Guidance Note – Contingency Planning for Power Outages

Synopsis

This document provides guidance for railway undertakings on planning for and implementing contingency arrangements in the event of power outages.

Authorised by

James Burt
Chair, RDG Train Operators Emergency Planning Group
RDG Guidance Note – Contingency Planning for Power Outages

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Part 1  About this document

1.1  Responsibilities

1.1.1  Copies of this Guidance Note should be distributed by RDG members to persons within their respective organisations for whom its content is relevant.

1.2  Explanatory note

1.2.1  RDG produces RDG Guidance Notes for the information of its members. RDG is not a regulatory body and compliance with RDG Guidance Notes is not mandatory.

1.2.2  RDG Guidance Notes are intended to reflect good practice. RDG members are recommended to evaluate the guidance against their own arrangements in a structured and systematic way. Some or all parts of the guidance may not be appropriate to their operations. It is recommended that this process of evaluation and any subsequent decision to adopt (or not to adopt) elements of the guidance should be documented.

1.3  Guidance Note status

1.3.1  This document is not intended to create legally binding obligations between railway duty holders and should be binding in honour only.
Part 2  Purpose and introduction

2.1  Purpose

2.1.1 The purpose of this document is to provide guidance to enable railway undertakings to better understand, plan for and implement individual and joint business contingency arrangements in the event of a widespread power outage. It is not intended to be an emergency plan in itself, but rather to assist railway undertakings to put in place their own strategic level plans for widespread power outage.

2.2  Scope

2.2.1 This Guidance Note applies to all RDG Train Operator members.

2.2.2 It considers the impact and possible mitigating actions that could be undertaken by a railway undertaking during a widespread power outage, whether planned or unplanned. In terms of scale, it is intended to encompass everything from a localised outage lasting no more than a couple of hours through to a regional power outage extending up to 5 days.

2.2.3 While it does describe more major outages, the circumstances in which they might be experienced and the broad process and timescales for recovering supplies, it does not attempt to explicitly address how railway undertakings should prepare for these, nor suggest that they need to do so. The wholesale loss of the power-generating network nationally is the extreme end of the power outage scenario. All power stations would need to be started from scratch and it is expected that it would take up to 14 days to reinstate the power to its fullest extent. It is obvious that in this kind of scenario, there would be very major consequences for the functioning of the UK as a whole, with the resumption of rail services unlikely to be considered an immediate priority and resources hence directed elsewhere. Running any kind of rail service anywhere on the network in these conditions would be, to all intents and purposes, impossible.

2.2.4 It is therefore upon this middle ground - widespread power failures across large parts of the network, with other parts remaining unaffected - that this document is primarily focused, as it is here that maintenance of a service, potentially involving modified depot, train operations or station working, is possible and hence here that most benefit can be derived from pre- rather than ad hoc planning.

Part 3  About power outages

3.1  Introduction

3.1.1 In recent decades, Britain has become used to a generally very consistent electricity supply. Whilst localised short disruptions to power supplies are experienced, with consequent minor impacts on the rail network across the country, these disruptions rarely extend for significant periods of time (e.g. beyond a 24-hour window) or across wide areas. Supplies are often re-connected within hours or a day at most; the cause is relatively obvious to ascertain and to remedy.
3.1.2 The problem for UK communities in general and the rail industry in particular is that in an increasingly digitised and power-reliant world, a prolonged and widespread power outage would have far reaching impacts, both directly and indirectly, on their ability to function. Railway undertakings are increasingly reliant on power, not only to do obvious things like ensuring that the lights are on in stations, to keep signals working and provide traction current for trains, but also the digital means of doing previously manual tasks. Railway undertakings rely on power to manage ticketing systems, to get messages to staff and passengers, manage their payroll, operate equipment and machinery in depots and maintain security and alerting (such as fire detection) systems. In some cases, going back to paper-based or ‘mandraulic’ systems during disruptions may no longer be physically possible; some of the more indirect and therefore less obvious effects of a power outage could be the more difficult to manage or have the widest impact.

3.2 Types of power cuts

3.2.1 The most frequent blackouts (complete loss of power) occur in emerging economies which have typically underinvested in their energy infrastructures, and which are also prone to serious weather and natural hazards1. The UK has a partial advantage here, as the energy infrastructure is mature and therefore generally very stable.

3.2.2 There are two types of power failures considered under the Local Resilience Forum (LRF) risk assessment process;

- **H41**: Total failure of GB’s National Electricity Transmission Network (i.e. a complete failure of the system); and

- **H45**: Disruption to Regional Electricity Distribution or Transmission Network (i.e. a regional power supply issue).

3.2.3 The level of disruption caused by each differs significantly. The third, and more frequent, risk is that of very localised power disruption. Whilst this is not specifically within the scope of this document (because such disruptions are so small and frequent as to not require any special response arrangements), the impact of such a loss of power would be included in the impact of a more major loss of power.

3.2.4 The more problematic type of power outage (H41) would be caused by an infrastructure failure, would result in the wholesale loss of the UK’s power generating capacity and would mean the shutdown of all power generating stations. This is known as a Black Start. Restarting them would itself require a huge amount of electricity. Around 15 power stations are therefore equipped with generators able to produce enough power locally to restart those stations. In turn, these would then generate enough power to restart the rest of the network. If there were a national power outage under Black Start, this would be immediately obvious to the power industry. It would mean a minimum period of disruption and lead times to get the power up and running again. This is likely to be around 5 days with a complete loss of power and up to 14 days in total before power is fully restored.

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3.2.5 During this time, there would be rota disconnections, meaning that areas would be disconnected from power for specific periods of time (usually 3 hours a day at specific times). Areas adjacent to the 15+ black start power stations would be likely to be connected sooner than those further away.

3.2.6 Under an H45 local or regional disruption to the power network, the cause and solution is likely to be identified and resolved within a relatively short period (normally hours but the outage could still potentially last days). The cause would almost certainly be a localised infrastructure issue affecting a greater or smaller degree of the power distribution network, not normally the power generation itself. Examples include severe weather bringing down overhead cables, storm water affecting a sub-station or a fire near the distribution board. Although the outage may affect a large area, key functions would still be able to continue at a national level. The time it would take to restore the power to that area would be heavily dependent on the damage to the infrastructure and from where spare parts could be sourced.

3.3 Likelihood

3.3.1 To date the UK has never lost the entire power supply network (H41). However, this does not mean that it would not be possible, in the future, for this to occur. Whilst there has never been a complete failure of the electricity network, there have been storms and other events that have caused significant electricity disruption. It is therefore considered that the most likely cause of an entire electricity shutdown would be severe weather, in particular a combination of strong winds and lightning causing technical failures. Severe space weather could also have similar impacts because of the nature of how the power network could be knocked out or affected.

3.3.2 Regional outages (H45) covering larger areas, can and have occurred in the UK, most recently in Lancashire in December 2015. When putting together Community Risk Registers (CRR), LRF risk assessment groups are provided with prescribed likelihood ratings. The pre-determined likelihood rating for either H41 or H45 occurring has been provided nationally to LRFs as being Medium (between 0.5% and 5% chance of occurring in the next 5 years, i.e. between a 1 in 200 and 1 in 20 chance).

<table>
<thead>
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<th>Type</th>
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<td>National power failure</td>
<td>H41</td>
<td>Medium²</td>
<td>Catastrophic</td>
<td>Very high</td>
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<tr>
<td>Regional/ Widespread power failure</td>
<td>H45</td>
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<td>Localised power failure</td>
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² For each of the risks being analysed, an assessment of national is provided, but this can be amended as needed by the LRF if they feel that they are affected to a greater or lesser degree than the provided figure.

³ Ratings provided are estimated by the Author as there is no assessment provided in the Community Risk Register guidance for this level of power outage.
Part 4 Government position

4.1 Risk outline

4.1.1 The National Risk Register 2015 provides this description against a nationwide loss of electricity:

A nationwide loss of electricity is an extreme scenario and to date a total system shutdown has not occurred in the UK. However, whilst this risk is considered very unlikely, our reliance on electricity means that even localised losses can have a severe impact on those affected.

A nationwide loss of electricity, for which the technical recovery process “Black Start” could take up to 5 days, would affect millions of consumers and critical services. If significant damage is caused to the transmission lines, it could be weeks before some parts of the network are fully recovered and power is restored. Consequences may include:

- some casualties and fatalities, caused by accidents of various sorts due to loss of power
- loss of/interruption to supply of essential goods and services and disruption to transport and energy networks

Planning by the UK Government, the devolved administrations and emergency responders

The Department of Energy and Climate Change (DECC)\(^4\) is responsible for managing the central government response to and recovery from an electricity disruption event in England, Scotland and Wales.

DECC works closely with industry to ensure that there are comprehensive plans in place for handling a complete national outage, and in collaboration with the devolved administrations to ensure plans are in place to handle more likely localised outages across a number of local areas. In the event of a national power outage, and provided there has been no damage to the system, the objective would be to restore supplies throughout the UK within five days although full restoration may take longer. Restoration of supplies could take longer if significant damage had been sustained to electricity infrastructure.

4.2 National Plans

4.2.1 There is no National Power Outage Plan in the UK. Planning for such incidents sits within generic emergency management structures and mechanisms as described by the Civil Contingencies Act 2004, with responsibility sitting with each organisation to maintain its own contingency arrangements. Some LRFs (such as Hampshire and the Isle of Wight) have started to develop their own LRF level plans and railway undertakings are encouraged to join in with those discussions and influence those plans where necessary.

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\(^4\) DECC became part of Department for Business, Energy and Industrial Strategy in July 2016
4.2.2 Any response to a very large-scale power outage is likely also to result in parts or all of the National Communications Strategy and National Fuel Plan (NFP) being enacted, because of the impacts on communications between responders and fuel management. Railway undertakings are therefore also encouraged to find out more about the local application of those plans, if they are not already aware of them.

Part 5 Characteristics of power outages

5.1 Phases of a power outage

5.1.1 The following diagram (figure 1) illustrates the phases of a power outage:

![Phases of a power outage diagram]

Figure 1: Phases of a power outage

Normal supply

This is the business as usual period of electricity supply. This includes minor disruptions in very localised areas, because the duration and impact of such events is frequent and very minor. During this time, contingency plans can be drawn up and the minor interruptions can be used to test new resilience equipment.

Warning period

The first phase is pre-power cut, but at a time when there may be indications that there is something going wrong with the power supply. If the supplier is carrying out work on the network, they may provide notice that there could be power disruption at a specific time. In some cases, if the supplier is aware that routine or planned maintenance work on a line is going to affect power supply to a specific area, they will notify their customers of the likely time and duration of the outage. During this time, it may be possible for a railway undertaking to start taking steps to implement new arrangements for staffing and position standby power generators.
However, if emergency repairs are needed, it may be necessary, without warning, to take another section of the grid off line to carry out the works. Additionally, the area itself may be affected by the root cause and may be without power until the emergency repairs have been carried out in totality. Unfortunately, the larger the incident, the less likely it is for there to be any warning or notice provided by the power companies.

**Response period**

This is the critical period during which there is no power or power has been disrupted, the issue is being identified and a solution developed. During this time, organisations should consider the full business continuity arrangements needed to manage the incident, as it may result in a loss of staff, denial of access or loss of access to a building etc. This period will be the most difficult to manage, as it is impossible to determine the exact nature of the power loss or its likely duration. It could last between 5 minutes and five days.

**Restoration period**

This is the period during which power is being restored, but it may not be back to its fullest extent or may drop out again. In the event of a Black Start, there will still be rota disconnections, meaning that although power may have been restored, it may not be to full capacity, therefore customers will be disconnected from power at pre-determined times. The timings of the disconnection are determined by rotas. This continued disruption could continue for up to 14 days after the power was first lost. This will still cause problems, however the disconnections will only be for certain parts of the day and these should be planned around. Even in non-Black Start scenarios, power may be intermittent until it has been fully restored.

**Recovery period**

This is the period after power has been fully restored, but whilst businesses, organisations and individuals are all finding their feet again and dealing with the aftermath of a significant loss of power. This period could last months, depending on the scale of the impact and the damage to the organisation’s infrastructure.

### 5.2 Duration

5.2.1 A power outage could be anything from a mere dip in power to a sustained power outage over a period of days, with recovery and restoration taking up to two to three weeks. As with all incidents, full recovery could take months or years depending on the scale of the event and its impact.

### 5.3 Generic impacts

5.3.1 At its most basic and obvious level, a black out would mean a loss of mains powered electrical equipment. Figure 1 on the following page (Source: Anytown Project, London 2013) shows the potential impacts of a power outage on various sectors, both in an immediate sense, and in respect of secondary impacts which result from other services not working.
5.3.2 A power cut may not happen in isolation. The cause of the power cut (e.g. severe weather damaging infrastructure) may in fact still be ongoing and be impacting on service provision in other aspects (staff unable to attend work as there is ongoing flooding, etc.). Power cuts would therefore pose a range of problems to a railway undertaking in potentially less obvious but even more troubling ways.

5.3.3 The more widespread and prolonged the power outage, the more exacerbated the effects. In the diagram, it is important to note that some of the impacts for other sectors will be the same for railway undertakings or that the issue will emerge in one sector but have a knock-on effect to them:

Figure 2: The wider impacts of a power cut (Source: Anytown Project, 2013)

5.3.4 Fire and security alarm systems

- An increase in property fires is likely, due to fire alarm systems failing and an increase in alternative and less safe heating and lighting sources (such as open fires or candles).
• Intruder alarms will cease working, which will draw down on resources or potentially raise the likelihood of opportunist theft (particularly if security or other lighting has failed).

• Security doors will revert to their failsafe mode. In some instances, this could mean a ‘default to open’ position, which could cause a security breach, or a ‘default to locked’ position, which could cause a safety issue for any persons trapped inside (though this is highly unlikely).

5.3.5 Transport (other than rail)

i) Traffic lights and street lighting will stop working thus causing traffic chaos and additional hazards for travellers.

• Fuel supplies may be unavailable or the ability to fuel vehicles severely restricted (see section 5.3.8 below).

• There is likely to be widespread disruption to all forms of motorised transport. It may not be possible to run transport services through tunnels and across bridges.

5.3.6 Water and food

i) Water supplies may be affected depending on the length of time the power is out (anything extending beyond 3 days would start to impact on a clean water supply). This finite supply is likely to be eroded by people stockpiling water, thus diminishing the length of time that water might be available. Water may need to be boiled before consumption for a significant period even after the power supply has been reconnected if water treatment has not functioned properly during the outage.

• In periods of emergency, people also tend to panic-buy foodstuffs, which can result in low food stocks in shops and queues for basic goods.

• Freezers and fridges losing power will lead to food spoiling quickly and there will need to be a subsequent food waste management strategy to reduce the likelihood of food quality, hygiene and public health issues.

• Loss of ports could impact on national supplies of goods including food. Many supermarkets work on ‘just in time’ delivery and therefore will start to run out of food (at normal rates of consumption) within around 3 days.

5.3.7 Cash machines and cash flow

i) Cash machines may not work, so any transactions will have to be with cash already in circulation. Electronic payment systems may also not work.

• Tills and credit card authentication systems would also be affected.

• Businesses may experience cash flow problems as automatic payments leave accounts and other incoming cash is not able to move around as per normal.
5.3.8 **Fuel**

i) Petrol pumps would not be able to pump fuel, therefore road users will need to be fuel-efficient and or travel further distances to fill up. For those petrol stations that still pump, re-supply may still be an issue as refineries would be unlikely to be able to operate without alternative power supplies.

ii) It is likely that fuel prioritisation would need to take place and therefore that the National Fuel Plan would be enacted. There should be a strong link between any power outage planning and any local arrangements for fuel plans.

5.3.9 **Generators and alternative power**

i) Generators will be a relatively temporary fix, as refuelling of the generators will be necessary after a number of hours (depending on the fuel tank capacity) and is likely to be an issue. In addition, many organisations fail to maintain their generators, thus anticipating a greater level of resilience than they actually have.

5.3.10 **Business resilience**

i) Members of staff are likely to find it difficult to move around because of traffic disruption and therefore may not come in to their normal place of work. Additionally, schools will most likely be shut and this will have a knock-on effect on staffing, noting that some job roles are more likely than others to be performed by people with school aged children.

ii) Economic impacts to businesses through loss of trade, loss of ability to take payments, delays in payments affecting cash flow of the organisation, loss of staff in key roles and positions causing business continuity issues.

iii) Multiple businesses could be affected and would need to consider whether they work together to manage any scarce resources or whether they work as individual organisations. The wider the area, the less opportunity there would be for mutual aid provision, as more and more businesses would be involved and would therefore be vying for those scarce resources.

5.3.11 **Communications**

i) Critical National Infrastructure (CNI), telecoms and locally significant sites are expected under a range of legislation and good practice to have mitigation strategies in place to withstand reasonably foreseeable scenarios, such as the consequences of a power cut.

ii) Communications mechanisms would be significantly hampered. This would be of particular concern to the emergency services if they had to deal with a major incident during this time. Organisations need to consider how they would manage with remaining communications methods in the event of mobile phone lines being lost. There is a strong link between any power outage planning and communications plans.
iii) High Integrity Telecoms Systems (HITS) is a standalone network for sharing information and communicating between central government and Strategic Command Group (SCG) centres – often referred to as ‘Gold’. How this information is disseminated further is a matter for each SCG to determine.

iv) Some mobile phone masts have generators, others run off locally generated solar power and the rest have none. Therefore, in the event of a power outage, there will be a deteriorating service across the mobile networks until eventually none work. After around 8 hours networks will be lost, irrespective of any individual’s battery life on their mobile phone.

Part 6 Electricity usage by the rail industry

6.1 Overview

6.1.1 There are two types of power supplied to the rail industry:

- **Traction current and signalling**: Electricity used for traction purposes is provided to railway undertakings via Network Rail. It, along with that used for signalling, comes direct from the grid, and is independent of the domestic supply.

- **Stations, offices and control rooms etc**: Powered through local power supplies.

6.1.2 In the majority of power outages, the problems are rarely or unlikely to be related to being able to move trains around the network and, in respect of passengers, are more likely to do with providing a safe environment to board or alight from trains and generally negotiate stations.

6.1.3 The rail industry is the largest user of electricity nationally and is designated as a priority user. This means that traction power would be prioritised in the event of both a reduction in electricity availability and reconnection should the power have gone down completely. It gets industrial power supplies from the network at transmission level for signalling and traction current. Traction current is through the traction transmission network, via the 3rd rail (750v DC system) or overhead catenary (250 000v AC system). This is managed via Network Rail (see following section).

6.1.4 Traction current is separate to signalling power and therefore it is possible to lose one without the other. To date there has never been a disruption caused by external issues at the power-generating end of this power supply. Where there have been disruptions, these have tended to be due to severe weather or rail equipment bringing the overhead wires down. Although ‘degraded operation’ without normal signalling is theoretically possible, by means of Temporary Block Working, this tends to be very (human) resource hungry, takes a long time to set up, cannot realistically be applied over a very large area and has very limited capacity.

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5 It is believed that in some cases these supplies are also drawn from the traction current supply – railway undertakings are advised to investigate locally if the supply source is not obvious.
6.1.5 Thus, if signals are lost over a wide area trains are to all intents and purposes not going to run, as there is no real sustainable alternative to the provided signalling system. Network Rail signal boxes have generators, but again, there is a risk that refuelling or poor maintenance could be a problem.

6.1.6 **Signal power failure**

The power supply to the signalling system can fail for a variety of reasons, for example due to a power cut or a blown fuse in the circuit. The signalling system is designed to fail-safe: when the power fails, signals revert to either a red aspect or no aspect (i.e. blank or ‘black’), in either case requiring a driver to stop the train.

6.1.7 Mitigation measures are the responsibility of Network Rail but might be expected to include:

i) Providing auxiliary power supplies or standby generators.

ii) Introducing uninterruptible power supplies (UPSs), which take over when the power supply is lost.

iii) Monitor the health of the power supply system using wireless monitoring backed up with annual inspections.

iv) For areas without UPS, replacement of aging cables to improve power supply reliability.

v) Power suppliers notifying of any planned interruptions to the power supply so backup supplies can be put in place.

vi) Investing in fault-finding equipment for older systems so problems can be identified and addressed before they affect services.

vii) Use of modern “intelligent” systems to immediately identify the location of faults as soon as they occur, enabling a quick response to get trains running again.

viii) Sometimes the quickest and simplest option is to switch to another power source, so in some situations use of portable generators to restore power.

6.1.8 If there are rota disconnections, then this should in theory not affect the traction current or signalling as they run off a different part of the power network.

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6 A UPS differs from an auxiliary or emergency power system or standby generator in that it will provide near-instantaneous protection from input power interruptions, by supplying energy stored in batteries, super-capacitors, or flywheels. The on-battery runtime of most uninterruptible power sources is relatively short (only a few minutes) but sufficient to start a standby power source or properly shut down the protected equipment.

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7 National Rail Enquiries, *Signal Power Failure*. [http://www.nationalrail.co.uk/service_disruptions/80833.aspx](http://www.nationalrail.co.uk/service_disruptions/80833.aspx)
6.2 Network Rail position

The following information has been provided by Network Rail.

**Risk to operational capability for localized power supply outages**

**Policy on traction power redundancy:** Redundancy to N-1 (see following section for definition) is the norm as defined in the [Network Rail] Electrical Power Asset Policy statement. This means a minimum of one alternate [electrical] feeding arrangement is generally available. In practice multiple alternate feeds may be available. Alternate feeding arrangements are planned so that Grid supply outages are manageable. Operational capability can be affected if supply equipment is out of service for prolonged periods as the designed redundancy may be compromised. Routes are expected to manage this risk locally.

**Policy on signalling power supplies:** A back up alternate supply is always provided which is either traction derived in electrified areas or standby generators in non-electrified areas. Uninterruptible power supply systems (battery backed for short durations) are provided on many key Routes. Automatic reconfiguration systems are also becoming more common such that full N-1 redundancy is available. The system design and associated whole life cost reflects the Route criticality.

**Risk to Network Rail operational capability for widespread traction power outages**

The risk of widespread impact is minimised by traction power supply connections at Transmission voltages. (400kV) Connecting to the National Grid integrated system minimises this risk. Network Rail does have connections at 132kV and planned arrangements for connecting at 33kV with static frequency converters, but in this case the redundancy achieved would be expected to be better than N-1.

**Is there a risk and mitigation for widespread traction power supply failure?**

The risk has not materialised to date and with the trend towards higher voltage connections it is perceived to have reduced. It is considered by Network Rail that there is sufficient redundancy and back up capability to cope with the historic risk of power supply disruption.

6.3 Trains operations

During a power outage, any or all of the following could result:

i) Trains, along with their passengers, becoming stranded. It should be noted that this may apply equally to diesel powered trains if they are unable to move because of a disabled electrically powered train on the line ahead of them.

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*The information was supplied by Network Rail’s Head of Power Distribution and has therefore not been edited. Additional definitions are available in the Appendix.*
i) Failure of electrically powered on-train lighting and environmental control systems (i.e. the system(s) which control(s) temperatures and air circulation or provide(s) heating in on-train passenger accommodation together with any systems associated with the operation of or access to on-train passenger toilets). On electrically powered trains, most of these systems have only limited back up batteries in the event of the traction current being lost.

ii) Internal communications systems on the train.

iii) External communications systems with control or stations (GSMR).

iv) Catering on board.

6.3.2 More so than other causes of trains becoming stranded, a reasonably wide scale power outage affecting routes/areas predominantly served by electrically powered trains is likely to result in multiple stranded trains. It follows that it may take a very considerable time before all of them can be ‘rescued’ by diesel locomotives (quite apart from the additional challenges that potential simultaneous failure of the signalling system would present).

6.3.3 From the above it follows that a key priority is maintaining the welfare of passengers until the train can resume its journey or they can be evacuated from it - reference should be made to ATOC/Network Rail Guidance Note ATOC NR/GN SP01 - Meeting the Needs of Passengers when Trains are Stranded and ATOC/GN015 - Extreme Weather Arrangements including Failure or Non-Availability of On-Train Environment Control Systems.

6.3.4 Once any stranded trains have been removed, and if the power outage is continuing, there may be an option of substituting diesel powered trains for electric (noting also that a significant proportion of the IEP fleets shortly to be introduced into service are bi-mode). However, there are many reasons why this may not be feasible, most obviously signalling systems may not be functioning, spare diesel units may be unavailable, drivers with the necessary combination of route and traction knowledge may not be available, fuel for diesel trains may not be available, fuelling of diesel trains may be difficult (see next section).

6.4 Depots

6.4.1 During a power outage, depot operations/functions likely to be affected include:

i) Access to depots.

ii) Refuelling.

iii) Train maintenance in general (as power to operate machinery, measuring/diagnostic devices, etc. may be unavailable).

6.4.2 Local loss of electricity could affect train access to and from depots (as power for points and local signals could be affected). While in such cases it may usually be possible to operate points manually and use hand signalling, the number of competent persons available for this may be limited, particularly if there are demands for them to be deployed to main running lines. Access for staff may also be affected with manual checks needing to be put in place if electronic access systems are non-operational.
6.4.3 Maintaining an adequate supplier of diesel fuel may also be challenging, especially if refineries cease operation and/or being able to transport their goods to customers. In addition, re-fuelling itself in the absence of electricity to power pumps will be problematic and time-consuming.

6.4.4 More generally, most train maintenance procedures also require use of powered equipment, whether this is as simple as carriage washing, emptying toilet tanks or changing vehicle components. Maintenance and safety checks will also become limited. Security of the line and of depot areas may require additional staffing as electronic security systems are designed to ‘fail safe’ i.e. unlock, in the event of power loss.

6.4.5 Consideration should be given to providing depots with back-up generators – or requesting contractors to do so where train maintenance is outsourced. Thought should be given to what depot functions need to be supported and for how long – it is unlikely that it will be possible to maintain full depot functionality for prolonged periods by means of generators. Where such generators are provided, suitable maintenance and testing regimes should be defined and compliance with these periodically checked.

6.5 Stations

6.5.1 Loss of power to stations would be the most immediate impact for railway undertakings. Each station’s emergency plan should detail the actions required in the event of a power outage. Many stations in the UK were built in the Victorian era and have been subjected to various upgrades and reconfigurations over the years. In some cases, the network diagrams for the power distribution in the stations do not match up with what is physically in place, even where the wiring is up to date. This can mean that it is difficult to anticipate how a power outage may manifest itself. It is understood that Network Rail (as the landlord of almost all stations) is in the process of ensuring that the wiring and distribution diagrams are updated, but there are many stations still outstanding and which have out of date distribution network diagrams. It is quite likely, depending on the wiring at the station, that power could remain unaffected in some areas but not be available in others.

6.5.2 Railway undertakings should assess which of their stations require back up power generators, taking into account such factors as the number of trains calling, number of passengers, characteristics of the station (such as stairs, subways, etc.) and the availability of other sources of lighting. Where such generators are provided, suitable maintenance and testing regimes should be defined and compliance with these periodically checked.

6.5.3 There is increasing reliance by station staff on mobile phone technology, digital customer information screens and other IT systems for information on real time train running. If these go down, staff may have to work ‘blind’, looking at the front of incoming services and speaking to train staff to determine the destination of each train. This takes time and also means that passengers will have to move to platforms as and when trains are announced, with very little time to transfer from one place to another.

6.5.4 During a power outage, any or all of the following could be affected:

i) Platform lighting.

ii) Lighting for passenger movement areas (subways, stairs and overpasses).
iii) Lighting for ticket offices and staff only areas.
iv) Lighting for waiting rooms and public areas.
v) Ticket machines (both in ticket offices and self-service).
vi) Communications means (mobile phones, radios, VOIP\(^9\) phones, the internet and landlines).

vii) Lifts and escalators (both lighting and functionality).

viii) Customer Information Screens (CIS).

ix) Ticket gates and therefore revenue protection.

x) Automatic doors and exits (including emergency exits - these may default to open or to closed and this is worth investigating in advance).

xi) Staff welfare facilities (toilets, water pumping, hot water provision, heating/air conditioning).

xii) Any concessions and or stall-holder areas or stores within the station.

xiii) On-train catering providers’ facilities, particularly refrigeration of food products.

6.5.5 Minimum requirements to open a station:

With regard to maintaining safe operations, during daylight hours on a day with mild weather, a loss of power would not present a significant problem at many, particularly smaller, stations if platforms, walkways and other areas used by passengers receive sufficient natural lighting. In other cases, it may be necessary to close parts of the station – for example a platform only accessible by means of a subway in which the lighting has failed.

If passengers are obliged to use subways or other areas without natural light then clearly there is a need to provide artificial lighting in those areas at all times that the station is open if they are to be able to do so safely. If, as at Clapham Junction, there is a subway and a footbridge option, then the former could be closed off and appropriate crowd control measures introduced.

The position is clearly more challenging during the hours of darkness, though it should be remembered that modern trains tend to have good interior lighting which may be capable of sufficiently lighting platforms while passengers are joining or alighting from the train. It may therefore be an option to instruct train crew not to dispatch the train until all alighting passengers are clear of the platform, though this has the potential to significantly extend dwell times and hence may not always be practical.

\(^9\) Voice over internet protocol. A VoIP phone or IP phone uses Voice over IP technologies for placing and transmitting telephone calls over an IP network, such as the Internet, instead of the traditional public switched telephone network (PSTN).
As a minimum for a station to be open it must be possible for passengers to safely board and alight from trains and exit the station. It should be the Station Manager’s role to make a judgment call on when it becomes unsafe to have people in the area and therefore when the station should be wholly or partly closed.

Non-safety related impacts of a power outage include an inability to issue tickets – where passengers can be asked to pay on the train or at their destination (clearly without penalty) - and the loss of customer information, both visual and audio. This may be addressed to at least some extent by asking train crew to make additional or more comprehensive announcements when calling at any station so affected.

6.5.6 In all cases where stations are wholly or partly closed due to power supply problems, relevant train crew should be alerted accordingly.

6.5.7 In addition to the impact on and arrangements for passengers at stations affected by power outages, consideration should also be given to the effect on station staff. The basic requirements according to Health and Safety Executive (HSE) Guidance for staffed stations comprise:

   i) Toilet & washing facilities (separate where possible for male/female/non-gender specific). These must have warm / cold running water.

   ii) Access to drinking water.

   iii) Facilities to make hot drinks and heat food.

   iv) Facilities to clean cooking / eating utensils.

6.5.8 Contingency arrangements should be put in place to ensure that staff continue to have access to these (or alternative) facilities in the event of an extended power outage – it should be the responsibility of the Station Manager to ensure that provision for this is included in the individual station incident response plan.

6.5.9 If there is widespread disruption to the area because of a power outage beyond just the station itself, it is likely that staff may experience difficulties getting into work, or may need to stay at home due to child care issues if schools are closed. It should therefore be expected that there will be fewer staff than normal with which to operate the station. For further information on absenteeism, please see section 7.3.2 below.

6.5.10 *Contingency options:*

   i) It may be possible to hire in or have a standing contract with a hire company to provide any of the above (e.g. lighting, catering services, etc.) in the event of a very localised disruption. However, it is unlikely that this will be successful or even possible at all in a widespread outage as many other businesses will be thinking along the same lines and hire companies may be hiring out their equipment on a first come first served basis.

   * Torches and other forms of emergency lighting, e.g. lamps, and loud hailers are generally useful and relatively cheap options for managing immediate communications with members of the public and for guiding them around a darkened station.
• One option that may be possible if platform capacity allows, is to berth a suitable train at the station for use as a mobile or stationary office hub. Potentially this could provide a power supply for any mobile electrical items, heating and air conditioning, Wi-Fi, cooking, hot water and toilet facilities. Clearly if the traction current has also been affected this will need to be a diesel-powered train with one engine left running.

• The space on such a train could also be offered to other organisations, for example to use for triage or as a welfare centre.

• It may be possible to move staff from one area/function which is not able to function without power (e.g. ticket sales) to another that supports a reduced power service (e.g. safe management of the platform train interface). However, it should be recognised that staffing a station during a power outage could require more staff than during normal operations.

• The rail industry, through Network Rail, has a relatively standalone communications system which functions independently of BT networks using cables running alongside railway lines. This is quite resilient, however it is being removed as alternative more modern systems replace it.

• The LRF may ask for a station to become a central hub for welfare and information provision. This would be to keep people away from and hence reduce the pressure on key responders such as hospitals, police, fire and ambulance stations, so that they are able to do their core work unhindered. Railway stations tend to be easily accessible and are designed to have waiting space and information display capabilities.

• Similarly, railway undertakings may wish to designate certain hub stations from which to channel their resources. In this case, staff could be asked in the event of communications going down, to report to their nearest station or their nearest hub station in order to be provided with work instructions. In the event of prolonged or pre-announced power outages, railway undertakings could provide briefings to staff to report to pre-defined locations to be issued with their work or given other instructions.

• In the event of a loss of power at multiple stations, an option would be to focus attention and resources (in particular staff and resilience equipment) at key hub stations and close smaller stations.

6.5.11 It is important to note that for any locations where a generator is provided, for it to be an effective back up power supply that can be relied upon, there are a number of factors that need to be borne in mind:

1. The generator needs to be installed appropriately to match the power generation output required to meet the needs of the location during a power cut. This could be a greater or lesser load than under normal circumstances.

2. The generator needs to be maintained regularly to ensure that it has not broken down in the intervening months or years since it was last used or tested.
3. The generator needs to be tested on a regular basis, at full load. It is not sufficient to simply make sure that it can be switched on. The generator should be run for a meaningful period, powering a meaningful amount of the power infrastructure in that location. So, for example, lifts are still required to function, the generator’s ability to provide for this should be tested during a period of maximum power consumption.

4. The generator is reliant on the availability of fuel and appropriate fuel supply plans should be put in place. These should include where spare fuel would come from and the delivery time. Railway undertakings should also seek to be on the priority access scheme within the local part of the national fuel plan and/or maintain sufficient supplies elsewhere. There may be an option to work with other railway undertakings to establish a common fuel stockpile and document how this would be managed and accessed.

5. Railway undertakings should also recognise that enterprising locals may seek to gate crash their contingency power supply once its existence is made known. This happened in a hospital in Lancaster which had 200% capacity from its generators, but university students set up in its waiting rooms with 6-gang extension cables when it became known that it was one of the few locations with power.

6.6 Communications, control networks and systems

6.6.1 If control rooms are within the area of power disruption or outage, this will bring with it a range of issues which could exacerbate any already being experienced on trains or in stations. Control rooms should therefore have business continuity or contingency plans that allow their key functions to be maintained in the event of a loss of building or utilities.

6.6.2 In addition to the generic heating, lighting and communications problems already described, during a power outage, mapping systems used within the industry to monitor the position of trains – such as TRUST and P2, could be affected thus rendering control and other staff blind to trains locations and movements on the network.

6.6.3 There is a great deal of reliance in the railway undertaking community on digital information systems, either to display information in stations or for communications between train, station and control staff.

6.6.4 Communications means with staff in general:

i) Wi-Fi on board trains is based on the local network and therefore is likely to be affected.

- Most train guards/conductors now work with a smart phone. With no Wi-Fi or mobile phone signals locally, this will cause limited issues, as there are other mitigation strategies on board trains such as GSMR and Driver Guard communication systems. Station staff are more vulnerable as they need to be able to provide information in real time to passengers arriving at the station.

- GSMR radios are provided in the cabs of all trains and can be used to dial other GSMR units, internal railway numbers only and in some cases also selected external numbers. Some hand held GSMR radios are also available at key locations within some railway undertakings such as depots and control offices.
There are two types of signal post telephones, type 1 dial the signaller directly only (these are the type provided on the signal post but may also be found at stations) while type 2 can be found on station platforms, these can dial any internal number.

Some railway undertakings have limited landline capacity and those with internet based VOIP phones will be even more vulnerable.

PABX: This is an internal Communications system between signallers, the station and the control room. Where it still exists, it is likely to be very localised.

Power banks are now available for tablets and mobile phones, there are limited back up batteries for laptops also. However, without a longer-term solution for powering the chargers, and if there is no internet or mobile phone signal available, they are of limited value.

### 6.7 Remaining business functions

6.7.1 Aside from the operations of train services, there is also a need for the rest of the business to continue to function. Business continuity planning is part of any organisation, and it is expected that railway undertakings will have business continuity arrangements for offices and office staff as well as for stations (see next section for more on business continuity).

6.7.2 Some parts of the business could be slimmed down but will be otherwise unaffected by a power outage, whereas other parts are likely to see their workload increase because of the incident. For many of those parts of the organisation that are non-essential in the immediate term, there will be a time limit beyond which it will not easily be possible to operate in the absence of that function. Railway undertakings should have an understanding of what the Maximum Tolerable Periods of Disruption (MTPD) are from Business Impact Analyses (BIA) undertaken as part of the Business Continuity Planning that should have taken place. The MTPD will be different for different parts of the business.

6.7.3 Broadly speaking the business activities of a railway undertaking can be broken down into the following functional areas. Points that have already been made elsewhere are not repeated below.

6.7.4 Commercial:

Overall cash flow is important and will be affected by the loss of ticket sales in stations and potentially also online ticket sales as well as difficulties in maintaining revenue protection. Railway undertakings have many costs which are fixed irrespective of whether they are able to operate trains; staff and rolling stock leasing costs are likely to be the biggest two. Commercial teams may also need to manage suppliers who are either unable to deliver their goods in the circumstances or who can deliver them but to a location which is not able to receive them.
6.7.5 **Customer service:**

This is likely to be severely impacted by a loss of power, both in the immediate area and through knock-on effects from one elsewhere on the network, in which case the number of contacts (in particular complaints) made by the public is likely to increase. More customers are likely to contact customer services by phone if their Wi-Fi has gone down and they need train times (especially if a revised service is implemented). This could be the case even for those at a station, as both the CIS and the public announcement (PA) systems are unlikely to be working.

Should the customer service office itself be affected by the power outage at the same time or because of a separate incident, this will mean that response times will go up and increased numbers of complaints can be expected, as queries remain unanswered and frustration mounts.

6.7.6 **Human resources:**

Loss of the payroll system, or access to it, is likely to be the biggest issue for HR. In addition, it should be assumed that all staff records are now electronically held rather than paper based so access to these would be lost. This is probably not too important in the short term, but if it is a prolonged outage, this could become more significant as a back-log builds up.

Another issue would be determining what to do with staff who are unable or unwilling to attend work; are they required to take absence time from their leave allocation, take unpaid leave, be granted additional leave or will some other form of special arrangement apply? Will there be penalties for those not able to attend or symbolic gestures of thanks for those who have gone the extra mile in challenging circumstances? Each railway undertaking should have a policy for such a situation.

6.7.7 **Regulatory issues, compliance and insurance:**

Legal departments are likely to be impacted by any cases made against the organisation for, for example, any slips, trips and falls as a result of dark stations or in respect of passengers stranded on and potentially evacuated from trains.

It is recognised that the effects of a power outage (particularly prolonged and/or widespread outages) may compromise compliance with regulatory requirements such as:

i) Franchise commitments.

- Performance regimes.

- Safety Certificates / authorisations.

- Railway Group Standards.

- Scheduled and periodic competence and medical assessments.

- Security checks required by the DfT Land Transport Security Division.
The assessment of risk and subsequent contingency arrangements must take into account the mandatory requirements of the above, with appropriate representation made to the regulatory body concerned where specific derogation or relaxation may be required on a temporary basis.

Additionally, because of the power outage the organisation may wish to make a claim on insurance. However, risk transfer via insurance has usually required physical damage to either the insured’s assets or the assets of specific service providers to trigger a business interruption claim. Only 20% to 25% of business interruptions, such as supply chain disruptions, are related to a physical loss. Therefore, depending on the type of insurance a railway undertaking holds, it should be aware that it may face very significant uninsured losses. This might trigger an increasing demand for new risk transfer solutions related to power blackout risks in the future.

6.7.8 **Information Technology (IT):**

As a power outage is likely to affect IT systems and access to them, it follows that hard copies of any power outage response plans should be kept in suitably accessible locations – having a power outage plan that cannot be accessed when it is needed due to it being saved on an inaccessible server would hardly be helpful.

6.7.9 **Managing Director and Crisis Team:**

The senior management team is likely to need to be activated to deal with any power outage of significance. Getting it to meet may be a challenge if its members are in disparate locations and unable to communicate with each other or unable to travel to meet in person. Some decision-making may have to fall to those local managers in place at key locations and what decision-making is acceptable at a local level will have to be communicated in advance. Alternatively, decision-making may have to be carried out by a smaller group of the senior management team than would usually be the case. Additionally, as with most other office-based members of staff, senior management could be subject to loss of mobile communications and or their office equipment.

6.7.10 **Media and communications:**

Whilst not business critical in terms of day to day activities, if it is perceived as mismanagement by the railway undertaking that the power outage has occurred or that it has handled the situation poorly, then this could cause reputational damage to the company. There will need to be a significant effort on the part of the media and communications teams to mitigate this, with positive messages around what steps the railway undertaking is taking or took to manage the situation and how it is continuing to look after its passengers.
Part 7 Business continuity planning

7.1 Introduction

7.1.1 A lot of mitigation strategies will be business specific and it is expected that all railway undertakings, as large organisations, will have in place Business Continuity Plans (BCPs) to manage their core business in the event of a power outage.

7.2 Plan structure

7.2.1 It is suggested that railway undertakings have in place:

A) A strategic plan that describes the approach to the key company-wide issues around power outages, in particular those affecting a wider area where multiple facilities could be affected. This should cover issues which are not location specific, such as:

i) Company approach to managing staff absences and absenteeism.
   - Company approach to redeploying staff to key areas.
   - Company approach to managing routes with fewer staff and additional safety roles - key routes and hub stations identified (if these are being used).
   - How communications will be maintained with staff.
   - How communications will be maintained with external agencies.
   - Company approach to managing ticket sales and revenue protection.
   - Company approach to managing suppliers who may not be able to supply.
   - How the plan links in with any other responding agencies, including the LRF.
   - How finite resources will be managed (staff, generators, etc.).

B) Local level plans for each location (station, depot, office, etc. - termed facility for the rest of the section), developed and generated around the key principles outlined in the strategic document. These should include:

i) Identification of the Key electricity infrastructure.

   - Plans and maps of the facility (if a station this should include hazard areas such as stairs, dark areas, underpasses, etc. and an indication of whether to provide additional staff there or whether to close the area).
   - Whether the facility is safe to keep open without staff or the minimum number of staff needed and in which positions to run the facility safely.
   - The circumstances under which the facility must close.
   - Any electricity sensitive machinery and how this must be managed.
• Whether any other agencies have expressed a wish to use the facility as a hub and how this is going to be accommodated.

• Any other facilities dependent on that facility and the maximum period that they can be without it.

• Mitigation measures – generators, redeployment of staff, equipment available, etc.

• Restoration factors – if power can only be restored partially, how this will be managed.

7.2.2 It is recognised that existing BCPs may already cover the key issues (loss of staff, denial of access or loss of building, etc.). However, such plans may tend to reflect a single agency (i.e. one railway undertaking) view of responding to a power outage and may focus on specific locations, such as individual stations or depots, rather than adopting a company wide approach to the issue, with little thought given to how the plan links in with those of other agencies or to an incident affecting multiple sites.

7.3 General considerations for BCPs

7.3.1 Multi-agency planning:

Railway undertakings should consider the multi-agency aspect of any plans, particularly alignment with those of Network Rail. There is little evidence currently that there is a widespread multi-agency approach to power-outages within the railway undertaking community. This could result in a lack of real understanding of how a power outage would or could play out in practical terms if the incident extended beyond the railway undertaking’s own site boundaries. It is important to recognise, however, that many other responding agencies, including the emergency services and local authorities, will be concentrating on maintaining care of the vulnerable and prioritising the safety of those individuals.

A power outage may not only affect a station in isolation. If a wider area is affected then the problem is likely to be disproportionately worse, as the impacts will be greater and the mitigating resources available within all affected organisations more thinly spread.

Railway undertaking BCPs and associated procedures for dealing with a loss of power in the short, medium and long-term should consider the likely local impacts of a power outage in the railway undertaking’s area, beyond the immediate facility concerned.

7.3.2 Absenteeism:

Railway undertakings should assess the impact of absenteeism amongst employees carrying out core activities, which should include the following:

i) Safety critical work.

ii) Essential business or administrative tasks (such as financial, information technology and payroll activities).
iii) Work activities that may have a significant impact on operational performance (such as control, train planning, rostering and maintenance of rolling stock).
Much of this information should have been assessed as part of planning for other disruptive events (such as pandemic flu, extreme weather or industrial disputes). It is not possible to determine likely absenteeism levels during a power outage as this will be dependent on the scale and location of the incident. In general terms absenteeism levels below 20% will not significantly affect business operations and normal working will continue (albeit with minor day to day alterations), though the following should be noted:

i) Lower levels of absenteeism (less than 20%) may pose a proportionately larger staffing problem in some or all business activities, depending on the area.

ii) Absenteeism levels will reflect those caring for sick relatives or dependants. Health services will be under immense strain and a power outage would clearly compromise their ability to provide a business as usual level of care. There may also be those who are obliged to take time off to look after children in the event of school closures, which would be expected in the event of a power outage.

iii) Some may be unwilling / unable to attend work because of travel difficulties.

- Absenteeism levels may not be consistent across the company:
  - Certain roles may be performed by members of staff who travel greater distances to their workplace and therefore are likely to experience greater difficulties travelling to work.
  - Certain grades of staff may include a higher percentage of employees with children of school age.

7.3.3 Staffing:

Railway undertakings should also consider how changes in staffing requirements are managed. The nature and extent of a power outage is going to cause a number of HR issues, notably those around staff absences or changes to working patterns, either because of an inability to attend work or because of a need to provide care to dependents who would otherwise be uncared for. These changes may already be covered under existing HR policies and contracts, but should include how to manage and compensate staff in the event that they need to:

i) Be redeployed to different roles.

ii) Be redeployed to different locations.

iii) Work alternative hours (amended timings or extended hours).

iv) Work from home.

v) Be put up in accommodation nearby if it is not possible for them to return home.
7.3.4 Identifying third party risk:

Railway undertakings should also consider the effect of a power outage on the capability of approved suppliers to ensure continuity of supply of critical goods and services, and the risk associated with shortages, or over-supply if goods are not being used and therefore have to be stored.

7.3.5 Financial impact:

Railway undertakings should consider the effect of a power outage on financial aspects of the business, including cash flow, payment of staff, impact of lower takings and higher costs in the long run.

A power outage of significance is likely to have a major impact on the demand for travel as a whole, and use of public transport in particular. A significant fall off in passenger numbers would hence be inevitable during the period of disruption to power supplies.

Depending on the cause of the incident and associated secondary impacts (e.g. fuel shortages or severe weather hampering the response), government and or specific railway undertakings may advise passengers against unnecessary travel. Footfall and passenger numbers are likely to increase as soon as the services are up and running again and the power restored.

7.3.6 Coordination:

Railway undertakings should consider how communication and coordination will take place in an environment where potentially there is a finite number of response or resilience resources and equipment but competing priorities. This should include how they will work with others and through which mechanism decisions about resource allocation are both made and communicated. This should include Network Rail, other railway undertakings and other responding agencies.

7.3.7 Communication:

Unusual or emergency situations can only be managed effectively if there is an efficient and robust communications process. This will undoubtedly be a major challenge in the event of a power outage where many modern methods of communication are unlikely to be working effectively. Existing communication plans should be updated or new ones put in place to identify key contacts - with alternatives in case they are absent - and set up chains of communication so that information can be disseminated quickly to everyone.

Communication mechanisms need to be reviewed and consideration should be given in any existing communications plans to providing a default physical location for employees to respond to. That way, even if phone and internet communications go down, employees can still attend a physical location for an update. In addition, anyone coordinating those messages centrally can concentrate on ensuring communications routes are maintained to a small but more resilient number of locations.

7.4 Mitigating control measures

7.4.1 As with section 7.3.2 on absenteeism, many of the mitigation measures that could be put in place would be relevant in a pandemic flu situation, as this is really a 'loss of staff' situation, combined with a loss of utility.
Possible mitigation measures will typically comprise a combination of staged train service contingency plans, redeployment of staff to key existing or additional activities (such as passenger safety on stairs or in dark areas) and locations and derogations from certain requirements (particularly those based on a periodicity).

Contingency train service plans:

Railway undertakings should work with Network Rail and with each other to identify the level of train service that can be delivered in relation to:

i) Potential levels of absenteeism.

ii) Increased workload in parts of the operation (such as passenger safety).

• Decreased workload in other work areas (e.g. ticket sales and revenue protection).

• Likely reduction in passenger demand.

• Difficulties in communicating any amended timetables to both passengers and staff.

Station management

Railway undertakings should consider the following contingency arrangements to ensure continued staffing of key stations, taking into account the special requirements for subsurface stations. There should be a specific focus on those stations which have been identified as key hubs:

i) Operation of stations, which are normally staffed as unstaffed stations.

• Prioritising of stations that require staff presence and at which times.

• Utilising available staff from other grades with the appropriate competencies to provide a staff presence at key stations to undertake core activities (including train dispatch and shunting) during peak times.

• Whether operations can be pared back to serve only core / hub stations.

Rolling stock maintenance and fleet management:

Railway undertakings should consider the following contingency arrangements in respect of rolling stock maintenance activities:

i) Modification of fleet maintenance / servicing schedules.

• Operating train services “short formed” to minimise accumulated miles and release stock for day time maintenance.

• Derogation / extension in duration between time-based examinations being agreed in principle between railway undertakings and Rolling Stock Leasing Companies (ROSCOs).

• Availability and authority of professionally competent persons to make risk assessed decisions on the above.
7.4.6 Signalling and electric traction control:

Railway undertakings should request from Network Rail details of how it has assessed the impact of absenteeism amongst signalers and electrical control room operators in addition to the impact that a lack of power may have on safety checks for sections of the line. Mitigation measures could include prioritisation of resources to key routes and restricted hours of operation. Such measures should be co-ordinated with relevant railway undertakings to support mutual agreement on the level of service to be operated.

7.4.7 Business administration:

Railway undertakings should also consider contingency arrangements to ensure the continuity of essential business or administrative activities, which may include the following:

i) Maintenance of pay bills/salaries.

ii) Sickness/absence management processes where workload will be increased or where attendance management procedures may require to be suspended.

- Staff requiring to take time off to care for dependants.
- Increased demands upon staff who are at work during a power outage.
- Increased demands upon the care and support system.
- Critical IT support.

7.5 Maintenance of BCPs and exercising

7.5.1 Railway undertakings should consider how any plans and / or procedures developed to manage a power outage are appropriate and remain current. Including a power outage scenario in future exercise scenarios is advised. Peer reviewing by other rail industry partners and local responders is also recommended to ensure that learning is shared and that the plans and procedures reflect best practice, as well as the actual rather than assumed response practices of other agencies with whom the plan will have to integrate.
Part 8 Experiences and case studies

8.1 Introduction

8.1.1 The following examples provide real cases of loss of power affecting the rail industry and some of the impacts on services. Unfortunately, there are not many significant incidents of widespread power outage and so many of the examples provided only paint a picture of the isolated loss of power to a station or to traction power.

8.2 Power cuts directly affecting trains

8.2.1 Aberdeen, May 2016

Aberdeen railway station was left without power in May 2016 after a rat chewed through a cable, causing a power cut. Electricity engineers found the dead rat beside a gnawed cable shortly after the power went out at 09.30 and power was not restored until later in the afternoon with the help of an outsourced generator.

It was just the railway station that was affected, not any of the surrounding buildings. Although train services were not affected by the incident, lighting and electronic timetables were down. Station workers put up posters displaying timetable information around the premises and staff were on hand to assist passengers.

8.2.2 Birmingham, April 2016

In the early hours of 11 April, the power supply to signals in the Proof House Junction area, close to Birmingham New Street station, failed, this eventually being identified as due to malicious damage to a cable. Around an hour later it was reported that the backup diesel generator had not cut in owing to a failure of the alternator. Attempts were made to source a second generator but this not immediately available. Power was eventually restored by means of diverting other supplies and normal working resumed at 09.59. Overall the incident resulted in 131 cancellations, 137 part cancellations and total delays of 6026 minutes.

It was reported on the BBC and Birmingham Mail thus:

A major signalling power failure caused hours of delays to trains through Birmingham New Street in April this year when there was damage caused to cables. Network Rail asked people to avoid the station after signal problems at Proof House Junction. Trains struggled to get in and out of the south end of the station, with problems affecting Arriva Trains Wales, CrossCountry Trains, London Midland and Virgin Trains. CrossCountry said the problem caused up to an hour-long delay between Manchester Piccadilly and Bournemouth. Virgin Trains West Coast reported waits of up to 30 minutes between Wolverhampton and London Euston. Passengers went on social media to vent their frustration at the service, which had also suffered delays only two days before.

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10 https://www.pressandjournal.co.uk/fp/news/aberdeen/932619/passengers-left-dark/
London Midland said it was expecting services to be affected until about 16:00 BST that day. The incident was expected to cost the rail industry hundreds of thousands of pounds. Network Rail said it believed the cause of the problems was vandalism. This outage was relatively contained as it only affected the signalling power and therefore the problems on the line were limited to being a rail issue, rather than a power outage affecting the wider area.

8.2.3 Lancaster, Dec 2015 – widespread loss of power and severe weather

In December 2015 Lancaster was affected by a significant power outage. This coincided with and was caused by a period of severe weather which caused river levels to rise resulting in a main substation being flooded, thus causing the power cut. The wider area in and around the city was affected not only by the power cuts, but also by the storm damage, flooding and severe winds. The power was out for 5 days. During this time, Lancaster station lost all power.

The main impacts on Lancaster station were:

i) Although there was no power to the station itself, trains were still able to pass through the area. Because the weather had brought down overhead power lines, diesel trains were being run North of Preston.

- Generators were in short supply in the local area as the power cut affected much of the city of Lancaster. Therefore, Virgin Trains had to react quickly to get a generator from a local company.

- Customer Information Systems (CIS) were down – staff had to wait for trains to come into the station before they could identify where they were going and advise passengers accordingly.

- The fire alarms went down. This caused the system to make a loud audible beep and resulted in staff having the additional burden of having to carry out regular manual checks to ensure the station remained fire free.

- The intruder alarm system went down. This also made bleeps.

- As there was no light, many of the passenger waiting room areas had to be shut, even during the day as the small windows meant that there was insufficient lighting for them to be a safe area in which to wait.

- The footbridges and stairs required additional staff to ensure that passengers could move through those areas safely. Additional lighting was able to be provided for some of the areas.

- There were no mess or catering facilities for staff; outside caterers had to be brought in to feed staff working at the station.

- There is only one small retail outlet in the station. Its operator took its own decision to close for the duration, based on the decreased footfall in the station as well as the difficulties in proceeding without power.

- Many of the station staff working would normally have used their mobiles to communicate. At points these went down because of a lack of power to the local mobile mast. However, even where the network was working, it was still a challenge to keep phones and tablets charged without functioning power sockets.
- Landlines were still running (as they were powered by the exchange and this was still operating) and so contact with control was maintained.

- Passenger numbers using the station were down significantly. Customers were advised not to travel where possible, not only because of the power cut, but also because of the weather.

- Power to the booking office was lost and staff relocated to other functions. Some were safety critical trained and therefore could be repositioned to get passengers on and off trains.

- Another challenge was that buses were being run between Penrith, Oxenholme and Carlisle because of the damage to the infrastructure as a result of the storm. Running buses requires a greater number of staff per passenger than running a normal train service.

- A greater number of staff were needed because of the loss of electricity. This was because many of them were performing safety functions that would otherwise not have been necessary with light or would normally have been performed by automated systems. Additional members of staff were needed to provide information, whilst at the same time having very little information to give out.

8.2.4 Clapham Junction, 30 April 2015

A displaced conductor rail shortly before 08.00 resulted in the closure of three of the four tracks serving Victoria and 5 trains becoming stranded. More than 1000 passengers were evacuated to trackside. Normal working was not resumed until some eight and a half hours later and overall the incident resulted in 587 cancellations, 253 part cancellations and total delays of 14,522 minutes.

This incident attracted the attention of the London Evening Standard, Guardian and Daily Mail, the latter reporting it under the headline “Rail hell: Power failure traps thousands for five hours, fights break out as temperatures soar and passengers are helped onto the track on ladders” and including numerous pictures and Tweets from passengers involved.

Sky reported:\ref{0}:

\textit{Passengers had to be evacuated from trains at Clapham Junction after a major power supply problem left them stranded for hours and caused Victoria station to grind to a halt. Trains were unable to get through Clapham Junction, the busiest interchange station in the UK.}

\textit{Passengers left the trains via ladders after being stuck for hours. British Transport Police said it had evacuated 904 passengers from one train, while commuters on another service had to wait to be towed. Police and ambulance service staff boarded the trains due to the hot weather and lack of air conditioning. They brought water but initially not enough for everyone to have one bottle each.}

\ref{0} http://news.sky.com/story/passengers-trapped-on-trains-after-power-failure-10361393
8.2.5 Leeds station, Apr 2013 – loss of power

Leeds station was without power for a prolonged period in April 2013. A Class 185 diesel unit was eventually brought in as a mobile office (as it has its own generator) and to provide power for meeting rooms, kettle, power sockets etc.

Trains were unaffected by the outage but arrival and departure boards, lighting and loudspeakers were down, as were lifts, escalators and ticket machines. Passengers took to Twitter to comment on the “pitch black” conditions, which meant that station staff had to guide passengers around using torches. Shops and food outlets lost trade after most were forced to shut because of the outage.

One passenger described the situation: “Leeds train station without power is like a zombie apocalypse.”

8.2.6 London, Aug 2003

In August 2003 a severe loss of power supply, resulting from poor infrastructure maintenance of the grid affected parts of south-east London, with up to 500,000 people affected. Despite the power only being off fully for around 34 minutes, around 1800 main rail services were brought to a standstill in south London and the south-east. Mainline and underground stations were shut and evacuated as they were plunged into darkness at around 18.20. Sixty percent of the London Underground was affected (London Underground had shut down the last of their independent generators in favour of using Grid supplies in 2002) and people were stuck underground. 270 sets of traffic lights were hit. To relieve the transport problems, buses accepted train and Tube tickets, but were subject to significant queues. Thousands of people took to the rain-soaked streets. Pubs filled up with people sitting out the delays.

APPENDIX A - Further information from Network Rail

Electrical Power Asset Policy Appendix 2A AC and DC electrification system design to N-1

N-1 Definition: N-1 is defined as the occurrence of one key piece of electrification system infrastructure being taken out of service. This outage could be due to routine maintenance, emergency maintenance or equipment failure. Key pieces of infrastructure are defined below as:

- Grid Supply Point circuits AC and DC systems:
  - Autotransformers AC system Autotransformer feeders AC system Transformer Rectifiers DC system HV AC Cables DC system
  - Low Voltage Switchgear DC system

N-1 Policy: N-1 relates to the ability of the electrification network to continue to enable the operation of a full timetable with one key piece of electrification infrastructure out of service. This outage could be due to routine maintenance, emergency maintenance or equipment failure. Key pieces of infrastructure are defined as:

- Grid Supply Point circuits AC and DC systems:
  - Autotransformers AC system Autotransformer feeders AC system Transformer Rectifiers DC system HV AC Cables DC system
  - Low Voltage Switchgear DC system
  - Grid Supply Point circuits

At each Grid Supply Point, in the event of one Grid Supply Point circuit being taken out of service, another of similar rating must be present to continue to be able to provide adequate supply to the electrification network or available to feed from an adjacent site.

Autotransformers – AC network: At each Autotransformer substation, in the event of one Autotransformer being taken out of service, another of similar rating must be present to continue to be able to provide adequate voltage regulation. This generally equates to two Autotransformers required at paralleling substations and three at mid-point sectioning substations, with the third being able to cover an outage of the Autotransformer on either side of the neutral section. Site-specific loading studies are required to determine whether additional Autotransformers would be required under normal operation.

Autotransformer Feeder - AC network: Two sets of Autotransformer Feeders are required with each set having the ability to carry the full load current in the event of one set being taken out of service. The number of conductors that make up a set is dependent on the level of load for that specific section. Typically, each set will consist of one or two conductors. It is standard practice to locate one set on either side of the track to aid in the reduction of induced voltage in line side cables.
Transformer Rectifiers - DC network: At each line side substation, in the event of a transformer rectifier being taken out of service, another of similar rating must be present or surplus capacity available from an adjacent site, to continue to be able to provide for the supply of load along with adequate voltage regulation. Site-specific loading studies are required to determine the appropriate number of Transformer Rectifiers required.

HV AC Cables - DC network: When the HV AC cable that connects two DC system line side substations is taken out of service, the HV AC cable network must be able to be reconfigured so that extended/alternate feeding allows for the affected DC system line side substations to continue to be fed and remain in service.

LV Switchgear / Circuit Breaker DC network: At each DC system line side substation, in the event of a circuit breaker being taken out of service, the affected section of track must be able to continue to be kept in service with adequate voltage regulation. This requires the Track Feeder Circuit Breaker at the neighbouring DC Substation/Track Paralleling Hut (TPH) that also feeds the affected section to be able to support the entire load on the electrical section.
## APPENDIX B - Glossary and Terms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>BCP</td>
<td>Business Continuity Plan</td>
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<tr>
<td>BIA</td>
<td>Business Impact Analyses</td>
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<tr>
<td>CNI</td>
<td>Critical National Infrastructure</td>
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<tr>
<td>BEIS</td>
<td>Department for Business, Energy and Industrial Strategy</td>
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<tr>
<td>DECC</td>
<td>Department of Energy and Climate Change</td>
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<td>GSM</td>
<td>Global System for Mobile Communications</td>
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<tr>
<td>GSMR</td>
<td>Radios on the GSM system.</td>
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<td>HSE</td>
<td>Health and Safety Executive</td>
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<td>HITS</td>
<td>High Integrity Telecoms Systems</td>
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<tr>
<td>HST</td>
<td>High-Speed Train</td>
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<tr>
<td>IEP</td>
<td>InterCity Express Programme</td>
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<tr>
<td>IT</td>
<td>Information Technology</td>
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<tr>
<td>LRF</td>
<td>Local Resilience Forum</td>
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<tr>
<td>MTPD</td>
<td>Maximum Tolerable Periods of Disruption</td>
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<tr>
<td>NFP</td>
<td>National Fuel Plan</td>
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<tr>
<td>PA</td>
<td>Public Announcement</td>
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<tr>
<td>PABX</td>
<td>Private Automatic Branch Exchange</td>
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<tr>
<td>PSTN</td>
<td>Public Switched Telephone Network</td>
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<tr>
<td>ROSCOs</td>
<td>Rolling Stock Leasing Companies</td>
</tr>
<tr>
<td>SCG</td>
<td>Strategic Command Group</td>
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<tr>
<td>TRUST and P2</td>
<td>Rail industry mapping systems used to monitor where any trains are at any one time.</td>
</tr>
<tr>
<td>UPSs</td>
<td>Uninterruptible Power Supplies</td>
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<tr>
<td>VOIP</td>
<td>Voice over internet protocol</td>
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</table>

An automatic telephone switching system within a private enterprise. For railway undertakings, it is an internal comms system between the signallers, the station and the control room.

A VoIP phone or IP phone uses Voice over IP technologies for placing and transmitting telephone calls over an IP network, such as the Internet, instead of the traditional PSTN.