[redacted]

Major Incident 03/05/2024
Power Outage, Estates Report

Abstract

This report documents the events of 3rd May 2024 when a High Voltage cable joint fault resulted in loss of power to various building on the Bristol Royal Infirmary precinct. It is focused on the Estates response and engineering systems.

[redacted] Associate Director Estates

[redacted]

Key report contributions

- [redacted] UHBW Senior Electrical Estates Officer
- [redacted] UHBW Electrical Estates Officer
- [redacted] Deputy Director Estates & Facilities
- [redacted] ETA Projects (Authorising Engineers)
- [redacted] UHBW General Manager Estates

Contents

Introduction

This report has been prepared in response to a Major Incident on 03/05/24 which involved a power outage to the BRI (Bristol Royal Infirmary) precinct. All Bristol City Centre Hospitals were impacted in different ways, and a multi-agency major incident was declared. This report is focused on the engineering elements of the incident to establish what happened, the timeline of events, the root cause, the Estates response, identify actions to mitigate future events and any lessons learnt.

Key Staff Involved

- [redacted], Director Estates & Facilities
- [redacted], Deputy Director Estates & Facilities
- [redacted], Associate Director Estates
- [redacted], Electrical Estates Officer HV AP
- [redacted], Senior Estates Officer HV AP (
- [redacted], Electrio and Trust HV AP
- [redacted], Electrio
- [redacted] Estates Operations Manager
- [redacted], Principal Fire Officer
- [redacted] and [redacted] ETA Projects, Trust Authorising Engineers
- [redacted], General Manager Estates
- [redacted], Enerveo Contractors

Timeline of Key Events

Date	Time	Event
03/05/24	13:23	Loss of power
03/05/24	13:24	[redacted] walked Ring No.2 to establish system status
03/05/24	13:25	Fire Alarm Activated 2-438 OHD
03/05/24	13:40	CSM called fire brigade to confirm fire
03/05/24	TBC	Fire Brigade arrived on site
03/05/24	TBC	Reports of ceiling/fire issue on L2 Queens Building
03/05/24	13:51	[redacted] arrived on site to assist [redacted] in switching
03/05/24	13:52	[redacted] operated (QB L3)
03/05/24	13:53	[redacted] operated (QB L3)
03/05/24	13:58	Emergency switching commenced as per HV Logbook entry. See photo below – Appendix 1
03/05/24	15:32	Generator ordered from Power Electrics
03/03/24	15:35	Fire Brigade showed GG cable fault in duct
03/05/24	17:34	Generator arrived on site
03/05/24	19:19	Power restored to Queens Building via temporary emergency LV generator
03/05/24	20:30	[redacted] signs Incident handover form from Avon Fire Brigade
03/05/24	22:00	Testing completed on HV leg between THQ and BEH (Bristol Eye Hospital) indicating no cable fault.
04/05/24	00:20	Power restored to BEH, BDH and EDC via HV network
04/05/24	01:10	LV generator taken offline, and power restored to the Queens Building via the HV network

Electrical Infrastructure – Background

The BRI precinct has a High Voltage (HV) network consisting of 11 HV substations. In normal operating conditions we operate 2 HV rings. Ring 2 (blue) consists of BHI, THQ, BEH, BDH, EDC, QB and ring 1 (red) consists of BHOC, STM, TSB, BRHC, Boiler House.

The main intake at Southwell Street consists of 3 main incomers from the National Grid. (WPD INC 1, WPD INC 2 and WPD INC 3). The site is also served by 5 HV generators located at the boiler house. The generators have enough capacity to serve the whole site when the ring is not compromised.

Image 1 shows an electrical schematic of the sites HV network.

***Image 1 – Site HV Network**

Cause of the Power Outage

The cause of the power outage was a cable joint fault on the leg of the HV network from Queens Building to SSI. This joint is in Zone 13 of the duct.

Image 2 (a-e) shows the damaged cable joint.

Image 3 shows the temporary repair – New joint.

Image 4 shows the BRI service tunnel and duct network.

Image 5 shows access to Zone 13 of the duct network.

During the fault finding it was also identified that the HV leg from THQ VCB to BEH VCB would not close to restore power to the BEH as the Translay Relay had tripped and wouldn't reset. This meant that the BEH, BDH, EDC and QB were isolated from the HV network.

It is suspected that due to the high fault current of the cable fault this would have also damaged the suspected, weakened, Translay Relay on the BEH VCB to THQ VCB Translay cable.

Note - A Translay cable is a cable that runs alongside a HV cable that detects a fault at high speed (also known as point-to-point protection). If an imbalance is detected it trips the HV breaker. This would explain why it was not possible to close the THQ VCB to BEH VCB leg to reinstate the HV Ring.

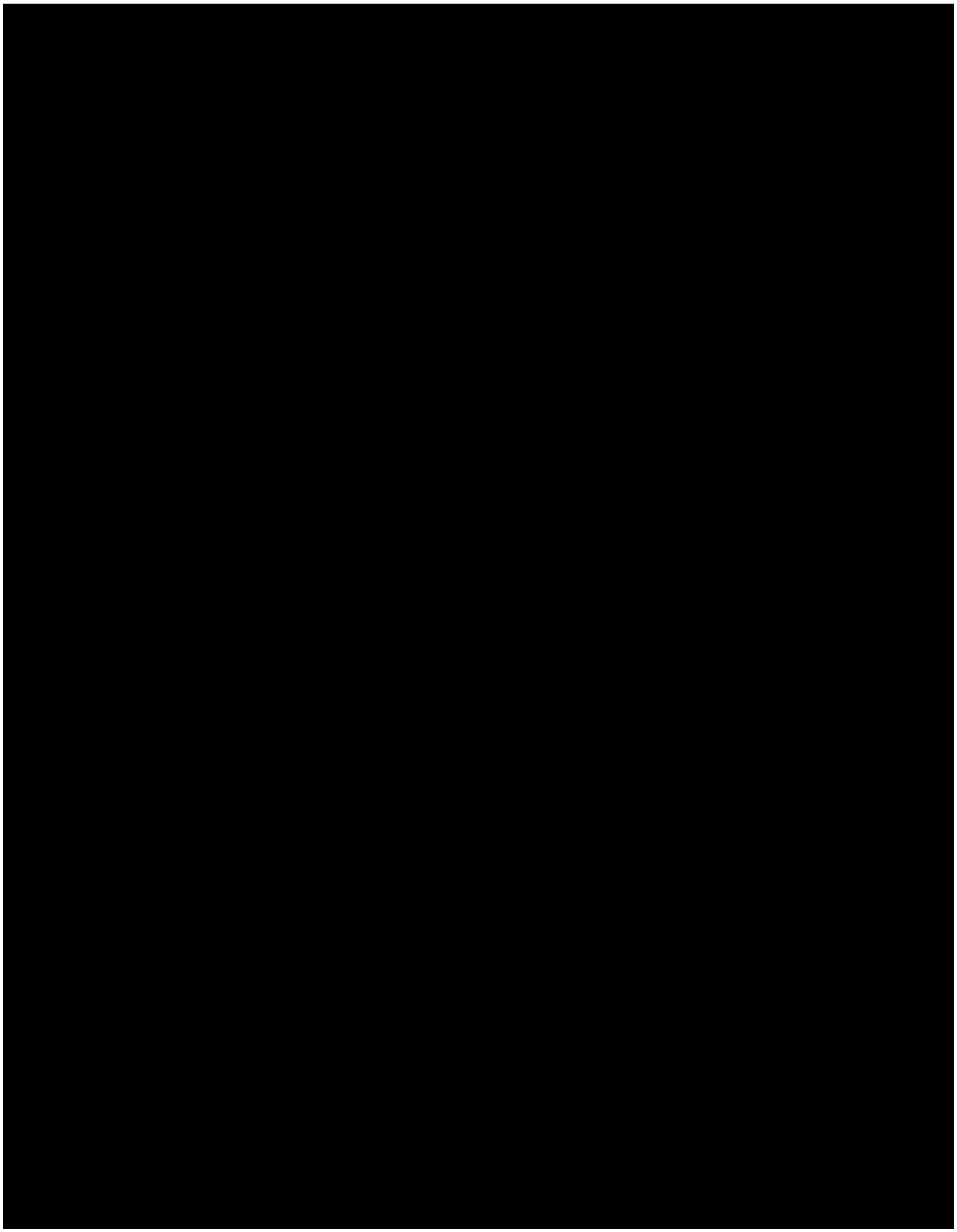

Image 2e

***Image 2a-e – failed HV cable joint**

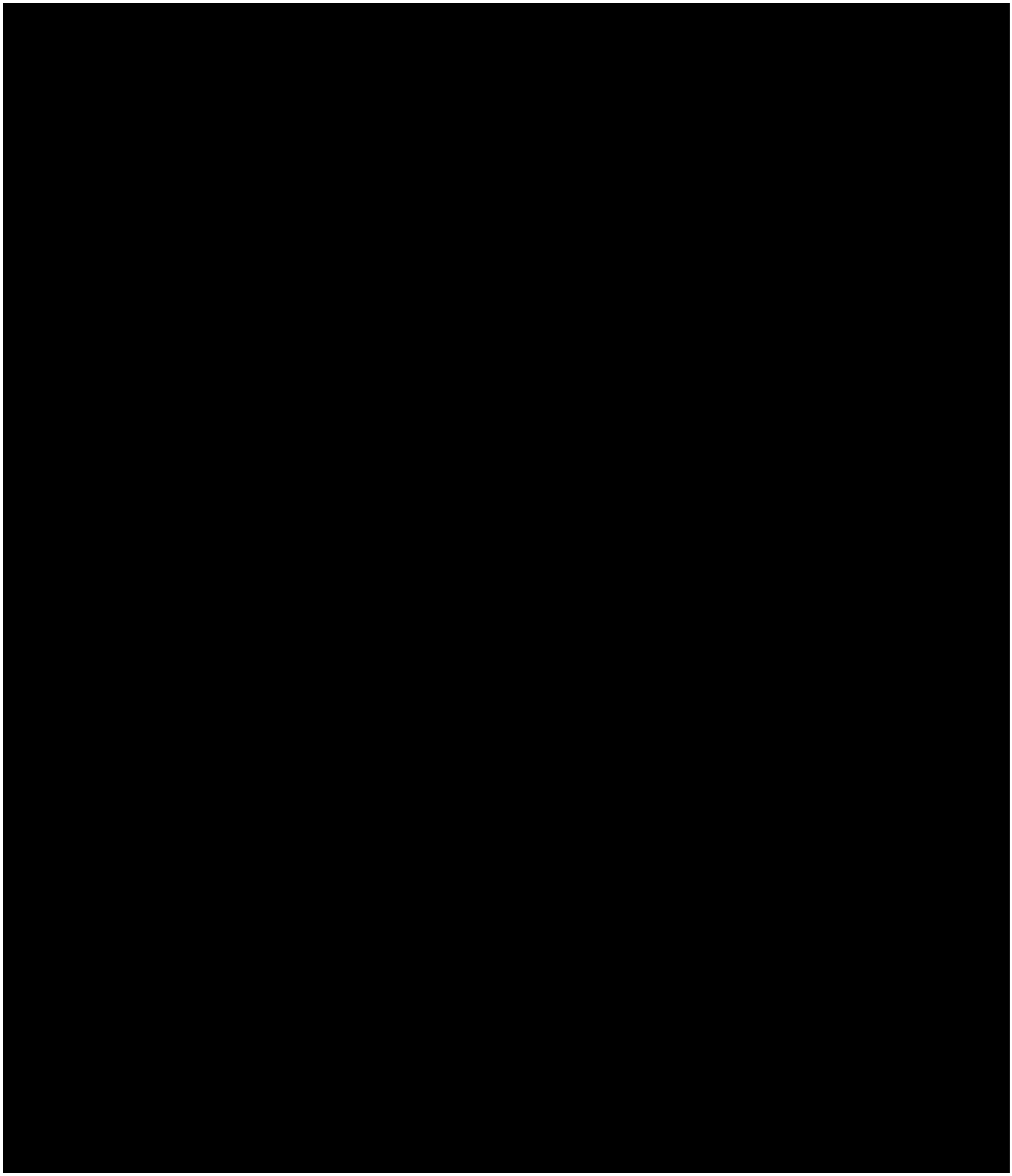

***Image 5 – Access to Zone 13**

Estates Response

[redacted] was on-site at the time of the initial power interruption and suspected the issue may lie within a joint situated outside our Dental Hospital and where current roadworks were taking place. [redacted] walked Ring No.2 to establish the status and found power was only restored on the BHI VCB to THQ VCB leg so we had two open points on the same ring. [redacted] joined [redacted] at ~13:51. On resetting the Translay relay at the SSI Substation they attempted to re-energise the cable from SSI VCB to QB VCB, this was unsuccessful. [redacted] and [redacted] then walked to the QB Substation, reset the Translay relay and opened the TX1 & TX2 VCB's to remove load prior to attempting to energise this cable again. They walked back to the SSI Substation, again reset the Translay relay, and tried to close at ~14:33. At this point it was clear there was a significant issue and further investigation would be required into the THQ VCB to BEH VCB leg to try and restore power. At ~14:52 the Translay relay was reset at the THQ VCB to BEH and then the cable route walked with regards to suspected damage through civils exposure, the roadworks seemed to be complete, but no crews were in the vicinity to speak to. The Translay relay would not reset at the BEH VCB to THQ VCB, so a decision was made to try and close the VCB at the THQ end as this was our last chance to restore some power. This was also unsuccessful, and the decision was made at 15:32 to order a temporary 2MVA LV Generator to feed the Queens Building switchboard, this was through Electrio.

[redacted] was on-site at the time of the power loss and co-ordinated the initial response to fire brigade attendance and reports of ceiling collapse, asbestos contamination, and attended incident control meeting.

[redacted] was working from home (approx. 6 miles from site). When it was suspected that the THQ VCB to BEH VCB leg would not close, he drove to site arriving at approx. 15.00.

PL was working at home (Gloucester). When it was suspected that the THQ VCB to BEH VCB leg would not close, he drove to site arriving at approx. 15.45.

Trade staff were part of the first response and most stayed assisting wherever needed including assisting pulling LV cables for the emergency generator.

A low voltage (LV) generator was ordered 15:32 and arrived on-site, via police escort at 17:34. The Queens Building switchgear has an emergency generator plug in facility (Litton connections) which made connecting of the generator quicker and easier.

[redacted], [redacted], and [redacted] attended incident response meetings chaired by the Trust Chief Operating Officer.

Jackson Lifts were onsite and pulled in an additional engineer to check that no persons were trapped within lifts/assist on their safe release. Two lifts had people stuck in them. Due to power being out for a while each lift was checked to make sure nobody was stuck in them.

Morris Churchfield called to site and pulled in an additional engineer to monitor the fire alarm system which was now running on the nodes internal battery systems.

After a 4 hour of the power being off some of the access control started to fail. Scutum where on site.

MEMO engineers were on-site and reset any medical gas systems.

Authorising Engineers Review

The root cause of the incident was a cable fault on the HV ring between the main intake substation (Southwell Street) and Queens Building.

BRI HV system operates as a closed ring with 2x separate rings. The system is protected against cable faults by a 'Translay' unit protection system. The Translay system (balanced voltage) utilises relays at all substations at in/out points of the HV ring and a pilot cable between all relays. In the event of a cable fault, a circulating current flows in the pilot cable, causing the 2x relays at either end of the faulted cable to trip and isolate the fault. The rest of the HV ring should remain unaffected and continue to supply the load.

In the incident, the Translay relays at Southwell Street and the Queens Building operated correctly and cleared the fault. However, the Translay relay at the Bristol Eye Hospital substation operated incorrectly and caused the spurious tripping of the circuit breaker at the substation on the circuit towards the Trust HQ substation. This relay went into 'lockout' mode and could not be reset, causing another open point in the network, and resulting in continued loss of supply to Bristol Eye Hospital, The Education Centre, and the Queens Building substations. This was only resolved by connection of an LV generator at the Queens Building LV switchroom. Subsequently the faulted 'Translay' relay at Bristol Eye Hospital substation was replaced to allow full restoration of power to the HV ring. Estates staff should be praised for their efforts in restoring power for what was a challenging incident.

It should be noted that the Translay relay that was used to replace the faulted relay, operates at a different voltage, and cannot be guaranteed to operate should another HV cable fault occur.

Recommended actions;

- It was noted that the initial fault occurred on a cable joint between a Triplex cable and an older PILC (Paper Insulated Lead Covered) cable – the section of PILC cable should be replaced with Triplex
- Ideally all HV joints should be removed from the system, with continuous cables installed
- Insulation Resistance testing of all sections of both HV rings should be undertaken to gauge the condition of all HV cables
- The integrity of all pilot cables should be checked
- The operation of all 'Translay' relays should be checked
- An updated protection discrimination study should be undertaken
- An Arc Flash study should be undertaken
- Translay protection is notorious for spurious operation due to the problem of balancing the system, as such it is rarely used anymore– consideration should be given to replacing the system with a more modern equivalent such as 'Solkor' which although it operates on the same principle as 'Translay' is more widely used and has proved more reliable.
- BRI is unusual amongst hospitals in that it uses a closed ring system – whilst such a system offers the advantage of automatic restoration of power with very little delay it is also prone to spurious tripping (as seen in this incident), and requires more maintenance, and in the case of Translay replacement relays are becoming harder to source.
- Therefore, consideration should also be given to an 'open ring' system (more commonly used in hospitals) whereby an open point is maintained on the ring, which is normally protected by IDMT relays with discrimination between relays – this system will be slower to restore power than a correctly functioning closed ring system, and will require manual switching, but will be more reliable – an open ring system can be further enhanced by the

use of fault passage indicators and can also be fully automated, or operated remotely via a control room

- It has previously been observed that the current closed ring system already has Sepam IDMT relays installed (configured with identical settings) – this is not recommended practice with a closed ring system as should the 'Translay' system fail to operate it could result in the tripping of all IDMT relays around the ring as discrimination is impossible to achieve without an open point in the ring.
- All LV switchboards should have an LV generator connection installed.
- Consideration should be given to installing permanent LV generators at critical LV switchrooms to give future protection against future HV cable and switchgear faults.

[redacted], ETA Projects, Authorising Engineers

Lessons Learnt

1. Fencing/barriers – during the incident access to the front of the hospital was controlled by the security and Facilities teams. At the time of the incident there was significant road works being completed on Upper Maudlin Street therefore barriers were repositioned to assist with controlling the public. If a similar incident were to occur elsewhere on the precinct The Trust to not have ready access to barriers and/or Harras fencing.
2. Torches – Estates hold some supply of torches in the Estates stores. These were distributed at the start of the incident. Once the emergency lighting batteries had run out (requirement to last circa 3 hours) it was very dark on the wards. Consideration to be given to if each ward/department should hold a stock of torches and additional torches/battery lighting in HV/LV switch room.
3. Security – access control fails safe. The Dental Hospital, Eye Hospital and Education Centre lost power to the access control system and after the system batteries failed the access and egress doors failed open. Security of the buildings was a concern for the division, especially the Dental Hospital. Security patrols were put in place, however the division felt that this was a significant risk.
4. Accessibility of asbestos detail – On fire alarm activation the fire brigade asked if there was asbestos contamination within the duct (Zone 13) as the sign on the door has a hazard label. [redacted] requested this information from [redacted], Estates Building Officer who confirmed that there was nothing on the Asbestos Register. [redacted], the Trust Asbestos Analyst also attended the location to visually inspect the area with the fire brigade to assess the asbestos exposure risk. It was confirmed that Asbestos was not identified in the area, at which point the fire brigade accessed the location to investigate the fire alarm activation.
5. Lifts – Several lifts tripped out because of the power failure resulting in a few trapped passengers.
6. Managing the messages – rumour management– collapsed ceiling, fire. There were a few reports that transpired to not be 100% accurate or reflect the position. This gave a feeling of being 'reactive'. It is inevitable that this happens in a Major Incident, however we should learn from this as a team and the proposed review of the Estates Incident Management Structure could assist with this.
7. Generators plug in connections – We were fortunate that the Trust had foresight to install LV generator connections so that when the LV generator turned up, we could 'plug in' to the LV

switchboard with no challenges around connecting to LV busbars. We have similar arrangement at St. Michaels and Bristol Haematology & Oncology Centre. Bristol Heart Institute, Education, BRHC, Terrell Street Ward Block and King Edward Building/Trust HQ have generator connection points, but these are bolt on rather than plug-in. The Eye and Dental Hospitals can be considered as one system but there is no easy method of connecting a generator. The Joint Boiler House and IM&T do not have a generator connection point and these two areas need the electrical services combined and reconfigured. A generator connection point could be added at this time. The King David Offices and all the remote buildings have no generator backup as they have independent electrical supply not on the Trust HV network and no provision to bring generators in.

8. MRI/CT scanning capability all located in Queens Building – There was significant clinical impact on the Trust capability to deliver trauma services as all the Adult MRI and CT capability sits within the Queens Building.
9. Emergency lighting lasted well (over the 3-hr requirement) with reports into incident control centre of no lighting around 5-6 hours after power outage.
10. It was noted that QB stairwell was dark.
11. Estates roles and responsibilities to be clearly defined for critical incident/multi-agency incident management. Incident command governance (identifying operational (Bronze), tactical (Silver) and strategic (Gold) leads within Estates team) to be considered to help shape the Estates emergency/corrective response and improve cross-divisional lines of communication during such incidents.
12. We were extremely fortunate to obtain an HV joint through a third party.
13. The LV Generator was leased through Power Electrics (Warmley), but it was the last one available of the two they had at this size.
14. The Queens Building under croft was very ‘busy’ and in a poor state of hygiene through Pigeons mess.
15. [redacted] sent the Asbestos surveyor with fire brigade up to zone 13 duct to provide reassurance the area is clear on Asbestos. On walking through the zone 13 duct void the cable joint xxx (Sparked). It is assumed this xx sparked when the HV AP was switching. If the Asbestos surveyor was any closer or had touched this joint at time it was switched this could have caused serious injury to individual.

Action Plan

Action Ref.	Action detail	Action Owner	Target Completion date	Status	Monitoring Group
01	Undertake replacement of the HV cable from duct 13 joint to Queens Building.	[redacted]	31/08/2024	Not Started	E&F Divisional Management Board CPSG?
02	Undertake repair/replacement of the BEH Translay relay	[redacted]	31/05/24	In Progress	E&F Divisional Management Board
03	Review current stock of barriers and fencing. Purchase new as needed. Agree suitable location for emergency store.	[redacted]	30/05/24	Not started	E&F Divisional Management Board
04	Review all building main LV panels to establish if connections are readily available for a temporary LV generator to plug in.	[redacted]	09/05/24	Complete	E&F Divisional Management Board
05	Review existing Incident Command governance and consider to what extent this can be improved the emergency/corrective response from Estates and how Estates output/corrective action taken/to be taken may be effectively communicated throughout the organisation.	[redacted]	30/6/24	Not Started	E&F Divisional Management Board
06	Obtain various HV joints to keep on-site as spares	[redacted]	14/06/24	Not Started	E&F Divisional Management Board
07	Contact generator suppliers to get details of what they have in stock of a suitable size that they could deploy in an emergency	[redacted]	31/05/24	Not Started	E&F Divisional Management Board
08	Clean and tidy Queens Building under croft area, remove pigeons and install netting	[redacted]	31/05/24	Not started	E&F Divisional Management Board
10	Duct – Zone 13 – clean out rubbish and re-install hoop to access ladder. Review egress and access to duct zone 13.	[redacted]	30/06/24	Not Started	E&F Divisional Management Board
11	Review resilience of Estates team out of hours.	[redacted]	31/06/24	Not started	E&F Divisional Management Board
12	QB stairwell emergency lighting to be assessed	[redacted]	31/06/24	Not started	Fire Improvement Group
13	Review HV resilience and any opportunity to increase or improve the set up	[redacted]	31/07/24	Not started	E&F Divisional Management Board
14	Review al AE recommendations at the Trust Electrical Safety Group and agree which ones are taken forward.	[redacted]	31/07/24	Not started	E&F Divisional Management Board

Abbreviations

HV	High Voltage
LV	Low Voltage
VCB	Vacuum Circuit Breaker
QB	Queens Building
THQ	Trust Headquarters
BEH	Bristol Eye Hospital
BDH	Bristol Dental Hospital
EDC	Education Centre
STM	St. Michaels Hospital
SSI	Southwell Street Intake
TX1	Transformer 1
TX2	Transformer 2
BHI	Bristol Heart Institute
BHOC	Bristol Haematology and Oncology Centre
BRHC	Bristol Royal Hospital for Children
AE	Authorising Engineer
AP	Authorised Person
MCP	Manual Call Point

Appendix 1 – HV Switching Logbook

Sitewide power outage at ~13.26 Simon Taynton walked HV Ring No.2 to find VCB's open at THQ-BEH (~13.30) & SSI-QB (~13.58) so two open points within the HV ring and all four associated Translay relays activated. Await SAP before switching, suspect cable damage on HV leg THQ to BEH as civils a working in the vicinity

03 May 2024	SSI HV Substation	~13.58.00	SSI VCB Ring to QB	*Emergency Switching* Confirmed VCB tripped to off and Translay relay indicator lit, closed VCB to attempt to energise HV leg SSI to QB	NA	NA	[redacted]	NA	UHBW Estates	[redacted]
03 May 2024	SSI HV Substation	~14.30.00	SSI VCB Ring to QB	*Emergency Switching* Confirmed VCB tripped to off and Translay relay indicator lit, again closed VCB to attempt to energise HV leg SSI to QB	NA	NA	[redacted]	NA	UHBW Estates	[redacted]
03 May 2024	THQ HV Switchroom	~15.07.00	THQ VCB Ring to BEH	*Emergency Switching* Confirmed VCB tripped to off and Translay relay indicator lit, Translay relay will not reset @ BEH. Closed VCB to attempt to energise HV leg THQ to BEH	NA	NA	[redacted]	NA	UHBW Estates	[redacted]

Date	Location	Time	Circuit or Switch Concerned	Event or Operation and Reason	Safety Programme, Isolation and Earthing Diagram Numbers	Safety Document Type and Serial No.	Name of Persons Entering Sub-Station	To Whom Issued	Company	Signature of Authorising Person
03 May 2024	SSI HV Substation	~15.38.00	SSI VCB Ring to QB	*Emergency Switching* Opened VCB to isolate HV leg SSI to QB, needed for Enervas repairs team	NA	NA	[redacted]	NA	UHBW Estates	[redacted]
03 May 2024	QB HV Substation	~15.50.00	QB VCB Ring to SSI	*Emergency Switching* Opened VCB to isolate HV leg QB to SSI, needed for Enervas repairs team	NA	NA	[redacted]	NA	UHBW Estates	[redacted]
03 May 2024	THQ HV Substation	~15.56.00	THQ VCB Ring to BEH	*Emergency Switching* Opened VCB to isolate HV leg THQ to BEH, needed for Enervas repairs team	NA	NA	[redacted]	NA	UHBW Estates	[redacted]
03 May 2024	BEH HV Substation	~16.02.00	BEH VCB Ring to THQ	*Emergency Switching* Opened VCB to isolate HV leg BEH to THQ, needed for Enervas repairs team	NA	NA	[redacted]	NA	UHBW Estates	[redacted]