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| **Power Control Room Contingency - Change Assurance Plan**  |
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# **Purpose**

## This paper details the strategy for the safe operation of the LU power supply in the event that there is an insufficient number of Power Control Room Operators to cover line desks which could be due to full industrial action, no overtime working, sickness etc. Full industrial action has been announced starting at 20:00 on Tuesday the 1st July to 20:00 on Wednesday the 9th July 2014 and there is the possibility that Power Control Room Operators will not work any overtime (prior or post this period of proposed industrial action).

# **Introduction**

## Power Control Room Operators and Duty Control Room Managers voted in favour of industrial action following a formal ballot by Unite, TSSA and RMT Trades Unions . Unite stated that this action is in relation to a trade dispute over differential and worsening treatment in the terms and conditions for their members. The RMT cited a breakdown of Industrial Relations in the Power Control Room. TSSA stated a failure to enter negotiation on terms and conditions, issues on grade progression, failing to engage on progressing their claim for a professional Power Control Room agreement and failure to engage on major job cuts.

## This paper details the strategy for the safe operation of the LU power system during an industrial action or other cause resulting in the unavailability of some or all Power Control Room staff.

# **Background**

## LU derives its power supplies to run the Railway from the local Distribution Network Operator (DNO) via 6 major Bulk Supply Points (BSP) fed at 132kV and located at Neasden, Lots Road, Mansell Street, West Ham, Griffith House and Manor House and also from 2 smaller intakes located at Acton Lane and Finchley.

## The power is transformed to 22kV and 11kV and distributed via high voltage feeder cables to substations and transformer rooms where it is further transformed and rectified as necessary to provide 400/230V lighting supplies for stations, 630V/750V DC traction supplies, 400/600V signalling supplies, 400/230V for pumps, lifts, escalators and ancillary services, and 400/230V for compressors which provide compressed air to operate points and train stops for the railway.

## The power network assets are controlled and monitored using a Supervisory Control and Data Acquisition (SCADA) system utilising three discrete SCADA systems;

## ABB Micro SCADA Line Control desk, controlling the Central Line

## Siemens CROMOS Line Control desk, controlling the Northern Line

## ABB Spider Line Control desks, controlling the remainder of the network

## The power network is controlled from the London Underground Control Centre (LUCC) which includes the Shift Supply Engineers (SSE) Office, and the Power Control Room (PCR).

## There are two SSEs per shift with executive control of all power and compressed air supplies and with responsibility for the management and control of the network’s 22kV primary distribution ring.

## The Power Control Room consists of 7 line desks, each managed by a Power Control Room Operator (PCRO) and the room is supervised by one Duty Control Room Manager (DCRM) per shift. The PCR staff are licensed to carry out safety critical operations.

## The PCROs are responsible for:

* Restoration of power network and compressed air supplies,
* Setting published and amended switch on times onto the SCADA system,
* Taking safety critical messages from signallers for Traction Current Section (TCS) discharge at EoT,
* Contacting Service Controllers at End of Traffic for Tunnel Telephone (TT) discharge testing,
* Accepting Safety Critical Messages from Track Access Control (TAC) for line clear / safe for TCS recharge at the end of engineering hours.
* DC switching operations at the end / start of traffic and engineering hours,
* Miscellaneous DC operations when requested by the Service Controller e.g. TT reset, TT override, emergency discharge/recharge for open sections.
* Operation of some remotely operated track section switches,
* Operation of various HV and LV equipment on instruction from the SSE.
* Administering the LV safety management system.
* Directing and managing staff working in substations, switch house and transformer rooms,
* Managing substation access and security
* Managing of earth faults on the DC network.

## The DCRM is responsible for

* Managing the PCROs
* Covering for the PCROs if required during a shift,
* Managing DNO failures
* Providing a point of contact for power related issues to the rest of LU and other stakeholdes

3.9 Business continuity in the PCR is currently being maintained through the use of overtime which is currently running at a level of about 25 – 30% and is not sustainable over time. Should some or all staff in the PCR be unavailable due to Industrial Action or other cause including unexpected absence, it is likely that there will be an impact on traction switching arrangements. In the event of unavailable PCROs, Incident Power Control Room Operators may be used to cover some/all of the line desks. Where there is not enough staff to staff the line desks, there is potential for cancelled maintenance / engineering work as traction current will be left on or the suspension of service on some lines. Details on how this will be managed safely are set out below.

# **Control Measures**

## Competence of staff in PCR

## Senior Managers / Engineers with extensive knowledge of the LU power system have been identified and have been given intensive, simplified operator training over a minimum period of three weeks to enable them to operate defined areas of the power system. These people are Incident Power Control Operators (IPCRO). As of 20 June 2014, twenty four people had been trained and assessed as competent as IPCROs.

## The number of IPCROs identified is sufficient to cover all line desks at the Main Power Control Centre (MPCC) during full industrial action (based on working hour requirements set out in the LU Safety Critical Work standard (S1538).

## Where IPCROs are required for any other cause resulting in the unavailability of Power Control Room staff this cover will be provided from the Emergency Power Control Room (EPCR) at Long Acre which will be staffed by the IPCROs and a Floor Walker. This transfer to the EPCR includes:

* SCADA desk transfer by log off at the LUCC and log in at EPCR (reliant on user logging off or being logged off at LUCC)
* Telephony transfer (this is via a scripted process with third party supplier Damvo).

## The IPCROs are trained and licensed to operate the power network via the SCADA system by LU’s Network Control Manager and LU’s Power Control Manager who are trained and competent to assess the IPCROs competence. The training has taken the form of a specially developed training package which reflects the simplified activities that the IPCROs will be undertaking. The maintenance of this competence over a longer period of time and ensuring that the role has a clear and robust Competence Management System is currently being reviewed. They are therefore trained and competent for the duties they will undertake in operating the power network. They will also be supervised at all times and operate under the executive control of ‘Floor Walkers’.

## All Floor Walkers have extensive knowledge of the power network, testing of electrical equipment, power control procedures and operation of the SCADA systems. The Floor Walkers have been assessed as competent to carry out the Floor Walker role by the Professional Head of Power Engineering and the Head of Command & Control.

## As is normally the case, the IPCROs will also be supported by LU SCADA engineers, specialists from the original equipment suppliers ABB and Siemens for the variant SCADA systems, Chloride Engineers for OLBIs and specialists from Eastern Compressors for compressors in substations. These specialists will be able to be called upon for any plant or SCADA issues outside the support of LU’s own AP Power 24/7 staff.

## In the Power Control Room, overtime is used relatively frequently to cover line desks. This varies depending on illness, annual leave, etc. but two of the seven line desks are relatively frequently covered by overtime shifts (12 hour shift, 0800-2000 and 2000-0800). If required, ICPROs will cover these desks for these 12 hour shifts. The rosters for IPCROs, Incident Shift Supply Engineers (ISSEs) and Floor Walkers meets the requirements set out in LU’s Safety Critical Work standard (S1538). The Floor Walkers are very familiar with the operation of the Power Control Room, and with working shifts. As a ‘normal’ DCRM would, they will assess the performance of those working as IPCROs to ensure their wellbeing.

## Simplifying the traction switching process

## The switching on and off of LU’s traction supplies relies on a large volume of safety critical messages being passed over the telephone network between Signallers, Service Controllers, and Track Access Control (TAC) staff to authorise the PCR to carry out the switching of traction supplies. It is therefore not possible for a single operator to cover more than one line desk during such periods.

## Simplifying the traction switching process in the event of the absence of some PCRO staff

## Where PCR staff are available for some, but not all, desks, a contingency plan will be put in place based on the rostered, regular working hours of the PCROs. The plan has been developed to ensure PCRO or IPCRO presence on appropriate desks in the PCR or EPCR during key periods (to prioritise traction switching arrangements to allow essential maintenance and project activities).

## The plan will identify periods where IPRCOs will operate defined PCR desks. A simplified traction switching arrangement will be put in place for the relevant lines for these periods. The simplified arrangement involves giving up of traction current section in pre-determined blocks. This will allow access to the railway during Engineering Hours (but for fewer hours each night). The simplified plan and reduced traction switching requirements reduce the number of safety critical messages which the IPCROs will receive. This will allow them to process each switching action under less time pressure than normal.

## The pre-determined blocks will be agreed in advance with Service Control Managers. This will mean that fewer calls will be received by IPCROs. The IPCROs will switch traction current off in these sections in line with normal procedures. These arrangements will also be briefed to the service control staff affected to ensure that they are fully aware of the arrangements in place.

## When traction current is switched back on by IPCROs the following day, the same process will be implemented via the TAC who have been involved in the development of the block switching arrangements and are fully briefed on the arrangements in place. The TAC will confirm with the IPCRO that the track is clear in line with existing arrangements. As TAC will be fully involved, this also means that where work to be undertaken in Engineering Hours is booked on adjacent lines with different traction current switch off times, this will be managed in line with normal process. For example, no track access will be granted until traction current has been switched off on both lines.

## The implications of introducing ‘block switching’ is a reduction in Engineering Hours. The relevant maintenance areas have been involved in the development of the resilience plan for unplanned PCRO absence and for the period of Industrial Action. Where changes to staffing in the PCR are made due to unplanned PCRO absence, the relevant maintenance areas will be informed of a potential reduction in Engineering Hours for each night and will be informed of specific arrangements on a day-to-day basis via the SOO to the Duty Operations Maintenance Engineer (DOME) / Incident Engineer (DOME / IE) which is an existing communications process. During the period of industrial action, relevant engineering notices will include information on normal planned traction switching arrangements. The relevant engineering notices will make it clear that there is a potential that the published arrangements will change and make it clear that all access to the track environment in Engineering Hours must be booked with the TAC to confirm that traction current is switched off (in line with normal procedures).

## Any shifts ‘at risk’ of no coverage will be identified and prioritised. As the gaps in coverage will be known, communications / briefings will be distributed to affected parties within appropriate timescales. Where possible an additional IPCRO will also be made available to ensure that additional coverage is available.

## In the event that the PCR is unable to man a desk due to a shortage of staff, the DCRM or Floor Walker will recommend to the SOO that either maintenance / engineering work for the affected line be cancelled (as traction current will remain on) or that the line be shutdown (no service will be run) depending on what other safety critical activities are planned on that line.

## A decision to shutdown a line desk (and suspend the service) or cancel maintenance / engineering work will only be made in consultation with the Head of Command and Control. After a decision to either shutdown a line desk or to cancel maintenance / engineering work is made, the relevant Service Control Manager and Track Access will be informed in line with normal process.

## In the event of a service suspension the power system will be left energised. Should there be a subsequent failure, the system fails safe. However, this failure would be managed until such time there is appropriate coverage on the affected line. Arrangements for the emergency switch off of traction current on uncovered desks are outlined in section 4.18 below.

## Cancelling maintenance / engineering work will eliminate any need for traction current to be switched off which will result in traction current remaining on throughout the night on the affected line. If this is required traction current will remain under the control of Service Control. TAC will be informed via the SOO and all track access on the affected line denied.

## Simplifying the traction switching process in the event of the full industrial action

## In the event of full strike action the simplified arrangements outlined above will apply to the whole Power Control Room / Network.

Emergencies

4.20 If an emergency situation requiring the discharge of traction current during Traffic Hours or where traction current has been left on and maintenance / engineering activities cancelled, the Service Controller will continue to utilise the Tunnel Telephone (TT) functionality to discharge Traction Current Sections (TCS) in tunnels. Should the TT call fail for whatever reason, the Service Controller will request the IPCRO by telephone to discharge the relevant TCS in line with existing procedures. In open sections not covered by TT, the Service Controller will request the IPCRO by telephone to discharge the TCS in line with existing procedures. On average, overloads and emergency discharges of TCS occur 6 times a day across the network. IPCROs are trained and competent to undertake these activities.

4.21 If an emergency situation arises requiring the discharge of traction current where a line desk is uncovered (and the service is suspended) with respect to Service Control actions these remain as per those outlined in 4.17 above. The PCR response will be for a PCRO or IPCRO from an alternative desk under the executive authority of the Floor Walker to react in line with normal arrangements to deliver a safe condition.

Possessions

## There is one planned possession during the period of industrial action, this is for Jubilee line tunnel strengthening and will be taking place between close of traffic on Saturday the 5th and mid morning on Sunday the 6th July. There is a possession plan in place for this therefore traction current switch on / off will be undertaken by IPCROs in line with this plan. IPCROs are competent to undertake this activity and will operate under the executive control of the Floor Walker.

## In the event that there are any possessions taking place during periods where some PCROs are unavailable and IPCROs are covering there will be a requirement for IPCROs to switch off the traction supplies and the substation rectifiers within the possession areas. These actions will be checked by the Floor Walkers. This will create a double break to mitigate against accidental recharge. Software inhibits will also be applied to the affected rectifiers and DC breakers. Any possessions in tunnel sections will also be further protected by enhanced tunnel telephone procedures. At the end of Traffic Hours the tunnel telephone circuit is used to discharge all tunnel traction sections. The tunnel telephone call remains active until 5 minutes before the published ‘on’ time. At this point Service Control reset the tunnel telephone. If this reset is not done, the DC traction breakers cannot be closed by power control. These arrangements are in line with ‘normal’ procedures undertaken by Power Control Room Operators. IPCROs are trained and competent to undertake this activity.

## When each possession is complete and all staff and equipment are clear from the track the Possession Master will contact the Service Controller and hand back the possession. Service Control will then contact the Incident Power Control Room Operator and request a recharge of the traction current sections that were off as a result of the possession. The Service Controller will reset any tunnel telephone circuits, which will allow the IPCRO to recharge traction current which was discharged via the tunnel telephone circuit. The IPCRO will recharge all the requested traction sections and confirm that supplies have been restored and provide the Service Controller with a time of restoration. This is in line with normal arrangements for switching traction current back on following a possession.

Track inspections and patrols

## Based on these arrangements it is not anticipated that there will be any issues associated with track patrols being undertaken in line with LU Standards. However as there will be reduced Engineering Hours on some lines. Temporary Approved Non Compliances may be required for some areas and these will be approved by local Track Managers when and if they are needed in line with current arrangements. As part of this process the need for additional mitigation is assessed and cab patrols and / or temporary speed restrictions implemented if necessary.

## Based on these arrangements it is not anticipated that there will be a requirement for any formal concessions specifically for the strike relating to track inspections. In the unlikely event any are required the normal approval process will be followed and mitigation as detailed in section 4.22 implemented.

## LU Standard 1-143, Emergency Traction Discharge & Audio Communications Systems requires that an independent check of the Tunnel Telephone system is undertaken daily at the end of traffic hours. This is done everyday when Service Control use the tunnel telephone circuit to switch off traction current in Line Clear tunnel sections at the end of traffic hours. This will continue to be done where IPCROs are used in any circumstances.

# Training

## The identified IPCROs are either Senior Engineers with a sound understanding of the LU power system or people with extensive knowledge of LU’s control centres. The training provided considers this and covers all activities that IPCROs are required to undertake. The IPCROs have been assessed against defined criteria by competent engineers. Further detail on this is included as Appendix 1.

# **Assessment of Risks**

| **Hazard** | **Mitigation Measures** | **Likelihood** | **Severity** | **Risk** | **Difference to current situation** |
| --- | --- | --- | --- | --- | --- |
| Delay to post event recovery due to IPCRO less experienced with operation of power network and associated systems. | * IPCROs trained and competent to undertake all relevant activities
* Supervised at all times
* Management support
* Incident recovery will follow current process
 | Low2 | LowB | Tolerable5 | Increased likelihood but additional supervision provided. |
| There is a risk that there will be a failure of power distribution assets causing a disruption to the operating railway and increasing the pressure on the IPCROs. | This risk is mitigated by dual redundant feeding arrangements at each level of the power network which makes the risk of a single equipment failure causing an interruption of power supply low.* IPCROs trained and competent to undertake all relevant activities
* Supervised at all times
* Management support
 | Low2 | HighC | Tolerable7 | Existing risk |
| The failure of a single BSP will cause widespread disruption (likely to bring the railway to a halt depending on the scenario) to the operating railway and present significant pressure to the IPCROs during the restoration process. | The DNO and the National Grid have been requested and agreed to ensure that the network which feeds the LU BSPs is secure during the change period and routine maintenance work is cancelled or postponed. * IPCROs trained and competent to undertake all relevant activities
* Supervised at all times
* Management support
 | Low1 | HighD | Tolerable9 | Existing risk.Any evacuation requirements (i.e. safety) will not be impacted. May take slightly longer to restore railway operation. |
| The failure of multiple BSPs is likely to bring the entire railway to a halt. | The likelihood of such an event is very low and LU has in place a Central Emergency Power Supply (CEPS) contingency plan which involves a reconfiguration of the network to allow Greenwich Generating Station to provide emergency supplies for the safe evacuation of the Railway. * IPCROs trained and competent to undertake all relevant activities
* Supervised at all times
* Management support
 | Low1 | HighE | Tolerable10 | Existing risk.Any evacuation requirements will not be impacted. May take slightly longer to restore railway operation. |
| The failure of 600V signalling supplies will have an immediate impact on the LU train service. | * IPCROs trained and competent to undertake all relevant activities
* Supervised at all times
* Management support
 | Medium3 | MediumB | Tolerable8 | Existing risk |
| The failure of LU lighting supplies to stations or of OLBIs at subsurface stations will cause the affected station(s) to close until supplies are reconfigured or the failed OLBIs are repaired. | * Current risk, processes in place to manage this risk
 | Low2 | Medium/LowB | Tolerable5 | No change |
| Overloads and emergency discharges on DC traction current supplies occur on average 6 times a day. Chance of such overloads impacting service. | * This presents LU with a degraded mode of operation, which IPCROs are trained to quickly restore under direction of the Floor Walkers.
 | Low2 | LowA | Tolerable3 | No change |
| Curtailing of Engineering hours leading to delayed response to maintenance activities, fault response times  | * Maintenance staff are not in scope for the industrial action
* Statutory inspections will continue to be undertaken in line with LU Standards
* Assurance arrangements for these activities will be accommodated under Traffic Hours access arrangements
* IPCROs trained and competent to undertake all relevant activities
* Supervised at all times
* Management support
 | Medium3 | LowA | Tolerable6 | Re-phasing of maintenance and traffic hours access. |
| Change to normal Engineering/Traffic Hour arrangements introduces uncertainty to AP teams, Service Control teams, TAC, CPD, SOOs, Stations, contractors, etc. | * Communications / briefings to be undertaken with those affected
* TAC to inform staff booking on of any changes to traction current arrangements
* SOO to manage / communicate any changes in the event that a desk becomes uncovered and traction current remains on
 | Low2 | HighD | Tolerable 10 | Existing risk e.g. where incidents occur on the railway this situation may occur |
| IPCROs and floor walkers working in a separate location to PCROs and DCRMs (depending on the circumstances e.g. full strike action or only some PCROs unavailable) leading to less communications between all and less awareness of status of the railway | * These are normal contingency arrangements
* Current communications processes will be followed
 | Low2 | HighD | Tolerable 10 | Existing risk, existing processes in place to manage this |
| Different traction current arrangements in place on adjacent lines leading to confusion and staff accessing the track when traction current is on in Engineering Hours  | * TAC follow normal process
* IPCROs trained, competent and licensed to switch off traction current
* Track access will not be granted by TAC until traction current is off in all appropriate areas
 | Low2 | HighD | Tolerable 10 | Different traction current arrangements in place on some lines |
| Delay to traction current being switched off in an emergency where a PCR line control desk is uncovered | * Service Control actions remain the same
* PCROs/IPCROs (under executive control of Floor Walkers) will be reorganised to provide incident response
 | Low2 | HighD | Tolerable 10 | Line desks uncovered |
| Failure occurs on an uncovered desk leading to a delay in response to the failure until the next covered shift | * Systems fail safe
* Existing arrangements will be implemented for failure response as soon as practicable
 | Low2 | LowA | Tolerable3 | Line desks uncovered |
| IPCRO discharges traction current in error leading to delay to service, stalled trains | * IPCROs trained, competent and licensed to switch traction current on/off, including for possessions
* The operating patterns have been simplified to reduce complexity and potential for error
* IPCROs will work under the executive control of Floor Walkers
* No issues during non-traffic hours identified
* No safety issues identified during traffic hours, current procedures for dealing with stalled trains would be implemented
 | Low2 | LowA | Tolerable3 | Less experience staff but undertaking simplified activities |
| IPCRO recharges traction current in error leading to high voltage electric shock to persons on / about the track | * IPCROs trained, competent and licensed to switch traction current on/off, including for possessions
* The operating patterns have been simplified to reduce complexity and potential for error
* IPCROs will work under the executive control of Floor Walkers
 | Low2 | HighD | Tolerable 10 | Less experienced staff but undertaking simplified activities.  |
| Fatigue / stress risks as a result of roster plan  | * The rosters for IPCROs, ISSEs and Floor Walkers meets the requirements set out in LU’s Safety Critical Work standard (S1538).
* Management Support
* Acting under the executive authority of Floor Walkers
 | Low2 | LowA | Tolerable3 | Change in working patterns for IPCROS, ISSEs and Floor Walkers compared to normal working hours.  |
| Risk of extended uncovered PCRO shifts impacts on ability to carry out track patrols, routine engineering and asset maintenance, etc.  | * Engineering hours will be available, but to be shorter than usual.
* Review of impact of extended PCRO unavailability to be undertaken to prioritise desk cover to ensure critical and essential works are delivered.
 | Low2 | LowA | Tolerable3 | Engineering hours which would be shorter than usual (expected to be approximately 30 minutes shorter) |
| Risk of extended uncovered PCRO shifts impacts on provision of IPCRO, ISSE and floor walker support.  | * Short/medium term resilience plans are in place.
* Longer term resilience plans are currently being developed to reduce this risk.
 | Medium3 | MediumB | Tolerable8 | Reliance on IPCROs, ISSEs and floor walkers to cover the role.  |
| Confusion arises from traction switching arrangements (which may change at relatively short notice).  | * In line with existing procedures, staff/ contractors must book on with the TAC before accessing the track. The TAC has been involved in developing the resilience plan.
* Service Control Managers will be briefed and all other information will be passed via the SOO.
 | Low2 | LowA | Tolerable3 | Engineering hour publications may change.  |

Note: Risk score derived from Appendix 3 / Table 1 – Incident Classification Matrix

# **Potential Refusal to Work on the Grounds of Health and Safety**

## In the event of refusal to work on the grounds of safety, the steps detailed in the refusal to work procedure 5-547 will be followed. Local management will be briefed in preparation and in addition an HSE Manager / HSE Senior Manager will be available to assist Operational Managers with this process as required.

# **Communications**

## Relevant information on the contingency arrangements in place will be communicated / briefed to affected staff. Communications to maintenance and operational staff will be via the SOO which is a normal communication chain that these staff are familiar with.

## Key stakeholders such as the Senior Operating Officers, Service Control Managers, and Track Access Control Managers will be given detailed briefings for the purpose of awareness.

## The National Grid and the UKPN London and Eastern will be fully briefed and agreed to ensure that their HV networks are secure and all routine maintenance work / switching operations which might affect the LU power supplies is cancelled or postponed.

## The Senior Operating Officer and other control arrangements will be in place as normal.

## The line recovery, service and congestion control and emergency plans for each area of the business will remain in place as normal.

## Line and Asset Performance management teams will be briefed to ensure they brief their respective teams on the arrangements put in place under this plan and that priority will be on safe operations.

## Where there are changes to traction current arrangements these changes will be made clear to those affected when they book on with the TAC.

# **Consultation Arrangements**

## This Power Control Change Assurance Plan will be submitted for review and approval by the Directors Risk and Assurance Change Control Team.

## This Plan will also be submitted to the Office for Rail Regulation for information.

## Appropriate consultation with the Trades Unions will take place in line with the LU Health and Safety Machinery.

# Appendix 1 – IPCRO Training

* SCADA
	+ Loss of control of a single substation, multiple substations, single control desk, and multiple control desks.
* DC Systems
	+ Busbar voltage alarms,
	+ Single end opening of tracks, double end opening of tracks, track alive, emergency discharge of sections (TT call, open section), failure to close or trip of DC breakers,
	+ Depot track opening, track alive, emergency discharge of tracks,
	+ Traction voltage recorder, earth fault, earth tracing,
	+ Published switching times, dead line time, line clear / line safe, special line clear / line safe, (although these elements will be for information only)
* LVAC
	+ Busbar voltage alarms
	+ Lighting main / station feeder tripping
	+ Compressor tripping
	+ Frequency changer tripping
* Signals
	+ Busbar voltage alarms, signal earth fault detector alarms
	+ Signal main single end opening / double end opening,
* 22kV / 11kV Systems
	+ CEPS, multiple BSP failures, single BSP failures, Busbar voltage alarms, Busbar faults, SVC failure, Harmonic filter failure, Multiple feeder failure, Single feeder failure, (for these elements the key points will be any impact on the PCRO desks)
* Rectifiers
	+ Rectifier failure, SCADA alarms
* Auxiliary Transformers
	+ Failure, SCADA alarms
* BSP / Coupling Transformers
	+ Tap changing controls, transformer failure, SCADA alarms
* Miscellaneous
	+ Accidents in substations, fire alarms, building defects, Northgate phone system, OLBI failures, DNO failures etc.

# Appendix 2 – Abbreviations / Acronyms used in this paper

|  |  |
| --- | --- |
| **Abbreviation / Acronym** | **Meaning** |
| BSP | Bulk Supply Point  |
| CEPS | Central Emergency Power Supply  |
| CMS | Competence Management System |
| DC | Direct Current |
| DCRM | Duty Control Room Manager |
| DNO | Distribution Network Operator |
| EoT | End of Traffic |
| EPCC | Emergency Power Control Centre |
| HV | High Voltage |
| IPCRO | Incident Power Control Room Operators |
| LU | London Underground |
| LUCC | London Underground Control Centre |
| LV | Low Voltage |
| MPCC | Main Power Control Centre |
| OLBI | Offline Battery Inverter |
| PCR | Power Control Room |
| PCRO | Power Control Room Operator |
| PSC | PFI Power Service Contract |
| SCADA | Supervisor Control and Data Acquisition System |
| SSE | Shift Supply Engineer |
| TACC | Track Access Control Centre |
| TCS | Traction Current Section |
| TT | Tunnel Telephone |

# Appendix 3 / Table 1 – Incident Classification Matrix