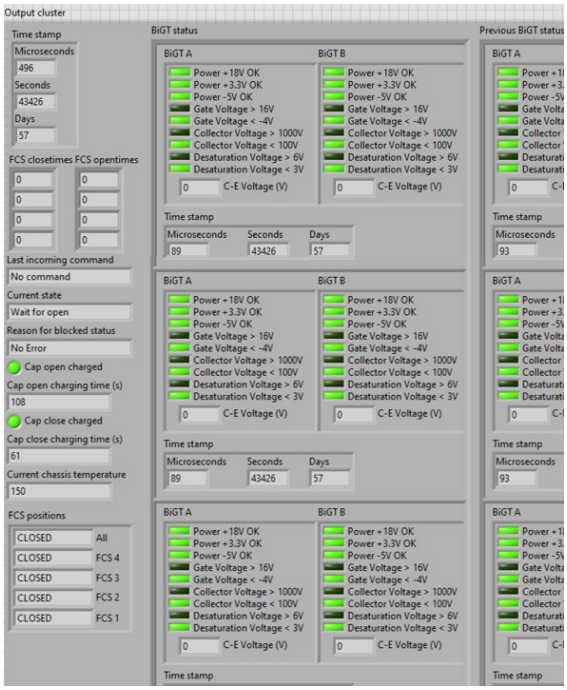

Figure 9 Screen capture of remotely checking the status of the FLCB

- Completing Engineering Operation Standard to be used by control engineers. Information within this document includes:
    - General concept and functionality;
    - Dimensions and location within substation;
    - Project trial running arrangements;
    - Explanation of signalling;
    - Instructions on how to operate the device and actions required for alarms; and
    - Single page key information.
- Updating the safety case with FNC; and
- Drafting learning report SDRC 9.2.1 – Interim Learning Report – Demonstration of a FLCB for substations

Challenges and lessons learned

This section describes the main challenges and lessons learned in the workstream during this reporting period.

- At the commissioning stage, we identified a few instances where protection related changes were required. These include:
    - The FLCB has an alarm we have named “FLCB Out of Service/Faulty”. This will be raised when any internal problems associated with the FLCB and control system are detected. The alarm could be triggered by minor events such as a capacitor taking longer than three minutes to charge or by a more critical factor such as issues with the semiconductors. This alarm should not be reset until ABB has completed an investigation. Although our control engineers could respond to this alarm and operate the two adjacent circuit breakers manually, to ensure safety of the network we added

protection logic which upon reception of this alarm, will initiate a trip of the two adjacent circuit breakers as a precaution; and

- When testing the tripping of the FLCB, the SCADA system could not pick up the trip signal from the FLCB relay although the device operated correctly. Further investigation identified that the signal was too quick for the SCADA system due to the speed at which the FLCB operates; we found the signal was present for approximately 100ms whereas SCADA needed it to be persistent for roughly 150ms. To overcome this problem, ABB used a spare relay contact and latched the signal so that it would remain present for the SCADA system. In parallel with this we consulted GE, the manufacturer of the Remote Terminal Unit (RTU), who provided a fix for SCADA not displaying short-duration fleeting alarms. The fix allowed the mimic to display alarms greater than 30ms and this patch was applied to the RTU during the commissioning visit in February. The valuable lesson learned here for wider rollout of the FLCB is to check the RTU is capable of displaying short-duration fleeting alarms.

- During commissioning in February it was identified that the magnetic lock which forms part of the HV compartment door interlock was malfunctioning. Following investigation from ABB it was suspected misalignment of the magnets was occurring due to the weight of the doors on the hinges and the slight slope of the floor. ABB required some time to design a fix/modification for the door interlock and due to lead times of the parts required for this modification, arrived at the trial site in March 2020. Due to the COVID-19 restrictions and the decision of UK Power Networks to stop non-essential works, the modification work was not completed. As the interlock is a critical safety mechanism, energisation has been postponed until site works can resume in such a way that ensures employee safety while carrying out the work.

- In January 2020 the London Borough of Tower Hamlets issued permits to allow UK Power Networks to commence excavating following the repair of the sinkhole discussed in the December 2019 PPR. There have since been two attempts to locate the cable fault associated with transformer, GT1, however it was not found. The cable is a fluid filled cable and locating the fault is a difficult and iterative process. In May the GT1 cable fault was found and repaired however a second fault has been identified. Hence GT1 cannot be put back in service; and

- As described in the previous PPR, the trial substation has three transformers in total, and the impact of GT1 being out of service is that GT2 and GT3 cannot also been taken out of service as two transformers must be in service to maintain security of supply. Although the repair of this cable fault is beyond the project scope, the impact is that both the auto-close scheme and the fault recording relays cannot be fully commissioned as transformer outages are required to complete the wiring and testing. To mitigate delays in commencement of the trial period, due to the uncertainty of when the cable repair will take place, the team has agreed to energise the FLCB without commissioning the auto-close scheme as it is only required during third trial running arrangement.

Outlook for next reporting period

The next period will see the completion of several key milestones for WS2 subject to site works recommencing due to COVID-19 restrictions and these include:

- Modification/repair of the HV compartment door interlock of the FLCB;
- Energisation of the FLCB and thus commencement of the trial period;

- Monitoring of FLCB performance data;
- Complete commissioning of auto-close scheme and fault recorders once the GT1 cable fault has been repaired and GT1 returned to service);
- Publication of learning report SDRC 9.2.1; and
- Phase 2 of the safety case will be on-going for the remainder of the project. Phase 2 will include updating the preliminary safety with any lessons learned and additional safety requirements identified during the preparation, installation, commissioning of the FLCB and design changes through the trial period.

2.5 Workstream 3 – Understanding Customers' Requirements

WS3 is responsible for understanding our customers' needs, ensuring that we design the solutions to meet our customers' needs and to recruit a trial participant for the M2 demonstration.

Following the removal of M2 from the project, SDRC 9.3.2 will no longer be produced and published. Further details of this SDRC can be found in section 7.

Progress during this reporting period

During this reporting period, the project team received final approval from Ofgem for the removal of M2 from the project.

UK Power Networks still intends to build upon the learnings generated from our engagements with customers willing to participate in such a trial, and continue to see real value in the customer placed FLCB. As such we have partnered with Western Power Distribution for a NIA project called EDGE-FCLi (Embedded Distributed Generation Electronic – Fault Current Limiter interrupter). The scope is similar to that of M2 and we aim to deliver similar benefits to the customers once the project is complete and proved to be successful. The technology readiness level (TRL) of the device being developed is lower than what was originally proposed with AMAT in M2 which provides a great opportunity to increase choice for customers.

Challenges and lessons learned

The project team experienced no challenges under WS3.

Outlook for next reporting period

During the next reporting period the project team intends to keep recipients on the project mailing list (which constitutes all interested stakeholders) informed about how M1 is progressing as it transitions from the development phase to the network demonstration phase of the project.

2.6 Workstream 4 – Knowledge Dissemination

WS4 oversees the dissemination and activities for learnings generated throughout the project. These are critical aspects of the project and will ensure that DNOs across GB can build on Powerful-CB learning, avoiding unnecessary duplication of work. Internal stakeholder engagement activities also play an important role in guiding the development and deployment of the new FLCB within the business and support the successful transition into BAU. Key learning reports are published on UK Power Networks innovation website.

Progress during this reporting period

Over the last reporting period, the project was presented at a number of external events including Low Carbon Networks Innovation (LCNI) conference. As such, with trials expected to commence in this period, the team strategically shifted the focus on internal knowledge dissemination for increased awareness and understanding.

The project was included in an innovation newsletter which was circulated throughout UK Power Networks. This was further shared on internal communications platform such as Yammer to hold interactive discussions.

A second training and information session was also delivered to LPN field staff in February following the keen interest from the first session held in the previous period. This provided opportunities to explain how the FLCB operates, the different network arrangements the FLCB will be trialled and an explanation of alarms. Feedback and considerations for the project team were also provided during this session.

In March we had planned to take members of the LPN Network Planning team to the trial site to showcase the FLCB so they were familiar with the FLCB, its operations and benefits. This team will be essential in ensuring the BAU rollout of the FLCB during the next Electricity Distribution price control (RIIO-ED2). Unfortunately due to COVID-19 restrictions we have had to postpone the tour.

Externally the project was presented at the UK Power Networks Developer's Forum in March. A press release was also issued during the reporting period, February 2020, to inform the industry and general public to raise general awareness about this smart solution, and more specifically to share the project progress including that of FLCB installation at the trial site. The release was widely publicised through trade media outlets and saw an overwhelmingly positive sentiment, driving roughly a quarter of all innovation related coverage for UK Power Networks for the month. The release can be found on our website here https://www.ukpowernetworks.co.uk/internet/en/news-and-press/press-releases/Worlds-first-and-fastest-power-technology-paves-way-for-decarbonisation.html#art-top.

Figure 10 Image used from press release with FLCB in the background

In addition to the above press release, a project update newsletter was sent out in February to our project mailing list. The newsletter provided an update on general progress of the project, notification of the M2 removal change request approved by Ofgem and directing people to learning report, SDRC 9.1.1, which was published in the previous period. Following this newsletter we have engaged further with individuals who have expressed interest in the technology.

Challenges and lessons learned

This section describes the main challenges and lessons learned in the workstream during this reporting period:

- UK Power Networks had planned an external event in June however COVID-19 has led to postponing this event. This would have provided a great opportunity to present our learnings from installation and commissioning of the FLCB.

Outlook for next reporting period

The following activities are planned for the next reporting period:

- The project is planning to feature in other UK Power Networks led external events or webinars;
- Complete tours to key internal stakeholders to showcase the FLCB;
- Inform project mailing list of key milestones such as the start of the trial period;
- Publication of learning report SDRC 9.2.1; and
- Continued updating of the project website.

3. Business case update

We have not discovered any new information that affects the business case; thus the business case remains consistent with our FSP. During this period the change request submitted to request the removal of M2 from the project has been approved by Ofgem. Based on this, the project assumes 100% deployment of M1 across GB and the delivery of committed benefits of up to £403m by 2050.

4. Progress against plan

This section summarises the project's progress in the period January to June 2020. 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 Summary of changes since the last Project Progress Report

Figure 11 below shows the key activities and changes to the project plan during the current reporting period. As previously mentioned, our initial assessment, at the time of writing this report, is that the project is expected to fully return to pre-COVID-19 lockdown status by end of July; four months after the initiation of national lockdown on 23 March. Based on this estimate all future planned activities and deliverables for the project will be delayed by four months, including the project completion date. It must be noted that this is the best estimate at this point of time, as COVID-19 is a developing situation and we will continue to monitor and assess the return date.

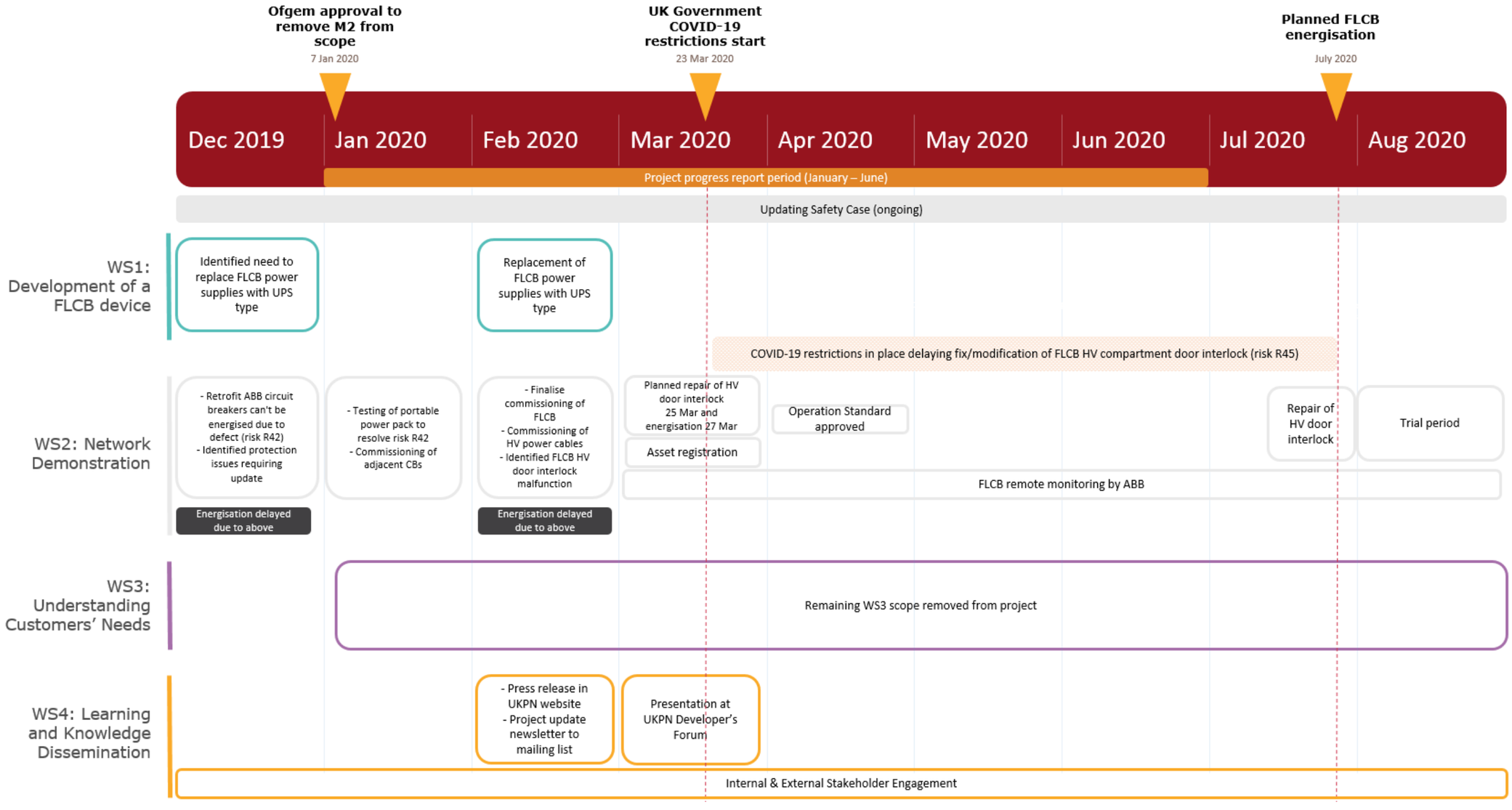

Figure 11 High level project plan highlighting changes during the current reporting period

Since the last reporting period, the following notable changes have been made to the project plan:

- Energisation of the FLCB was delayed from the end of December 2019 and planned for the beginning of March 2020 due to a number of issues including:
    - Risk R42, delay in energisation due to defect identified in the retrofit ABB circuit breaker (type VOR-M) which materialised in the last reporting period;
    - Changes to the FLCB power supplies; and
    - Executed a number of protection logic changes to address additional issues that were identified during commissioning in December 2019.
- A further delay to energisation was introduced in this period. During commissioning in February, we identified that the HV compartment door interlock was malfunctioning. Additional time was required to design a fix/modification and to allow for the lead time of parts to be shipped to the trial site; this modification was scheduled for end of March. To overcome ABB Germany's travel restrictions, the project team put a plan in place to have ABB UK carry out the modifications as directed by video from ABB Germany while maintaining safe distances between employees on site. However due to the escalating risk of COVID-19, UK Power Networks made the decision to shut down non-essential project sites the week prior to the UK Government directive to ensure safety of employees and contractors. Work is postponed until it is safe for employees of UK Power Networks and ABB to carry out the work. As previously mentioned, the current assumption is that work will recommence four months from the UK Government directive for 23 March.

4.2 Detailed progress in the reporting period

The project has made significant progress during this reporting period, as shown below:

Task description	Workstream	Status at start of period	Status at end of period
Installation of HV power cables	2	Complete	Complete
Designing and testing of portable power pack	Out of project scope	In progress	Complete
Commissioning of busbar extension, unit protection, etc.	2	In progress	Complete
Commissioning of FLCB	2	In progress	Complete
Modification of HV compartment door interlock of FLCB (postponed due to COVID-19)	2	In progress	In progress
Commissioning of auto-close scheme and fault recorders	2	In progress	In progress
Energisation (postponed due to COVID-19)	2	In progress	In progress

4.3 Identification and management of issues

The project team recognises the importance of robust risk management methodologies for any project, but more specifically for complex innovation projects. Due to the nature of complex innovation projects, it is likely that certain risks will impact the overall project activities in some form. A full list of project risks identified for the project is provided

in Section 11. However, during this period it can be reported that risks R34, R44, R45, R46 and R47 have the potential to or begin to impact the schedule of specific project activities.

R42, the risk of delay in energisation due to defect identified in the retrofit ABB circuit breaker (type VOR-M) materialised in the last reporting period. This issue was resolved following the testing of the portable power pack in January and receiving approval to commission and energise the retrofit CBs from Asset Management in February.

R43 identified that the auto-close scheme and fault recording relays could not be commissioned due to an existing cable fault of GT1 at the trial site. This risk has been updated to R44 as the sinkhole previously linked to R43 has been repaired. In May the GT1 cable fault was found and repaired however a fault has been identified which now needs to be located and repaired.. This repair lies outside of the scope of the project but does impact on project activities. As highlighted in Section 2.4, locating the fault is a complex and an iterative process with two attempts during the period being unsuccessful and now identification of a second fault delaying GT1 being put back in service.

The following issues have been reported in the workstream reports and are also captured below:

Ref	Issue	Impact	Mitigation
R34	Delay and/or cost overrun – commissioning	Additional visits to complete commissioning in February, and activities captured in R44 and R45 requiring additional time has had an impact on the budget planned for the completion of commissioning. Contingency funding will be used.	Costing exercise completed to estimate remaining costs for commissioning and energisation. These include: • Multiple remobilisation and demobilisation costs due to site shutdown from COVID-19 and returning to complete remaining commissioning; • Time to complete HV door interlock repair; • Energisation; and • Commissioning of auto-close scheme and fault recorders.
R44	Delay in GT1 cable fault repair Due to the redundancy in our network, this cable fault is currently not affecting customers or security of supply. In May cable fault was found and repaired	Both the auto-close scheme and the fault recording relays cannot be fully commissioned until the transformers can be taken out of service. This needs to be done to complete wiring and testing. Trial site has three transformers in total and the	Return at a later date to commission auto-close scheme and fault recorders to mitigate delay in energisation. Auto-close scheme is required for running arrangement 3 (using the FLCB as a bus coupler) and the FLCB's internal fault recording mechanism could be used in the interim period until the fault is fixed.

Ref	Issue	Impact	Mitigation
	however a second fault has been identified.	impact of GT1 being out of service is that GT2 and GT3 cannot also been taken out of service as two must be in service for security of supply of the network.	
R45	Delay in modification/repair of HV compartment door interlock on the FLCB due to COVID-19 restrictions	Delay in energisation of the FLCB as the interlock is a critical safety mechanism.	Prior to the full lockdown measures implemented by UK Government on 23 March, ABB Germany were unable to travel due to their own COVID-19 restrictions. To mitigate the uncertainty as to when ABB Germany could travel again, the project team arranged for ABB UK to carry out the modifications as directed by video from ABB Germany while maintaining safe distances between employees on site. Currently no mitigation is possible until site works can safely recommence.
R46	Delay in publication of learning report SDRC 9.2.1 – Interim Learning Report – Demonstration of a FLCB for substations	To fulfil the requirements of SDRC 9.2.1 energisation of the FLCB needs to be complete. The delay of this SDRC is the same assumption as for R45 – anticipated four month delay.	To minimise the impact of delays the project team has already starting drafting SDRC 9.2.1 with our learnings to date from installation and commissioning.
R47	Potential extension to project trial end date (also linked to R9)	Extension of overall project end date. Delays encountered during type testing, approval to energise the retrofit circuit breakers due to the defect linked to R42 (outside the scope of the project), issues	The project team will monitor performance of the FLCB once the trial period has started. If a number of network faults are experienced, the team will assess whether or not an extension to the project trial is required. The reliability of our network means that network faults occur infrequently.

Ref	Issue	Impact	Mitigation
		arising during commissioning have impacted the trial start date.	Performance data of the FLCB under network faults is vital as this maximises the learnings generated through the project and provides confidence in the reliability of the FLCB.

4.4 Key achievements and notable events

Key achievements and notable events in the reporting period are shown below:

- Approval of change request by Ofgem to remove M2 from the project;
- Commissioning of all switchgear, equipment and FLCB with the exception of the auto-close scheme and the fault recording relays;
- Training of LPN field staff;
- Remote monitoring of the FLCB and control system by ABB following commissioning;
- Commenced drafting learning report SDRC 9.2.1 and
- Press release highlighting the project.

4.5 Look-ahead to next reporting period

The following major tasks and milestones are planned for the next reporting period:

- Commence network demonstration period (WS2);
- Updating Phase 2 of the safety case (WS1 and WS2);
- Publish learning report 9.2.1;
- Present at UK Power Networks hosted event (WS4); and
- Provide tours to key internal stakeholders if safe to do so based on the latest COVID-19 advice. Alternatively web events can be carried out.

5. Progress against budget

This section is provided in the Confidential Appendix A.

6. Project bank account

This section is provided in the Confidential Appendix A.

7. Successful Delivery Reward Criteria (SDRCs)

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. We have struck-through the SDRCs that we have requested to be removed as part of the change request.

Project Deliverable	Deadline	Evidence	Progress
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)	31 May 2019	**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.	Complete
~~9.1.2 Prototype and lab test a customer-based solution (Method 2)~~	~~31 August 2019~~	~~**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.~~	Removed from project
9.1.3 Independent review of safety case	31 May 2018	**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.	Complete
9.1.4 Safety case for FLCB installation without back-up	31 May 2018	**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.	Complete
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)	31 July 2020	**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.	Publication delayed due to COVID-19 preventing energisation of FLCB (see R46). A non-material change request will be submitted in due course. According to our initial assessment, at the time of writing this report, all works

Project Deliverable	Deadline	Evidence	Progress
			are expected to fully return to pre-COVID-19 lockdown status by end of July; four months after the initiation of national lockdown on 23 March. It must be noted that this is the best estimate at this point of time, as COVID-19 is a developing situation and we will continue to monitor and assess the return date.
~~9.2.2 Install and commission solution at a customer's premises (Method 2)~~	~~31 July 2020~~	~~**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.~~	Removed from project
9.2.3 Demonstration of solution at an 11kV substation (Method 1)	30 June 2021	**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.	Delayed due to COVID-19 restrictions. Current estimate is the same as for SDRC 9.2.1; four months
~~9.2.4 Demonstration of solution at a customer's premises (Method 2)~~	~~30 June 2021~~	~~**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.~~	Removed from project
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	31 October 2017	**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.	Complete

Project Deliverable	Deadline	Evidence	Progress
~~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~~	~~31 March 2020~~	~~**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.).~~	Removed from project
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	30 September 2021	Publish key materials from the stakeholder event (e.g. slides), and provide Ofgem with a list of invitees and attendees.	Delayed due to COVID-19 restrictions. Current estimate is the same as for SDRC 9.2.1; four months

8. Data access details

To view the full Innovation Data Sharing Policy, please visit UK Power Networks' website here: https://innovation.ukpowernetworks.co.uk/wp-content/uploads/2019/11/UKPN-Innovation-Data-Sharing-Policy-7-Nov-19.pdf

UK Power Networks recognises that innovation projects may produce network and consumption data, and that this data may be useful to others. This data may be shared with interested parties whenever it is practicable and legal to do so and it is in the interest of GB electricity customers. In accordance with the Innovation Data Sharing Policy, published in 2019, UK Power Networks aims to make available all non-personal, non-confidential/non-sensitive data on request, so that interested parties can benefit from this data.

9. Learning outcomes

The project team recognises the importance of learning and dissemination. Specific lessons learned in each of the workstreams are captured in the workstream progress reports in Section 2 of this progress report.

During this reporting period, the project team commenced work on drafting SDRC 9.2.1 and is planned to be published on the Powerful-CB website during the next reporting period. Previous learning reports highlighted in Section 7 are also available through this website.

10. 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.

IPR generated this period (January – June 2020)

IPR Description	Owner(s)	Type	Royalties
Commissioning reports	UK Power Networks	Relevant Foreground IPR	Nil
FLCB and control system status snapshots (as necessary)	ABB	Relevant Foreground IPR	Nil

IPR forecast next period (January – June 2020)

IPR Description	Owner(s)	Type	Royalties
Data and performance of FLCB during network demonstration	ABB UK Power Networks	Relevant Foreground IPR	Nil

11. Risk management

This section lists the risks highlighted in the FSP plus any other risks that have arisen in the reporting period. We have described how we are managing the risks we have highlighted and what we have learned. Risks 1-36 are captured in the FSP although some have been updated. Risks 37-39 were identified during the progress of the project. The project continues to monitor risks and issues on a monthly basis where risk impacts and mitigation plans are updated.

Ref	WS	Status	Description	Mitigation/Planned Action	Current Status	RAG
R1	WS1	Closed	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	Closed	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 identified a potential customer and a location for trials.	G
R3	-	-	NOT USED.	NOT USED.	NOT USED.	-
R4	WS1	Closed	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 and signed the collaboration agreement with ABB to minimise the risk of cost overruns. The risk of delay in prototype development is still present. See risk R41 for more specific risk. FLCB was delivered to site 5 November 2019	G
R5	WS1	Closed	Delay and/or cost overrun - safety case (due to unforeseeable requirements).	We have allowed specific contingency for the safety case, based on FNC's experience of required effort in the event of unforeseen requirements.	FNC delivered the preliminary safety case within the given timescales. SDRC 9.1.3 and SDRC 9.1.4 are complete.	G
R6	WS1	Closed	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.	Regular meetings and ad-hoc communications between ABB, FNC, and UK Power Networks technical experts has meant successful collaboration on the FLCB specification and safety case. The preliminary safety case is complete. The FLCB has undergone type testing and FATs	G
R7	WS1	Open	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.	All key stakeholders, including ABB and UK Power Networks technical experts, attended the safety case workshops. The preliminary safety case is complete. Phase 2 of safety case to be completed during demonstration period.	G
R8	WS1	Open	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	Open	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. Additionally a 24 month trial period will be completed.	We have used historic fault data when looking at potential sites – recognising that fault history is not necessarily an indicator of future faults. The trial period has been reduced due to various delays experienced during type testing and commissioning. Uncertainty due to COVID-19 is preventing energisation and commencement of the trial period.	A

Ref	WS	Status	Description	Mitigation/Planned Action	Current Status	RAG
R10	WS2	Open	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	Open	Solution fails to operate correctly during field trial (i.e. fails 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	Closed	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.	M2 (customer site trials) will no longer be pursued as part of this project.	G
R13	WS4	Open	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	Open	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 and WS2	Open	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.	Lead times of UPSs and resource availability saw a second site visit for commissioning take place in February	G
R16	PM	Open	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.	N/A this period.	G
R17	PM	Open	UK Power Networks not able to deliver on commitments because other teams supporting the project have operational resource constraints.	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	Closed	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 method. If FNC withdraw from the project, we will seek an alternative partner who can provide the necessary safety case expertise.	AMAT did not sign the collaboration agreement and have withdrawn from the project. Following this change, we engaged with the market to find an alternative partner for M2. However when no suitable replacement could be found, the project team decided to request a change from Ofgem to remove M2 from the project.	G
R19	WS2	Closed	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.	Risk no longer valid. M2 (customer site trials) will no longer be pursued as part of this project. Change request submitted to remove M2 from the project.	G
R20	PM	Open	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	Open	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.	We have engaged with the protection team and they have not indicated any initial issues.	G
R22	WS2	Open	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	Open	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	Open	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	Status	Description	Mitigation/Planned Action	Current Status	RAG
R25	WS1	Closed	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.	4 of 5 type tests passed. Internal arc withstand will be re-tested. Re-test of IAC test completed in July 2019	G
R26	WS2	Closed	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.	This risk is closed as a trial site has been selected within LPN.	G
R27	WS4	Open	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	Open	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	Closed	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.	The customer based solution for M2 was removed from the scope of the project.	G
R30	WS2	Closed	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.	Civil works completed this period	G
R31	WS2	Closed	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.	See R17 for the delay in electrical installation works.	G
R32	WS1	Closed	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.	AMAT withdrew from the project and ABB have signed the collaboration agreement.	G
R33	WS1, WS2	Open	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 designs and specifications.	We are working closely with any relevant business units where necessary.	G
R34	WS2	Issue	Delay and/or cost overrun – commissioning.	Costing exercise is under way to estimate remobilisation costs and forecast time required to complete remaining works to minimise the use of contingency costs	Additional site works to complete commissioning in February, R44 and R45 requiring time and cost in the future has impacted the budget planned for commissioning	A
R35	WS3	Closed	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.	WS3 was removed from scope of project as it was related to M2.	G
R36	WS2	Closed	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[1].	The CBs used in the project are retrofitted from existing ones and we have used the same supplier for the retrofit before.	G
R37	WS3	Closed	Delay in contract phase with the customer.	Shortlist a number of potential customers should the customer withdraw from the project. Engage with the customer and legal team early to allow sufficient time for contracts to be drawn up.	WS3 was removed from scope of project as it was related to M2.	G
R38	WS1	Closed	Unable to sign contract with Method 2 supplier.	Find an alternative supplier. Efforts were made to find an alternative supplier but were unsuccessful. The decision was made to remove Method 2 from the project and a change request was submitted to Ofgem. We are awaiting official response from Ofgem but has been agreed in principle.	Method 2 is removed from the project.	G

[1] Joggling is a metalworking technique to attach two metal sheets together. It is an offset bending process in which the two opposite bends are each less than 90°, and are separated by a neutral web so that the offset (in the usual case where the opposite bends are equal in angle) is less than five work piece thicknesses. Often the offset will be one work piece thickness, in order to allow a lap joint, which is smooth on the 'show-face'.

Ref	WS	Status	Description	Mitigation/Planned Action	Current Status	RAG
R39	WS2	Closed	Delay in delivery of retrofitted CBs.	We have allowed adequate time contingency for ABB UK to supply approved circuit breakers.	The CB retrofit is complete and ready to be delivered to site. The CB retrofit were delivered to site	G
R40	WS2	Closed	Delay in completion of electrical design (CPP).	Close support of the electrical design team from the project team. Monitoring of progress and assistance from the supplier.	Electrical design completed in this period. The risk remains open for any changes that might be identified during commissioning.	G
R41	WS1	Closed	Delay in testing and/or FAT of FLCB device.	Change order of type tests depending on what is causing the delay.	This risk has become an issue due to the original high power test laboratory having a fault with the generator required for the type testing. Due to the long lead time (3-4 months) for repair of the generator, an alternate high power test laboratory has be booked. This will minimise the impact on the readiness of the FLCB for delivery to site. The FLCB failed the first internal arc classification (IAC) test so an investigation and panel modification were made. The re-test was completed in July 2019 but this did impact the delivery to site	G
R42	WS2	Closed	Delay in energisation and commencement of trial period (due to defect identified in QF switchgear (retrofit circuit breakers)). A defect was discovered with a batch of retrofit VOR-M CBs of the same type as the ones being used for the trial site. The defect caused capacitor failures due to a defective batch and they form part of the magnetic actuator mechanism. Failure of the capacitor would .prevent the CB from opening/tripping	Project team have identified that the retrofit CBs procured for the project are not part of the defective batch of capacitors so the risk of failure is low. UKPN has proposed that in the unlikely event of a DC power supply failure of the substation a portable power pack should be developed by ABB so that the CB can be operated.	ABB to design and produce portable power pack. Asset management have requested that the energisation of these CBs does not take place until this has been received.	G
R43	WS2	Closed	GT1 cable fault cannot be repaired until sinkhole near where excavation is required is fixed first. Trial site has three transformers in total and the impact of GT1 being out of service is that GT2 and GT3 cannot also been taken out of service as two must be in service. The result of this is that both the auto-close scheme and the fault recording relays cannot be fully commissioned.	Return at a later date to commission auto-close scheme and fault recorders to mitigate delay in energisation. Auto-close scheme is required for running arrangement 3 and the FLCB has its own fault recording devices.	Have been in contact with London Borough of Tower Hamlets to discuss when the sinkhole will be fixed.	G
R44	WS2	Issue	Replacement of R43. Delay in GT1 cable fault repair. Trial site has three transformers in total and the impact of GT1 being out of service is that GT2 and GT3 cannot also been taken out of service as two must be in service. The result of this is that both the auto-close scheme and the fault recording relays cannot be fully commissioned.	Return at a later date to commission auto-close scheme and fault recorders to mitigate delay in energisation. Auto-close scheme is required for running arrangement 3 and the FLCB has its own fault recording devices.	Delay in GT1 cable fault repair Due to the redundancy in our network, this cable fault is currently not affecting customers or security of supply. In May cable fault was found and repaired however a second fault has been identified.	A
R45	WS2	Issue	Delay modification of HV compartment door interlock on the FLCB due to COVID-19	Currently no mitigation is possible until site works can safely recommence.	This is currently preventing energisation of the FLCB and will continue to do so until site works can safely recommence.	R

Ref	WS	Status	Description	Mitigation/Planned Action	Current Status	RAG
			restrictions. This impacts energisation of the FLCB.	Prior to the full lockdown measures implemented by UK Government on March 23, ABB Germany were unable to travel due to restrictions. To mitigate the uncertainty as to when ABB Germany could travel again, the project team arranged for ABB UK to carry out the modifications as directed by video for ABB Germany while maintaining safe distances between employees on site.		
R46	WS2 and WS4	Issue	Delay in publication of learning report SDRC 9.2.1 – Interim Learning Report – Demonstration of a FLCB for substations.	To minimise the impact of delays the project team has already starting drafting SDRC 9.2.1 with our learnings to date from installation and commissioning.	To fulfil the requirements of SDRC 9.2.1 energisation of the FLCB needs to be complete.	A
R47	WS2	Open	Extension to project trial end date (also linked to R9).	The project team will monitor performance of the FLCB once the trial period has started. If a number of network faults are experienced, the team will assess whether or not an extension to the project trial is required.	Delays encountered during type testing, approval to energise the retrofit circuit breakers due to the defect linked to R42 (outside the scope of the project), issues arising during commissioning have impacted the trial start date.	A

12. Material change information

No material changes have been encountered during this reporting period and none are foreseen for the next reporting period.

13. Other information

Currently there is no other information to report to Ofgem.

14. Accuracy assurance statement

The project has 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 seventh six-month reporting period and an accurate view of our understanding of the activities for the next reporting period.

Signed 

Date 16 June 2020

Suleman Alli
Director of Customer Service, Strategy, Regulation & IS
UK Power Networks